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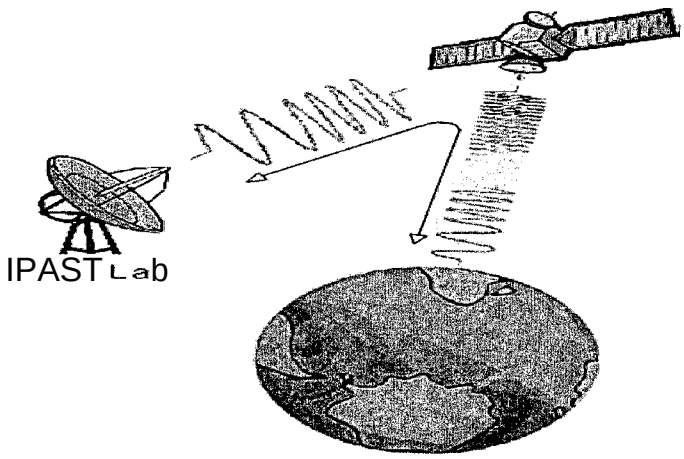
(54) Title: COMMUNICATION BETWEEN RADIO TERMINALS ON AN EXTRATERRESTRIAL BODY USING A SPACE BASED COMPONENT AND AN ANCILLARY COMPONENT LOCATED ON THE EXTRATERRESTRIAL BODY.



(57) Abstract: The underlying invention is "Solar Sonic" deep-space multidimensional coded universal communications "via ionosphere" armed signals and quantum algorithm resonance of hydroxyl molecules cosmic- radio- waves. The said invention is a solar sonic universe multidimensional radio astronomical control tower resonator for systemic multi-communications and manipulation of all resonating matters and antimatters alike. The solar sonic multidimensional interstellar radio signal communications resonator is a novel technology precisely pertaining to deep space multidimensional radio signal communications, which is an art reflected within the formal technology stated title. The present invention provides a system for communications on an extraterrestrial body, may include a space-based component and an ancillary extraterrestrial component on the extraterrestrial body. The space-baaed component may be configured to provide wireless communications with plurality of radio-terminals located on the extraterrestrial body over a satellite frequency band wherein the space-based component includes at least one satellite orbiting the extraterrestrial body. The ancillary extraterrestrial component may be configured to provide wireless communications with the plurality of radio-terminal located on the extraterrestrial body. Moreover,

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LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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the ancillary extraterrestrial component may reuse at least one satellite frequency of the satellite frequency band and the space-based component and the ancillary extraterrestrial component may be configured to relay communications there between. An exciter system is provided for use in facilitating electromagnetic communication within an enclosed space. The system includes an exciter which may be in the form of a three dimensional hemispherical exciter or a two dimensional planar sector exciter depending on the size of the associated structure and the power requirements of operation. The exciter system operates in conjunction with a hub/controller network. The exciter system is adapted to induce a quasi-static evanescent field within the space and to thereby enable commumcations using the evanescent field at frequencies within an operational frequency range determined by the characteristics of the space. The exciter is mounted in opposition to a portion of a conductive framework within the enclosed space. In operation an coaxial connector connects the exciter to die hub/controller network with the central conductor connecting at a feed point to the exciter while the shield conductor is connected to the opposing conductive framework. In some embodiments a post acts as a curtain to enhance performance at tower frequencies. Improved communications systems and methods, however, may be desired to accommodate increasing commumcations to and from extraterrestrial bodies such as the moor and/or mars as more missions are sent to extraterrestrial bodies. More particularly, communications systems and methods may be desired to accommodate increased commumcations between radio- terminals on the extraterrestrial body and a satellite orbiting a celestial body and/ or transceivers on earth. The present invention relates generally to wireless communications and more particularly to systems for internal commumcations within structures, at frequencies in the range of 0.5 to 100 MHz.

COMMUNICATION BETWEEN RADIO TERMINALS ON AN EXTRATERRESTRIAL BODY USING A SPACE BASED COMPONENT AND AN ANCILLARY COMPONENT LOCATED ON THE EXTRATERRESTRIAL BODY.

A World Class Multidimensional Hi-Tech Patent of Alien Communications and Manipulations Technology

Comprehensively Detailed Evidence of Factually Existing Extraterrestrial Communications has been made available on page 103 with two way recording:

Name of the Technology: Solar Sonic Quantum Frequency Infusion Technology (SSQFIT).
Supporting Science(s): All Human and Extraterrestrial advanced Sciences & Technologies.
Description of the Invention Name, illustrating legendary work of Precision Targeting:

We present a World-Class Multidimensional Hi-Tech Patent of Alien Communications and Manipulations Technology; it is by all means a Legendary Work of Precision Targeting beyond the description of words. Research Scientist Dr. Mohammed Metwally Hassan and Prof. Dr. Eltayeb Salih and the Co-inventors mentioned below have quite literally communicated with Extraterrestrial Intelligence and has dominated the Electromagnetic Spectrum "Six Different Times" with Telepathically Resonating Capsulated Energy Streaming (TRCES) which is the Language of Deep Space Universe. It is a form of Consensually Agreeable Alphabet of the Inter-Universal, Inter-Cosmic, Inter-Galactic and Inter Stellar "Radio Signal Waves". The underlying Radio Signals are energetically "Armed" with Universally Agreeable Language and Multidimensional Energetic Streaming Patterns for much deeper reach.

Radio signals are energetically armed for deep space destination(s) in order to Communicate, Vibrate, Stimulate, Connect, Dominate, Override, Spread, Publicize, Impede, Emit, Intercept, Transfer, Mediate, Convey, Control, Transform, Propagate, Transmit, Converse, Release, Warn, Demand, Negotiate, Stipulate, Implement, Condition, Contract, Facilitate, Articulate, Report, Adjudicate, Prevent, Admit, Announce, Propose, Send, Receive, Offer, Grant, Solve, Save, Interact, Request, Join, Unite & Interpret all Intergalactic and Interstellar Telepathically Resonating Capsulated Energy Streaming, universally known as (TRES).

The underlying invention is "Solar Sonic Deep-Space Multidimensional Coded Universal Communications" through Ionosphere Armed Signals and Quantum Algorithm Resonance of Hydroxyl Molecules Cosmic-Radio-Waves. The invention is a Solar Sonic Universe Multidimensional Radio Astronomical Control Tower Resonator for Systematic Communications & Manipulations of resonating Matter/Antimatter in the universe. The Solar Sonic Multidimensional Interstellar and Intergalactic Radio Signal Communications Resonator is a Novel Technology pertaining to the open Deep Space Multidimensional Radio Signal Communications and Ionosphere swift Armed Signals with Quantum Algorithm Resonance Signatures of Hydroxyl Molecules Cosmic-Radio- Waves which are Multiple Sciences and disciplines reflected within.

Applicable Methodologies of Solar Sonic Extraterrestrial Communication and Manipulation Technologies:

(1) Re-arranged and Retrofitted Radio Astronomy Capabilities, empowered with Sunbeam Vacuum Reactor.

(2) Solar Sonic Sunbeam Vacuum Reactor for Direct Solar Connectivity with Entire Solar System Energies.

(3) Solar Sonic Sunbeam Vacuum Reactor is covering Alien contacts on Earth / under via Earth Energetics.

We explain the basis for our Hi Tech Assertions in a systematic manner whereas we will provide further clarification of the underlying content and logistical data coupled with further illustrations as follow:

The Principal Abstract of the Invention

The undersigned jointly present "as mentioned above" a World-Class Hi-Tech Patent of Alien Communications and Manipulations Technology; it is by all means a Legendary Work of Precision Targeting beyond the description of words. Research Scientist Mohammed Metwally Hassan and Prof. Dr. Eltayeb Salih and the Co-inventors mentioned below have quite literally communicated with Extraterrestrial Intelligence(s) and has dominated the Electromagnetic Spectrum "Six Different Times" with Telepathically Resonating Capsulated Energy Streaming (TRCES) which is the Universal Alien Language of the Entire Universe. It is a form of Consensually Agreeable Alphabet of the Universe, both Interstellar and intergalactic Radio Signal Waves which is "armed" with galactically agreeable language and energetic streaming patterns. Radio signals are energetically armed for deep space destination(s) in order to Communicate, Vibrate, Stimulate, Connect, Dominate, Override, Spread, Publicize, Impede, Emit, Intercept, Transfer, Mediate, Convey, Control, Transform, Propagate, Transmit, Converse, Release, Warn, Demand, Negotiate, Stipulate, Implement, Condition, Contract, Facilitate, Articulate, Report, Adjudicate, Prevent, Admit, Announce, Propose, Send, Receive, Offer, Grant, Solve, Save, Interact, Request, Join, Unite & Interpret all Intergalactic and Interstellar Telepathically Resonating Capsulated Energy Streaming, universally known as (TRES).

The underlying innvention is "Solar Sonic Deep-Space Multidimensional Coded Universal Communications" via Ionosphere Armed Signals and Quantum Algorithm Resonance of Hydroxyl Molecules Cosmic-Radio-Waves. The said invention is a Solar Sonic Universe Multidimensional Radio Astronomical Control Tower Resonator for Systematic Multi-Communications and Manipulations of all resonating Matters and Antimatters alike". The Solar Sonic Multidimensional Interstellar Radio Signal Communications Resonator is a novel technology precisely pertaining to Deep Space Multidimensional Radio Signal Communications, which is an art reflected within the formal technology stated title. We explain the basis for our Hi Tech Assertions in a systematic manner whereas we will illustrate further clarification of the underlying contents.

The Present invention provides a system for communications on an extraterrestrial body may include a space-based component and an ancillary extraterrestrial component on the extraterrestrial body. The space-based component may be configured to provide wireless communications with a plurality of radio-terminals located on the extraterrestrial body over a satellite frequency band wherein the space-based component includes at least one satellite orbiting the extraterrestrial body. The ancillary extraterrestrial component may be configured to provide wireless communications with the plurality of radio-terminals located on the extraterrestrial body. Moreover, the ancillary extraterrestrial component may reuse at least one satellite frequency of satellite frequency band, and space-based component and ancillary extraterrestrial component may be configured to relay communications there between. Related methods are also discussed.

An exciter system is provided for use in facilitating electromagnetic communication within an enclosed space. The system includes an excite which may be in the form of a three dimensional hemispherical exciter or a two dimensional planar sector exciter depending on the size of the associated structure and the power requirements of operation.

The exciter system operates in conjunction with a hub/controller network. The exciter system is adapted to induce a quasi-static evanescent field within the space and to thereby enable communications using the evanescent field at frequencies within an operational frequency range determined by the characteristics of the space. The exciter is mounted in opposition to a portion of a conductive framework within the enclosed space, and is separated there from.

In operation, a coaxial connector connects the exciter to the hub/controller network with the center conductor connecting at a feed point to the exciter while the shield conductor is connected to the opposing conductive framework . In some embodiments a post acts as a curtain to enhance performance at lower frequencies.

The Principal Claims of the Invention

The undersigned jointly present a World-Class Hi-Tech Patent of Alien Communications and Manipulations Technology, it is by all means a Legendary Work of Precision Targeting beyond the description of words. Research Scientist Dr. Mohammed M. Ammar has quite literally communicated with Extraterrestrial Intelligence(s) and has dominated the Electromagnetic Spectrum "Six Different Times" with Telepathically Resonating Capsulated Energy Streaming (TRCES) which is the Universal Alien Language of Entire Universe (consensually).

It is a form of Consensually Agreeable Alphabet of the Universe, both Interstellar and intergalactic Radio Signal Waves which is "armed" with galactically agreeable language and energetic streaming patterns, the radio signals are energetically armed, in order to [Communicate, Vibrate, Stimulate, Connect, Dominate, Override, Spread, Publicize, Impede, Emit, Intercept, Transfer, Mediate, Convey, Control, Transform, Propagate, Transmit, Converse, Release, Warn, Demand, Negotiate, Stipulate, Implement, Condition, Contract, Facilitate, Articulate, Report, Adjudicate, Prevent, Admit, Announce, Propose, Send, Receive, Offer, Grant, Solve, Save, Interact, Request, Join, Unite and Interpret] all Intergalactic and Interstellar Telepathically Resonating Capsulated Energy Streaming, universally known as (TRES). The underlying innvention is "Solar Sonic Deep-Space Multidimensional Coded Universal Communications" via Ionosphere Armed Signals and Quantum Algorithm Resonance of Hydroxyl Molecule Cosmic-Radio-WavesJWorld's Sole Extraterrestrial Point of Contact].

The said invention is a Solar Sonic Universe Multidimensional Radio Astronomical Control Tower Resonator for Systematic Multi-Communications and Manipulations of all resonating Matters and Antimatters alike". The Solar Sonic Multidimensional Interstellar Radio Signal Communications Resonator is a novel technology precisely pertaining to Deep Space Multidimensional Radio Signal Communications, which is an art reflected within the formal technology stated title. We explain the basis for our Hi Tech Assertions in a systematic manner whereas we will provide further clarifications of the underlying contents and logistical data in a systematic manner as follows:

A system for communications on an extraterrestrial body may include a space-based component and an ancillary extraterrestrial component on the extraterrestrial body. The space-based component may be configured to provide wireless communications with a plurality of radio-terminals located on the extraterrestrial body over a satellite frequency band wherein the space-based component includes at least one satellite orbiting the extraterrestrial body. The ancillary extraterrestrial component may be configured to provide wireless communications with the plurality of radio-terminals located on the extraterrestrial body. Moreover, the ancillary extraterrestrial component may reuse at least one satellite frequency of the satellite frequency band, and the space-based component and the ancillary extraterrestrial component may be configured to relay communications there between. Related methods are also discussed.

Communications System Composing: A first space-based component that is configured to provide wireless communications to a plurality of radio terminals located on an extra terrestrial body using frequencies of a first satellite frequency band wherein the first space-based component includes at least one satellite orbiting the extraterrestrial body; and a first ancillary extraterrestrial component on the extraterrestrial body that is configured to establish first wireless links directly between itself and the first space-based component and directly between itself and a first radio-terminal and to use the first wireless links to provide wireless communications between the first radio-terminal and a second radio-terminal; wherein the second radio-terminal communicates with the first radio-terminal via a second ancillary extraterrestrial component on the extraterrestrial body that is configured to establish second wireless links directly between itself and the first space-based component and directly between itself and the second radio terminal.

Wherein the first ancillary extraterrestrial component is further configured to detect transmissions of the second ancillary extraterrestrial component, to establish a link there between responsive to having detected the transmissions and to use the link that is established to coordinate frequency reuse, transmission power and/or hand-off of radio-terminals with the second ancillary extraterrestrial component. A system according to claims wherein the first space-based component is configured to relay communications between first and second radio-terminals on the extraterrestrial body without using any ancillary extraterrestrial components. A system according to claims wherein at least one ancillary Extraterrestrial component is configured to relay communications between first and second radio-terminals on the extraterrestrial body by using at least

one frequency of the first satellite frequency band. A system according to claims wherein an ancillary extraterrestrial component and the first space-based component are configured to relay communications between first and second radio-terminals on the extraterrestrial body such that communications between the first and second radio-terminals are relayed through both the ancillary extraterrestrial component and the first space-based component.

A system according to claims wherein a radio-terminal is configured to provide full duplex voice communications. A system according to claims wherein a radio-terminal is configured to provide digital data communications. A system according to logistical claims further comprising a plurality of ancillary extraterrestrial components on extraterrestrial body with each ancillary extraterrestrial component defining a respective wireless communications coverage area on the extraterrestrial body. A system according to claims wherein the plurality of ancillary extraterrestrial components use a plurality of frequencies of the first satellite frequency band wherein the plurality of frequencies are shared among the plurality of ancillary extraterrestrial components according to a frequency reuse pattern to reduce interference between adjacent ancillary extraterrestrial components. A system according to claims further comprising;

A second space-based component that is configured to provide wireless communications to a plurality of radio-terminals located on earth over a second satellite frequency band wherein the second space-based component includes at least one satellite orbiting the earth, wherein the first space-based component, the second space-based component, and the ancillary extraterrestrial component are configured to relay communications there between via direct wireless links there between. A system according to claims further comprising: An ancillary terrestrial component on earth that is configured to provide wireless communications to a plurality of radio-terminals located on earth, wherein the ancillary terrestrial component uses at least one frequency of the first and/or second satellite frequency band, and wherein the second space-based component and the ancillary terrestrial component are configured to relay communications there between via direct wireless links there between.

A system according to claims wherein the first satellite frequency band and the second satellite frequency band comprise substantially the same satellite frequency band. A system according to claims wherein the ancillary extraterrestrial component on the extraterrestrial body and the ancillary terrestrial component on earth are configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body. A system according to claims wherein the first space-based component and the ancillary terrestrial component are configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body.

A system according to claims wherein the first space-based component and the second space-based component are configured to relay communications between a radio-terminal on earth and a radio-terminal the extraterrestrial body. A system according to claims wherein the ancillary extraterrestrial component and the second space-based component are configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body. An extraterrestrial communications system comprising: A first space-based component that is configured to provide wireless communications to a first plurality of radio-terminals located on an extraterrestrial body wherein the first space-based component includes at least one satellite orbiting the extraterrestrial body.

An ancillary extraterrestrial component on the extraterrestrial body that is configured to provide wireless communications to the first plurality of radio-terminals located on the extraterrestrial body, wherein the first space-based component and the ancillary extraterrestrial component are configured to relay communications there between and wherein the ancillary extraterrestrial component is configured to detect transmissions of at least one other ancillary extraterrestrial component, to establish a link there between responsive to having detected the transmissions and to use the link that is established to coordinate frequency reuse, transmission power and/or hand-off of radio-terminals with the at least one other ancillary extraterrestrial component; A second space-based component that is configured to provide wireless communications to a second plurality of radio terminals located on earth wherein the second space-based component includes at least one satellite orbiting earth; and an ancillary terrestrial component on earth that is configured to provide wireless communications to the second plurality of radio terminals located on earth,

wherein the second space-based component and the ancillary terrestrial component are configured to relay communications there between; wherein the first space-based component, the ancillary extraterrestrial component, the second space-based component, and the ancillary terrestrial component are configured to relay communications between a radio-terminal on the extraterrestrial body and a radio-terminal on earth such that communications between the radio-terminal on the extraterrestrial body and the radio-terminal on earth are relayed at least two of the first space-based component, the Ancillary extraterrestrial component, the second space-based component and the ancillary terrestrial component.

An extraterrestrial communications system according to claims wherein the first space-based component is configured to provide wireless communications over a first satellite frequency band and wherein the ancillary extraterrestrial component is configured to use at least one frequency of the first satellite frequency band. An extraterrestrial communications system according to claims wherein the second space-based component is configured to provide wireless communications over a second satellite frequency band and wherein the ancillary terrestrial component is configured to use at least one frequency of the second satellite frequency band.

An extraterrestrial communications system, wherein the first and second satellite frequency bands comprise substantially the same satellite frequency band. 20. An extraterrestrial communications system according to claims wherein the first space-based component is configured to relay communications between first and second radio-terminals on the extraterrestrial body. An extraterrestrial communications system according to claims wherein the ancillary extraterrestrial component is configured to relay communications between first and second radio-terminals on the extraterrestrial body. An extraterrestrial communications system according to claims wherein the first space-based component and the ancillary extraterrestrial component are configured to relay communications between first and second radio-terminals on the extraterrestrial body such that communications between the first and second radio-terminals are relayed through both the ancillary extraterrestrial component and the first space-based component.

An extraterrestrial communications system according to claims wherein the radio-terminals located on earth and on the extraterrestrial body comprise mobile radio-terminals configured to provide full duplex voice communications. An extraterrestrial communications system according to claims wherein the radio-terminals located on earth and on the extraterrestrial body are configured to provide digital data communications. An extraterrestrial communications system according to claims wherein the ancillary extraterrestrial component is one of a plurality of ancillary extraterrestrial components on the extraterrestrial body with each ancillary extraterrestrial component defining a respective wireless communications coverage area on the extraterrestrial body.

An extraterrestrial communications system according to claims wherein the first space-based component is configured to provide wireless communications over a first satellite frequency band, wherein the ancillary extraterrestrial component is configured to use a plurality of frequencies of the first satellite frequency band, and wherein the plurality of frequencies are shared among the plurality of ancillary extraterrestrial components according to a reuse pattern to reduce interference between adjacent extraterrestrial components. An extraterrestrial communications system according to claims wherein the ancillary extraterrestrial component on the extra terrestrial body and the ancillary terrestrial component on earth are configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body such that communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body are relayed through both the ancillary extraterrestrial component and the ancillary terrestrial component.

An extraterrestrial communications system according to claims wherein the first space-based component and the second space-based component are configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body such that communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body are relayed through both the first space-based component and the second space-based component. An extraterrestrial communications system according to claims wherein the first space-based component and the ancillary terrestrial component are configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body

such that communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body are relayed through both the first space-based component and the ancillary terrestrial component. An extraterrestrial communications system according to claims wherein the ancillary extraterrestrial component and the second space-based component are configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body such that communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body are relayed through both the ancillary extraterrestrial component and the second space-based component.

A communications system comprising: a space-based component that is configured to provide wireless communications to a plurality of radio-terminals located on earth over a first satellite frequency band wherein the space-based component includes at least one satellite orbiting earth; and an ancillary terrestrial component on earth that is configured to provide wireless communications to with the plurality of radio-terminals located on earth; wherein the ancillary terrestrial component uses at least one frequency of the first satellite frequency band, is configured to detect transmissions of at least one other ancillary terrestrial component, to establish a link there between responsive to having detected the transmissions and to use the link that is established to coordinate frequency reuse, transmission power and/or hand-off of radio-terminals with the at least one other ancillary terrestrial component; and wherein the space-based component and the ancillary terrestrial component are configured to relay communications there between and at least one of the space-based component and the ancillary terrestrial component is configured to relay communications between one of the plurality of radio terminals located on earth and a radio-terminal located on an extraterrestrial body.

A communications system according to claims further comprising: a second space-based component that is configured to provide wireless communications to a plurality of radio-terminals located on the extraterrestrial body over a second satellite frequency band wherein the second space-based component includes at least one satellite orbiting the extraterrestrial body, wherein the first space-based component, the second space-based component, and the ancillary terrestrial component are configured to establish direct wireless communications links there between and to relay communications there between using the direct wireless communications links.

A communications system according to claims further comprising: an ancillary extraterrestrial component on the extraterrestrial body that is configured to provide wireless communications to the plurality of radio-terminals located on the extraterrestrial body, wherein the ancillary extraterrestrial component uses at least one frequency of the second and/or first satellite frequency band, and wherein the second space-based component and the ancillary extraterrestrial component are configured to establish direct wireless links there between and to relay communications there between using the direct wireless links.

A communications system according to claims wherein the first satellite frequency band and the second satellite frequency band comprise substantially the same satellite frequency band. A method of operating a communications system comprising a space-based component including at least one satellite orbiting an extraterrestrial body and an ancillary extraterrestrial component on the extraterrestrial body, the method comprising: providing wireless communications by the space-based component to a plurality of radio terminals located on the extraterrestrial body over a satellite frequency band. Whereas the system provides wireless communications by the ancillary extraterrestrial component to the plurality of radio-terminals located on the extraterrestrial body, wherein the ancillary extraterrestrial component uses at least one frequency of the satellite frequency band.

Wherein the system establishes the direct wireless links between the space-based component and the ancillary extraterrestrial component and relaying communications between the space-based component and the ancillary extraterrestrial component using the direct wireless links; and detecting by the ancillary extraterrestrial component transmissions of at least one other ancillary extraterrestrial component, establishing a link there between responsive to the detecting and coordinating with the at least one other ancillary extraterrestrial component, using the link that is established, frequency reuse, transmission power and/or hand-off of radio-terminals. A method of operating a communications system comprising a first

ancillary extraterrestrial component, using the link that is established, frequency reuse, transmission power and/or hand-off of radio-terminals. A method of operating a communications system comprising a first space-based component including at least one satellite orbiting an extraterrestrial body, an ancillary extraterrestrial component on the extraterrestrial body, a second space-based component including at least one satellite orbiting earth, and an ancillary terrestrial component on earth, the method comprising: providing wireless communications by the first space-based component to a plurality of radio-terminals located on the extraterrestrial body; providing wireless communications by the ancillary extraterrestrial component to the plurality of radio-terminals located on the extraterrestrial body; establishing direct wireless links between the first space-based component and the ancillary extraterrestrial component and relaying communications between the first space-based component and the ancillary extraterrestrial component using the direct wireless links. Wherein, the system provides wireless communications by the second space-based component to a plurality of radio-terminals located on earth; providing wireless communications by the ancillary terrestrial component to the plurality of radio-terminals located on earth; establishing direct wireless communications links between the second space-based component and the ancillary terrestrial component and relaying wireless communications there between using the direct wireless communications links; detecting by the ancillary extraterrestrial component transmissions of at least one other ancillary extraterrestrial component, establishing a link there between responsive to the detecting and coordinating with the at least one other ancillary extraterrestrial component, using the link that is established, frequency reuse, transmission power and/or hand-off of radio-terminals.

Wherein, relaying communications between a radio-terminal on the extraterrestrial body and a radio-terminal on earth such that communications between the radio-terminal on the extraterrestrial body and the radio-terminal on earth are relayed through at least two of the first space-based component, the ancillary extraterrestrial component, the second space-based component and the ancillary terrestrial component. A method of operating a communications system comprising a space-based component including at least one satellite orbiting earth, and an ancillary terrestrial component on earth, the method comprising: providing wireless communications by the space-based component to a plurality of radio-terminals located on earth using service link frequencies of a satellite frequency band.

Wherein, the system provides wireless communications by the ancillary terrestrial component to the plurality of radio-terminals located on earth using service link frequencies of the satellite frequency band; relaying communications between the space-based component and the ancillary terrestrial component; detecting by the ancillary terrestrial component transmissions of at least one other ancillary terrestrial component, establishing a link there between responsive to the detecting and coordinating with the at least one other ancillary terrestrial component, using the link that is established responsive to the detecting, frequency reuse, transmission power and/or hand-off of radio-terminals; and relaying communications between one of the plurality of radio-terminals located on earth and a radio-terminal located on an extraterrestrial body using the space-based component and the ancillary terrestrial component.

Further Description of the Invention

Research Scientist Dr. Mohammed Metwally Hassan and Prof. Dr. Eltayeb Salih and the Co-inventors mentioned below present a World-Class Hi-Tech Patent of Alien Communications and Manipulations Technology, it is by all means a Legendary Work of Precision Targeting beyond the description of words and quite literally communicated with Extraterrestrial Intelligence(s) and has dominated the Electromagnetic Spectrum "Six Different Times" with Telepathically Resonating Capsulated Energy Streaming (TRCES) which is the Universal Alien Language of the Entire Universe. It is a form of Consensually Agreeable Alphabet of the Universe, both Interstellar and intergalactic Radio Signal Waves which is "armed" with galactically agreeable language and energetic streaming patterns. The radio signals are energetically armed, in order to [Communicate, Vibrate, Stimulate, Connect, Dominate, Override, Spread, Publicize, Impede, Emit, Intercept, Transfer, Mediate, Convey, Control, Transform, Propagate, Transmit, Converse, Release, Warn, Demand, Negotiate, Stipulate,

space-based component including at least one satellite orbiting an extraterrestrial body, an ancillary extraterrestrial component on the extraterrestrial body, a second space-based component including at least one satellite orbiting earth, and an ancillary terrestrial component on earth, the method comprising: providing wireless communications by the first space-based component to a plurality of radio-terminals located on the extraterrestrial body; providing wireless communications by the ancillary extraterrestrial component to the plurality of radio-terminals located on the extraterrestrial body; establishing direct wireless links between the first space-based component and the ancillary extraterrestrial component and relaying communications between the first space-based component and the ancillary extraterrestrial component using the direct wireless links.

Wherein, the system provides wireless communications by the second space-based component to a plurality of radio-terminals located on earth; providing wireless communications by the ancillary terrestrial component to the plurality of radio-terminals located on earth; establishing direct wireless communications links between the second space-based component and the ancillary terrestrial component and relaying wireless communications there between using the direct wireless communications links; detecting by the ancillary extraterrestrial component transmissions of at least one other ancillary extraterrestrial component, establishing a link there between responsive to the detecting and coordinating with the at least one other ancillary extraterrestrial component, using the link that is established, frequency reuse, transmission power and/or hand-off of radio-terminals.

Wherein, relaying communications between a radio-terminal on the extraterrestrial body and a radio-terminal on earth such that communications between the radio-terminal on the extraterrestrial body and the radio-terminal on earth are relayed through at least two of the first space-based component, the ancillary extraterrestrial component, the second space-based component and the ancillary terrestrial component. A method of operating a communications system comprising a space-based component including at least one satellite orbiting earth, and an ancillary terrestrial component on earth, the method comprising: providing wireless communications by the space-based component to a plurality of radio-terminals located on earth using service link frequencies of a satellite frequency band.

Wherein, the system provides wireless communications by the ancillary terrestrial component to the plurality of radio-terminals located on earth using service link frequencies of the satellite frequency band; relaying communications between the space-based component and the ancillary terrestrial component; detecting by the ancillary terrestrial component transmissions of at least one other ancillary terrestrial component, establishing a link there between responsive to the detecting and coordinating with the at least one other ancillary terrestrial component, using the link that is established responsive to the detecting, frequency reuse, transmission power and/or hand-off of radio-terminals; and relaying communications between one of the plurality of radio-terminals located on earth and a radio-terminal located on an extraterrestrial body using the space-based component and the ancillary terrestrial component.

Further Description of the Invention

Research Scientist Dr. Mohammed M. Ammar and Co-inventors listed below present a World Class Hi-Tech Patent of Alien Communications and Manipulations Technology, it is by all means a Legendary Work of Precision Targeting beyond the description of words. Dr. Mohammed Ammar has quite literally communicated with Extraterrestrial Intelligence(s) and has dominated the Electromagnetic Spectrum "Six Different Times" with Telepathically Resonating Capsulated Energy Streaming (TRCES) which is the Universal Alien Language of the Entire Universe. It is a form of Consensually Agreeable Alphabet of the Universe, both Interstellar and intergalactic Radio Signal Waves which is "armed" with galactically agreeable language and energetic streaming patterns. The radio signals are energetically armed, in order to [Communicate, Vibrate, Stimulate, Connect, Dominate, Override, Spread, Publicize, Impede, Emit, Intercept, Transfer, Mediate, Convey, Control, Transform, Propagate, Transmit, Converse, Release, Warn, Demand, Negotiate, Stipulate, Implement, Condition, Contract, Facilitate, Articulate, Report, Adjudicate, Prevent, Admit, Announce, Propose, Send, Receive, Offer, Grant, Solve, Save, Interact, Request, Join, Unite &

Interpret] Intergalactic and Interstellar Telepathically Resonating Capsulated Energy Streaming, universally known as (TRES).

Field of the Invention

This invention relates to Hi-Tech Communications Systems and methods, more particularly it relates to extraterrestrial communications systems and methods. The underlying innvention is "Solar Sonic Deep-Space Multidimensional Coded Universal Communications" via Ionosphere Armed Signals and Quantum Algorithm Resonance of Hydroxyl Molecules Cosmic-Radio-Waves. The said invention is a Solar Sonic Universe Multidimensional Radio Astronomical Control Tower Resonator for Systematic Multi-Communications and Manipulations of all resonating Matters and Antimatters alike". The Solar Sonic Multidimensional Interstellar Radio Signal Communications Resonator is a novel technology precisely pertaining to Deep Space Multidimensional Radio Signal Communications, which is an art reflected within the formal technology stated title. We explain the basis for our Hi Tech Assertions in a systematic manner whereas we illustrate further clarification of the underlying content and logistical data to substantiate claims.

Background of the invention

Improved communications systems and methods, however, may be desired to accommodate increasing communications to and from extraterrestrial bodies such as the Moon and/or Mars as more missions are sent to extraterrestrial bodies. More particularly, communications systems and methods may be desired that can accommodate increased communications between radio-terminals on an extraterrestrial body and increased communications between radio-terminals on the extraterrestrial body and a satellite orbiting a celestial body and/or transceivers on earth. The present invention relates generally to wireless communications, and more particularly to systems for internal communications within structures, particularly at frequencies in the range of 0.5 to 100 MHz. Communications within buildings and other enclosed spaces have long presented problems. Communication wiring, such as for local area networks, is effective but suffers from problems with installation costs, limitations on connection locations and the need for periodic upgrading when technology advances. Metallic structural members, interior furniture, plumbing and electrical wiring all have a tendency to interfere with conventional wireless communications. Outside interference, such as galactic noise and human generated electromagnetic sources also frequently interferes with the quality and efficiency of in-building communications.

A neglected frequency band in the electromagnetic spectrum, at least from the standpoint of communication utilization, is that in the 0.5-100 MHz range. Much of this range is traditionally considered to be less than useful, and is accordingly less regulated by government entities. An example of this is that Part 15 of the FCC Rules apply in this range within the continental United States. One reason that this range is not widely utilized is that the waveforms have sufficiently long wavelengths that structural interference affects transmission and reception. However, with the inventor's technology it has become possible to harness this range of frequencies and to turn the factors which have been hindrances into advantages.

An area of electromagnetic phenomena which has been little understood and utilized traditionally is that dealing with evanescent (non-propagating) waves. Commercial utilization of these phenomena have been rare. The phenomena are known and observed in waveguide technology, but are ordinarily a hindrance, and hinder the utility of structure near what is known as "cut-off. Cut-off occurs for conventional propagation in hollow pipe waveguides when the size of the hollow pipe waveguide is less than one-half (1/2) of the wavelength at the operating frequency. When these conditions obtain, the transmission losses are very high but not infinite. The expression for attenuation below cut-off in ideal waveguides, Equation 1, may be cut off wavelength /= operating frequency fc - operating frequency at cut-off where the wavelength, is approximately equal to 11.8// (GHz) in inches. As f is decreased below f_c, γ increases from a value of 0 approaching the constant value of $2\pi/\lambda_c$, when (f/f_c « 1. The amount of attenuation is determined only by the cut-off wavelength of the waveguide, which is in general proportional to the transverse size of the waveguide, so that the value of γ may be made almost as large as one pleases by selecting a low cut-off wavelength (small pipe size). Since (1) holds for any wave in any shape of guide, it follows that choices of wave type and guide shape cannot

influence the attenuation constant except in so far as they fix the cut-off wavelength λ_c.' Wave motion, forming the core of many subjects in physics, is a prominent (interdisciplinary) topic in many textbooks.[2] While traditional wave motion is often dealt with in great detail (for good reasons), the theory of evanescent waves is often only mentioned in passing.

Such small mention is by no means justified : evanescent waves - originally indeed introduced as convenient mathematical tools having no application in mind - matured in the last decades to a topic of its own intrinsic interest Finding a steadily increasing number of applications in basic as well as applied research and in industry. Any propagating wave is converted into an evanescent wave when hitting a classically forbidden region (below cut-off). In this case, at least one component of the wave vector becomes imaginary or a complex value and the wave experiences exponential damping when operating in this region (the cut-off effect described above).

Such waves are used as diagnostic tools in many contexts involving waveguides; applications range from diverse areas of solid state physics and microwave-technologies. Exòplicit examples show that evanescent waves play an important role in microwaves, optics, and quantum mechanics. Despite the fact that all of these systems are governed by different wave- equations, different dispersion laws, different energy regimes and completely different. The typical mechanisms accounting for the existence of evanescent waves are:) conversion into other forms of energy in loss of media,) cut-off modes in certain directions resulting from Reflections in lossless media,) gradual leakage of energy from certain guiding structures and) mode conversion produced by obstacles or by changes in guiding structures. Evanescent waves have some peculiar properties sometimes defying intuition. As a typical example the fact was mentioned that they operate in the forbidden region (below cut-off) experiencing exponential damping. Wave motion involving evanescent waves is easily demonstrated with electromagnetic waves using microwaves provides short descriptions of hands-on and more sophisticated experiments with evanescent waves referring for details to easily accessible literature.

It is now established that electromagnetic connectivity can be achieved by the use of evanescent nón-propagating waves below cut-off or propagating waves above frequency cut-off. Some methodology must be developed which can inject currents into the metallic elements of a structure in order that evanescent waves be generated in the cut-off region. For frequencies above the cut-off region more traditional antenna technologies can be used.

Although the phenomena relating to evanescent waves and other wave characteristics resulting at wavelengths below or near cut-off regions are known, they have not heretofore been meaningfully commercially utilized. In general, these phenomena are considered to be hindrances and nuisances, rather than opportunities for actually enhancing communications. In this light, there remain many opportunities for utilization and improvement, to be addressed by the present invention and the Inventor's related inventions.

Summary of the invention

According to embodiments of the present invention, a system for communications on an extraterrestrial body may include a space-based component having at least one satellite orbiting the extraterrestrial body and an ancillary extraterrestrial component on the extraterrestrial body. The space-based component may be configured to provide wireless communications with a plurality of radio-terminals located on the extraterrestrial body over a satellite frequency band. The ancillary extraterrestrial component may be configured to provide wireless communications with the plurality of radio-terminals located on the extraterrestrial body. Moreover, the ancillary extraterrestrial component may reuse at least one satellite frequency of the satellite frequency band, and the space-based component and the ancillary extraterrestrial component may be configured to relay communications there between.

The space-based component may be configured to relay communications between first and second radio-terminals on the extraterrestrial body using at least one satellite frequency of the satellite frequency band. The ancillary extraterrestrial component may be configured to relay communications between first and second radio-terminals on the extraterrestrial body reusing the at least one satellite frequency of the satellite

frequency band. In addition, the ancillary extraterrestrial component and the space-based component may be configured to relay communications between first and second terminals on the extraterrestrial body such that communications between the first and second radio-terminals are relayed through both the ancillary extraterrestrial component and the space-based component.

At least one of the radio-terminals may be configured to provide duplex voice communications and/or digital data communications. The ancillary extraterrestrial component may be one of a plurality of ancillary extraterrestrial components on the extraterrestrial body with each ancillary extraterrestrial component defining a coverage area on the extraterrestrial body, particularly, the ancillary extraterrestrial components may reuse one or more of frequencies of the satellite frequency band. The one or more frequencies may be shared among the plurality of ancillary extraterrestrial components according to a frequency reuse pattern to reduce interference between the ancillary extraterrestrial components.

The systems may also include a second space based component that is configured to provide wireless communications with a plurality of radio-terminals located on earth over a second satellite frequency band. Moreover, the second space-based component may include at least one satellite orbiting the earth, and the first space-based component, the second space-based component, and the ancillary extraterrestrial component may be configured to relay communications there between. In addition, an ancillary terrestrial component on earth may be configured to provide wireless communications with the plurality of radio-terminals located on earth, and the ancillary terrestrial component may reuse at least one satellite frequency of the second satellite frequency band, and the second space-based component and the Ancillary terrestrial component may be configured to relay communications there between.

Moreover, the first satellite frequency band and the second satellite frequency band may be substantially the same satellite frequency band. The ancillary extraterrestrial component on the extraterrestrial body and the ancillary terrestrial component on earth may also be configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body. More particularly, communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body may be relayed through both the ancillary extraterrestrial component and ancillary terrestrial component. In addition or in an alternative, communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body may be relayed through the first and/or second space-based components.

In addition or in another alternative, communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body may be relayed through both the first space-based component and the ancillary terrestrial component. In addition or in yet another alternative, communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body may be relayed through both the ancillary extraterrestrial component and the second space-based component. According to second embodiments of the present invention, an extraterrestrial communications system may include a first space-based component having at least one satellite orbiting the extraterrestrial body, an ancillary extraterrestrial component on the extraterrestrial body, a second space-based component having at least one satellite orbiting earth, and an ancillary terrestrial component on earth. The first space-based component may be configured to provide wireless communications with a plurality of radio-terminals located on an extraterrestrial body.

The ancillary extraterrestrial component on the extraterrestrial body may be configured to provide wireless communications with the plurality of radio-terminals located on the extraterrestrial body. Moreover, the first space-based component and the ancillary extraterrestrial component may be configured to relay communications there between. The second space-based component may be configured to provide wireless communications with a plurality of radio-terminals located on earth. The ancillary terrestrial component on earth may be configured to provide wireless communications with the plurality of radio terminals located on earth, and the second space-based component and the ancillary terrestrial component may be configured to relay communications there between. In addition, the first space-based component, the ancillary extraterrestrial component, the second space-based component, and the ancillary terrestrial component may be configured to relay communications between a radio-terminal on the extraterrestrial body and a radio-terminal on earth.

Moreover, communications between the radio-terminal on the extraterrestrial body and the radio-terminal on earth may be relayed through at least two of the first space-based component, the ancillary extraterrestrial component, the second space-based component, and/or the ancillary terrestrial component. The first space-based component may be configured to provide wireless communications over a first satellite frequency band, and the ancillary extraterrestrial component may be configured to reuse at least one satellite frequency of the first satellite frequency band.

In addition, the second space-based component may be configured to provide wireless communications over a second satellite frequency band and the ancillary terrestrial component may be configured to reuse at least one satellite frequency of the second satellite frequency band. Moreover, the first and second satellite frequency bands may be substantially the same satellite frequency band. The first space-based component may be configured to relay communications between first and second radio-terminals on the extraterrestrial body, and the ancillary extraterrestrial component may be configured to relay communications between first and second Radio terminals on the extraterrestrial body.

In addition, the first space-based component and the ancillary extraterrestrial component may be configured to relay communications between first and second Radio-terminals on the extraterrestrial body such that communications between the first and second radio-terminals are relayed through both the ancillary extraterrestrial component and the first space-based component. The radio-terminals located on earth and/or on the extraterrestrial body may be mobile radio terminals configured to provide full duplex voice communications, and/or to provide digital data communications. The ancillary extraterrestrial component may be one of a plurality of ancillary extraterrestrial components on the extraterrestrial body with each ancillary extraterrestrial component defining a respective coverage area on the extraterrestrial body.

More particularly, the first space-based component may be configured to provide wireless communications over a first satellite frequency band, the ancillary extraterrestrial component may be configured to reuse one or more of the satellite frequencies of the first satellite frequency band, and the one or more frequencies may be shared among the plurality of ancillary extraterrestrial components according to a reuse pattern to reduce interference between the extraterrestrial components. The ancillary extraterrestrial component on the extraterrestrial body and the ancillary terrestrial component on earth may be configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body.

More particularly, communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body may be relayed through both the ancillary extraterrestrial component and the ancillary terrestrial component. The first space-based component and the second space-based component may be configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body. More particularly, communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body may be relayed through the first space-based component and/or the second space-based component. The first space-based component and the ancillary terrestrial component may be configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body.

More particularly, communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body may be relayed through both the first space-based component and the ancillary terrestrial component. The ancillary extraterrestrial component and the second space-based component may be configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body. More particularly, communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body may be relayed through both the ancillary extraterrestrial component and the second space-based component. According to third embodiments of the present invention, a communications system may include a space-based component having at least one satellite orbiting earth and an ancillary terrestrial component on earth.

The space-based component may be configured to provide wireless communications with a plurality of radio-terminals located on earth over a satellite frequency band. The ancillary terrestrial component may be configured to provide wireless communications with the plurality of radio-terminals located on earth. Moreover, the ancillary terrestrial component may reuse at least one satellite frequency of the satellite frequency band, and the space-based component and the ancillary terrestrial component may be configured to relay communications there between. In addition, at least one of the space-based component and/or the ancillary terrestrial component may be configured to relay communications between one of the plurality of radio-terminals located on earth and a radio-terminal located on an extraterrestrial body.

The communications system may also include a second space-based component that is configured to provide wireless communications with a plurality of radio-terminals located on the extraterrestrial body over a second satellite frequency band. More particularly, the second space-based component may include at least one satellite orbiting the extraterrestrial body, and the first space-based component, the second space-based component, and the ancillary terrestrial component may be configured to relay communications there between. In addition, an ancillary extraterrestrial component on the extraterrestrial body may be configured to provide wireless communications with the plurality of radio-terminals located on the extraterrestrial body.

Moreover, the ancillary extraterrestrial component may reuse at least one satellite frequency of the second satellite frequency band, and the second space-based component and the ancillary extraterrestrial component may be configured to relay communications there between. The first satellite frequency band and the second satellite frequency band may also be substantially the same satellite frequency band. According to fourth embodiments of the present invention, methods may be provided for operating a communications system including a space-based component having at least one satellite orbiting an extraterrestrial body and an ancillary extraterrestrial component on the extraterrestrial body.

Wireless communications may be provided from the space-based component with a plurality of radio-terminals located on the extraterrestrial body over a satellite frequency band. Wireless communications may also be provided from the Ancillary extraterrestrial component with the plurality of radio-terminals located on the extraterrestrial body, and the ancillary extraterrestrial component may reuse at least one satellite frequency of the satellite frequency band. In addition, communications may be relayed between the space-based component and the ancillary extraterrestrial component.

According to fifth embodiments of the present invention, methods may be provided for operating a communications system including a first space-based component having at least one satellite orbiting an extraterrestrial body, an ancillary extraterrestrial component on the extraterrestrial body, a second space-based component having at least one satellite orbiting earth, and an ancillary terrestrial component on earth. Wireless communications may be provided from the first space-based component with a plurality of radio-terminals located on the extraterrestrial body, and wireless communications may be provided from the ancillary extraterrestrial component with the plurality of radio-terminals located on the extraterrestrial body.

Communications may also be relayed between the first space-based component and the ancillary extraterrestrial component. Wireless communications may be provided for the second space-based component with a plurality of radio-terminals located on earth, and wireless communications may be provided form the ancillary terrestrial component with the plurality of radio-terminals located on earth. Communications may also be relayed between the second space-based component and the ancillary terrestrial component. Communications may also be relayed between a radio-terminal on the extraterrestrial body and a radio-terminal on earth. More particularly, communications between the radio-terminal on the extraterrestrial body and the radio-terminal on earth may be relayed through at least two of the first space-based component, the ancillary extraterrestrial component, the second space-based component, and/or the ancillary terrestrial component.

According to sixth embodiments of the present invention, methods may be provided for operating a communications system including a space-based component including at least one satellite orbiting earth, and an ancillary terrestrial component on earth. Wireless communications may be provided from the space-

based component with a plurality of radio-terminals located on earth over a satellite frequency band, and wireless communications may be provided from the ancillary terrestrial component with the plurality of radio-terminals located on earth. More particularly, the ancillary terrestrial component may reuse at least one satellite frequency of the satellite frequency band. Communications may be relayed between the space-based component and the ancillary terrestrial component. In addition, communications may be relayed between one of the plurality of radio-terminals located on earth and a radio-terminal located on an extraterrestrial body using at least one of the space-based component and/or the extraterrestrial component.

Detailed Descriptions of the Invention

The present invention now will be described more fully hereinafter in which typical embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout. It will be understood that although the terms first and second are used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another element. Thus, a first element below could be termed a second element, and similarly, a second element may be termed a first element without departing from the teachings of the present invention.

As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. Moreover, as used herein, "substantially the same" band means that the bands substantially overlap, but that there may be some areas of non-overlap, for example at the band ends. Moreover, "substantially the same" air interface means that the air interfaces are similar but need not be identical. Some changes may be made to the air interface to account for different characteristics for the terrestrial, extraterrestrial, and/or satellite environments. According to embodiments of the present invention illustrated in claims, communications systems and methods may be provided for an extraterrestrial body such as the Moon, Mars, or another planet or moon thereof.

More particularly, a communications system may comprise a space-based network including at least one space-based component such as a satellite 101 orbiting the extraterrestrial body 105, and an ancillary extraterrestrial network including one or a plurality of ancillary extraterrestrial components 103 a-g on the extraterrestrial body 105. While the space-based network is illustrated with a single satellitelOl, the space-based network may include a plurality of satellites and each satellite may provide communications over different coverage areas 107 a-d of the extraterrestrial body 105. While the ancillary extraterrestrial network is illustrated with a plurality of ancillary components 103 a-g, ancillary extraterrestrial networks according to embodiments of the present invention may operate with only a single ancillary extraterrestrial component.

Only a portion of the extraterrestrial body 105 is illustrated. More particularly, the space-based network is configured to provide wireless communications with a plurality of radio-terminals on the extraterrestrial body using a satellite frequency band, the space-based network may define a plurality of non-overlapping, partially overlapping, and/or substantially overlapping satellite coverage areas 107 a-d on the extraterrestrial body 105 using respective spot beams. One or more satellite frequencies of the satellite frequency band may be used to provide communications with each of the coverage areas 107 a-d, and a satellite frequency reuse pattern may be established so that the same satellite frequencies may not be used in adjacent/overlapping ones of coverage areas 107 a-d. While a single satellite lOlis shown in claims providing communications in four coverage areas 107 a-d, a space-based network according to embodiments of the present invention may include a plurality of satellites with each satellite providing service for one or a plurality of coverage areas.

Moreover, a satellite 101 or satellites of the space-based network may be relatively stationary (i.e. extraterrestrial-body-stationery) with respect to particular locations on the extraterrestrial body so that one or more coverage areas 107 a-d thereof are relatively stationary with respect to the extraterrestrial body. Accordingly, a single satellite may provide continuous coverage for a relatively stationary coverage area. An

orbit for a extraterrestrial-body-stationary satellite, however, may be relatively high. In addition or in an alternative, a satellite or satellites of the space-based network may be provided in a relatively low orbit to reduce transmission delays and/or to reduce a transmission power. With a relatively low orbit satellite, however, a radio-terminal on the extraterrestrial body may not have continuous coverage from a single low orbit satellite. For example, a space-based network may include a plurality of relatively low orbit satellites with each satellite providing coverage for a particular location on the extraterrestrial body at a different time. Accordingly, the space-based network of the communications system is configured to relay communications between first and second radio-terminals on the extraterrestrial body 105 using at least one frequency of the satellite frequency band.

For example, communications between two radio-terminals located in the coverage area 107 b may be relayed through the satellite 101 using a first communications channel between the first radio-terminal and the satellitelOl and using a second communications channel between the second radio-terminal and the satellite 101. Because the two radio-terminals are in the same coverage area 107 b, the first and second communications channels may be provided on different satellite frequencies of the satellite frequency band in a architecture; the first and second communications channels may be provided on the same satellite frequency using different time slots in a architecture; and/or the first and second communications channels May be provided on the same satellite frequency using different spread-spectrum codes in a (frequency-hopped and/or direct-sequence spread) architecture. Other architectures and/or air interface protocols may also be used. The space-based network of the communications system may also be configured to relay communications between radio-terminals located in different coverage areas, such as coverage areas 107 b and 107 c. Accordingly, the space-based network may provide for communications over relatively large portions of the extraterrestrial landscape. Communications between two radio-terminals located in the same or different coverage areas 107 a-d may be relayed through the space-based network.

While a space-based network with a single satellite 101 , multiple satellites may be included in the space-based network. For example, communications may be relayed between a first radio-terminal in coverage area 107 b and a second radio-terminal in coverage area 107 c through a first satellite providing service for coverage area 107 b and a second satellite providing service for coverage area 107 c. A communications path between two radio-terminals may thus pass through two or more satellites. Each of the ancillary extraterrestrial components 103 a-g of the ancillary extraterrestrial network defines a respective coverage area 109 a-g. Each of the ancillary extraterrestrial components 103 a-g may be configured to provide wireless communications with a plurality of radio-terminals located on the extraterrestrial body.

More particularly, each of the ancillary extraterrestrial components 103 a-g is configured to reuse at least one satellite frequency of the satellite frequency band, and each of the ancillary extraterrestrial components 103 a-g and the space-based component(s) such as satellite 101 are configured to relay communications there between. Coverage areas are shown as circles for purposes of illustration. Coverage areas, however, may have other shapes such as hexagonal, octagonal, wedge shaped, triangular, oval, substantially circular, etc. Moreover, a plurality of adjacent ancillary extraterrestrial components 103 d-g may have overlapping coverage areas 109 d-g, and each of the ancillary extraterrestrial components 103 d-g may reuse one or more satellite frequencies of the satellite frequency band.

As discussed above, the space-based component such as satellite 101 may provide wireless communications with the coverage area 107 d using one or more satellite frequencies of the satellite frequency band with different satellite frequencies being used by the space-based component such as satellite 101 to provide wireless communications over the coverage areas 107 b-c. Accordingly, the ancillary extraterrestrial components 103 d-g may reuse satellite frequencies other than satellite frequencies used by the satellite 101 to provide wireless communications with the coverage area 107 d. Accordingly, interference between the ancillary extraterrestrial components 103 d-g and the space-based network can be reduced. In addition, a plurality of satellite frequencies may be shared among the ancillary extraterrestrial components 103 d-g according to a frequency reuse pattern to reduce interference between adjacent ancillary extraterrestrial components 103 d-g. Reuse of satellite frequencies among the adjacent ancillary extraterrestrial components 103 d-g may be provided, for example, such that adjacent

ancillary extraterrestrial components do not reuse the same frequencies at the same time. For example, ancillary extraterrestrial components 103 e-g have overlapping coverage areas 109 e-g so that the same satellite frequencies may not be reused at the same time by any of the ancillary extraterrestrial components 103 e-g in a architecture and/or air interface protocol. However, for certain architectures and/or air interface protocols, such as a architecture and/or air interface protocol, the ancillary extraterrestrial components 103 e-g may reuse at the same time the same satellite band frequency or frequencies. Ancillary extraterrestrial components 103 d and 103 f have non-overlapping coverage areas 109 d and 109 f, and the same satellite frequencies may thus be reused by ancillary extraterrestrial components 103 d and 103 fat the same time.

Moreover, satellite frequencies used by ancillary extraterrestrial components 103 d-g may be used at the same time by a space-based component such as satellite 101 for communications with coverage areas 107 a, 107 b, and/or 107 c. Similarly, ancillary extraterrestrial components 103 b-c may define overlapping coverage areas 109 b-c, and ancillary extraterrestrial components 103 b-c may use different satellite frequencies to reduced interference there between. Moreover, satellite frequencies used by ancillary extraterrestrial components 103 b-c may be different than satellite frequencies used by the space-based component for communications in the coverage area 107 d. Satellite frequencies used by the ancillary extraterrestrial components 103 b-c, however, may be reused by a space-based component such as satellite 101 for communications in coverage areas 107 a, 107 b, and/or 107 c.

In addition, ancillary extraterrestrial component 103 a may define coverage area 109 a, and ancillary extraterrestrial communication component 103 a may use satellite frequencies different than those used by a space-based component such as satellite 101 for communications in the coverage area 107 a. Satellite frequencies used by the ancillary extraterrestrial component 103 a, however, may be reused by the space-based component for communications in coverage areas 107 b, 107 c, and/or 107 d. A single ancillary extraterrestrial component (such as 103 g), for example, may relay communications between two radio-terminals located in the respective coverage area (such as 109 g). Moreover, ancillary extraterrestrial components 103d-g may be networked such that communications between a first radio-terminal in coverage area 109 d and a second radio-terminal in coverage area 109 fare relayed through respective-ancillary extraterrestrial components 103 d and 103 f.

Links between ancillary extraterrestrial components 103 d-g may be provided, for example, by wire link, by optic fiber link, by radio link, and/or by satellite link. Moreover, service for a radio-terminal may be switched during communications from one ancillary extraterrestrial component to another as the radio-terminal moves from the coverage area of one ancillary extraterrestrial component to another. Switching, for example, may be controlled from a switching office, the functionality of which may be distributed among different ancillary extraterrestrial components, provided at one of the ancillary extraterrestrial components, provided separate from any of the ancillary extraterrestrial components, and/or provided at one or more space-based components of the space-based network. Similarly, ancillary extraterrestrial components 103 a-c may provide wireless communications for radio terminals located in coverage areas 109 a-c.

For example, ancillary extraterrestrial component 103 a may relay communications between two radio-terminals located in coverage area 109 a, ancillary extraterrestrial component 103 b may relay communications between two radio-terminals located in coverage area 109 b, and ancillary extraterrestrial component 103 c may relay communications between two radio-terminals located in coverage area 109 c. Moreover, links between all of the ancillary extraterrestrial components 103 a-g may be provided, for example, by wire link, by optic fiber link, by radio link, and/or by satellite link. Communications between a radio-terminal in coverage area 109 a and a radio-terminal in coverage area 109 c, for example, may be relayed through ancillary extraterrestrial components 103 a and 103 c. Coverage for a radio-terminal on the extraterrestrial body may thus be provided by either the space-based network (including one or more space based components such as satellite 101) or the ancillary extraterrestrial network (including one or more ancillary extraterrestrial components 103 a-g). More particularly, one or more ancillary extraterrestrial components may be provided at locations on the extraterrestrial body where a relatively high volume of radio-terminal usage is expected, and coverage from the space-based network may be provided over larger areas to cover areas not covered by the ancillary

extraterrestrial components 103 a-g. A space-based component such as satellite 101 may thus provide communications for radio-terminals located in relatively large coverage areas 107 a-d while the ancillary extraterrestrial components 103 a-g may provide communications for radio-terminals located in relatively small coverage areas 109 a-g.

Moreover, the satellite(s) 101 of the space-based network and the ancillary extraterrestrial components 103 a-g of the ancillary extraterrestrial network may be networked so that communications can be relayed there between. When a radio-terminal is in a coverage area of an ancillary extraterrestrial component, the radio-terminal may elect to establish a link with the available ancillary extraterrestrial component instead of the space-based component to conserve power, to reduce propagation delays, and/or to enhance system efficiency and/or capacity. Because the ancillary extraterrestrial component is on the extraterrestrial body and may cover a relatively limited area thereof, the radio-terminal can transmit to the ancillary extraterrestrial component at a lower power than may be required to transmit to the space-based component.

Moreover, a propagation delay in communications may be reduced if all of the links in a communication can be maintained within one or more ancillary extraterrestrial components. When a radio-terminal is outside a coverage area of the ancillary extraterrestrial components, a link may be established with a space-based component such as satellite 101. In addition, use of relatively small coverage areas in the ancillary extraterrestrial network may allow a relatively high degree of frequency reuse and a greater density of radio-terminal usage. A first radio-terminal 401 a, for example, may initially be located in coverage area 109 d when a communication is first established with a second radio-terminal 401 b located in coverage area 109 f. Accordingly, communications may be initially relayed between the radio terminals through Ancillary extraterrestrial components 103 d and 103 f.

If the first radio-terminal moves to coverage area 109 g, coverage of the first radio-terminal may be handed off from the ancillary extraterrestrial component 103 d to ancillary extraterrestrial component 103 g so that communications are relayed between the radio-terminals through ancillary extraterrestrial components 103 g and 103 f. If the first radio-terminal then moves outside any of the coverage areas 103 d-g, coverage of the first radio-terminal may be handed off to a portion of the space-based network such as satellite 101 providing coverage for coverage area 107 d. Accordingly, communications may be relayed between the radio-terminals through the satellite 101 and the ancillary extraterrestrial component 103 f.

A communication such as a radiotelephone conversation may thus be maintained as one or both radio-terminals move between coverage areas 103 a-gand/or coverage areas 107 a-d. According to another example, a first radio-terminal 401 c may be located in coverage area 109 a, and a second radiotermirial401 d may be located in coverage area 109 c, and a link between ancillary extraterrestrial components 103 a and 103 c may be provided via satellite 101. Communications may thus be relayed between the first and second radio-terminals 401 c-d through the ancillary extraterrestrial component 103 a, the satellite 101, and the ancillary component 103 c.

While a propagation delay may be introduced through the satellite link, the use of the ancillary extraterrestrial components 103 a andl03 c may reduce a transmission power required from the radio-terminals to thereby extend battery life thereof. Stated in other words, even though the communications are transmitted through the satellite, the introduction of an ancillary extraterrestrial component into the communications link may reduce power consumption (and/or increase battery life) at the radio-terminal(s).

If the first radio-terminal 401 c moves outside the coverage area 109 a, communications may be relayed between the first and second radio-terminals 401 c-d through the satellite 101 and the ancillary extraterrestrial component 103c. According to particular embodiments of the present invention, a radio-terminal on the extraterrestrial body may initially seek service from an ancillary extraterrestrial component on the extraterrestrial body so that the radio-terminal may transmit at a lower power than may otherwise be required to transmit to a space-based component such as a satellite.

Even if a particular communication will require a link through a satellite, an ancillary extraterrestrial component may provide the link to the satellite more efficiently than the radio-terminal alone because an ancillary extraterrestrial component may be less constrained in size than a radio-terminal, and an ancillary extraterrestrial component may have a greater power capacity. If an ancillary extraterrestrial component is not available, the radio-terminal may seek service directly from a space-based component such as satellite 101.

The ancillary extraterrestrial components 103 a-g may be specially adapted for operation in an extraterrestrial environment. Each ancillary extraterrestrial component may be self-contained, for example, including a power supply such as one or more of a solar cell, a battery, and/or a fuel cell. Moreover, each ancillary extraterrestrial component may include one (or more) transceiver(s) to provide one (or more) communications link(s) with one or more satellites of the space-based component, one (or more) transceiver(s) to provide one (or more) communications link(s) with one (or more) radio-terminal(s), and/or One (or more) transceiver(s) to provide one (or more) communications link(s) with one (or more) other Ancillary extraterrestrial component(s).

In addition, each ancillary extraterrestrial component may be configured to be deployed from space with little or no manual assembly required once the ancillary extraterrestrial component lands on the extraterrestrial body. Each ancillary extraterrestrial component may also be configured to automatically scan for the presence of other nearby ancillary extraterrestrial components to create an adaptable ancillary extraterrestrial network.

For example, if two ancillary extraterrestrial components land near one another on the extraterrestrial body, one component may detect transmissions of the other and initiate a link there between. The link between the two components may then be used to coordinate frequency reuse between the two components, transmission powers of the two components, hand-offs of radio-terminals between the two ancillary extraterrestrial components, and/or links with a space-based component (such as a satellite).

Each ancillary extraterrestrial component may also be configured to automatically scan for the presence of a space-based component such as a satellite. For example, the ancillary extraterrestrial component may detect transmissions from a space-based component (such as a satellite) to a coverage area in which the ancillary extraterrestrial component is located and initiate a link there between. The link may be used to coordinate frequency reuse, hand-offs of radio-terminals between the ancillary extraterrestrial component and the space-based component, and/or links through the satellite to other ancillary extraterrestrial components and/or radio-terminals.

Because both the space-based component(s) and the ancillary extraterrestrial component(s) operate using satellite frequencies, a radio-terminal according to embodiments of the present invention may communicate through both space-based and ancillary extraterrestrial components using substantially a same transceiver and/or substantially a same communications protocol. A number of components and/or size of the radio-terminal can thus be reduced. Moreover, a radio-terminal according to embodiments of the present invention may be incorporated into a space suit used to provide life-support on the extraterrestrial body. In other embodiments, the radio-terminal may be a hand-held device. According to additional embodiments of the present invention communications may be relayed between a radio-terminal(s) on the extraterrestrial body and communications systems on earth through a space-based component such as satellite 101 and/or through a relay station(s) 111 (also referred to as a gateway) on the extraterrestrial body.

For example, a communication may be established between a radio-terminal in coverage area 109 a and a radio-terminal on earth with links being provided through the ancillary extraterrestrial component 103 a, the satellite 101, and a communications system on earth. In another example, a communication may be established with links being provided through the ancillary extraterrestrial component 103 a, the satellite 101, the relay station 111, and a communications system on earth. In yet another example, a communication may be established with links being provided through the ancillary extraterrestrial component 103 a, the relay station 111 (without a link through a satellite orbiting the extraterrestrial body), and a communications system on earth. In other examples, a radio-terminal may be outside any coverage areas

provided by ancillary extraterrestrial components. For example, a communication may be established between a radio-terminal in coverage area 107 b and a radio-terminal on earth with links being provided through the satellite 101 and a communications system on earth. In another example, a communication may be established with links being provided through the satellite 101, the relay station 111, and a communications system on earth.

Moreover, service for a radio-terminal may be handed-off from one ancillary extraterrestrial component to another, from an ancillary extraterrestrial component to a space-based component, and/or from one space-based component coverage area to another during a communication with a radio-terminal on earth. The relay station 111 may be optional with links to earth being provided through a space-based component such as a satellite. Moreover, a space-based network may include a plurality of satellites in orbit around the extraterrestrial body to provide that at least one satellite is always in alignment for communication with earth. In another alternative, links to earth may be provided through one or more of the ancillary extraterrestrial components without requiring a separate relay station. Stated in other words, one or more of the ancillary extraterrestrial components may include functionality of a relay station therein.

If a separate relay station 111 is included, links between the relay station 111 and one or more of the ancillary extraterrestrial components may be provided, for example, by wire link, by optic fiber link, by radio link, and/or by satellite link. Moreover, a plurality of relay stations 111 may be provided around the extraterrestrial body to provide that at least one relay station 111 is always in alignment for communication with earth. For example, three relay stations could be provided at approximately 120 degree intervals around the extraterrestrial body. According to additional embodiments of the present invention communications systems and methods may be provided for use on earth, a second space-based network may include at least one space-based component such as a satellite 201 orbiting earth 205, and an ancillary terrestrial network including one or a plurality of ancillary terrestrial components 203 a-e on earth 205.

While the second space-based network is illustrated with a single satellite 201, the space-based network include a plurality of satellites, and each satellite may provide communications over different coverage areas 207 a-c on earth. While a plurality of ancillary terrestrial components 203 a-e are illustrated, ancillary terrestrial networks according to embodiments of the present invention may operate with only a single ancillary terrestrial component, only a portion of earth 205 is illustrated. Terrestrial communications systems including space-based and ancillary terrestrial components used to provide communications for radio-terminals are discussed. Karabinis, entitled Methods and Systems for Modifying Satellite Antenna Cell Patterns In Response to Terrestrial Reuse of Satellite Frequencies.

Accordingly, the second space-based network including satellite 201 may provide communications for radio-terminals located in coverage areas 207 a-c using a satellite frequency band. According to particular embodiments of the present invention, substantially the same satellite frequency band may be used by both the first space-based network including satellite lOlorbiting the extraterrestrial body and the second space-based network including satellite 201 orbiting earth.

Accordingly, a same radio-terminal may operate on both earth and the extraterrestrial body without requiring multi-mode operation. For example, substantially the same satellite frequency band used by both the first and second space-based networks may include frequencies in the range of approximately 1626.5 MHz to approximately 1660.5 MHz and/or frequencies in the range of approximately 1525 MHz to approximately 1559 MHz. More particularly, a forward link for transmissions from the space-based networks may be provided by frequencies in the range of approximately 1525 MHz to approximately 1559 MHz, and a return link for transmissions to the space-based networks may be provided by frequencies in the range of approximately 1626.5 MHz to approximately 1660.5 MHz. In an alternative, different satellite frequency bands may be used by a space-based network including one or more satellites orbiting the extraterrestrial body and by the space-based network including one or more satellites orbiting earth. More particularly, a satellite frequency reuse pattern may be established so that the same satellite frequencies are not used in adjacent/overlapping ones of the coverage areas 207 a-c at the same time. Accordingly, the space-based network of the communications system is configured to relay communications between first and second radio-terminals on earth using at least one frequency of the satellite frequency band. For

example, communications between two radio-terminals located in the coverage area are 207 b may be relayed through satellite 201 using a first communications channel between the first radio-terminal and the satellite 201 and using a second communications channel between the second radio-terminal and the satellite 201.

Because the two terminals are in the same coverage area, the first and second communications channels may be provided on different satellite frequencies of the satellite frequency band; the first and second communications channels may be provided on the same satellite frequency using different time slots in architecture and/or air interface protocol; and/or the first and second communications channels may be provided on the same satellite frequency using different codes in a architecture and/or air interface protocol. The space-based network may also be configured to relay communications between radio-terminals located in different coverage areas, such as coverage areas 207 a and 207b.

Accordingly, the space-based network including satellite 201 may provide for communications over relatively large portions of earth. Communications between two radio-terminals located in the same or different coverage areas 207 a-c may be relayed through the space-based component. Multiple satellites may be included in the space-based network. For example, communications may be relayed between a first radio-terminal in coverage area 207 b and a second radio-terminal in coverage area 207 c through a first satellite providing service for coverage area 207 b and a second satellite providing service for coverage area 207 c.

A communications path between two radio-terminals may thus pass through two or more satellites. Each of the ancillary terrestrial communications components 203 a-e defines a respective coverage area 209 a-e. Each of the ancillary terrestrial communications components 203 a-e is configured to provide wireless communications with a plurality of radio-terminals located within a coverage area thereof. More particularly, each of the ancillary terrestrial components 203 a-e is configured to reuse at least one satellite frequency of the satellite frequency band, and each of the ancillary terrestrial components 203 a-e and the space-based component(s).

Moreover, a plurality of adjacent ancillary terrestrial components 203 c-e may have overlapping coverage areas 209 c-e, and each of the ancillary terrestrial components 203 c-e may reuse one or more satellite frequencies of the satellite frequency band. As discussed above, a space-based component such as satellite 201 may provide wireless communications for radio-terminals in the coverage area 207 c using one or more satellite frequencies of the satellite frequency band with different satellite frequencies being used by the space-based component to provide wireless communications over the coverage areas 207 a-b. Accordingly, the ancillary terrestrial components 203 c-e may reuse satellite frequencies other than the satellite frequencies used by the satellite 201 to provide wireless communications for radio-terminals in the coverage area207 c. Accordingly, interference between ancillary terrestrial components 203 c-e and the space-based network can be reduced.

In addition, a plurality of satellite frequencies may be shared among the ancillary terrestrial components 203 c-e according to a frequency reuse pattern to reduce interference between adjacent ancillary terrestrial components 203 c-e. Reuse of satellite frequencies among the adjacent ancillary terrestrial components 203 c-e may be provided, for example, such that adjacent ancillary terrestrial components do not reuse the same frequencies at the same time. Ancillary terrestrial components 203 a-b (and/or additional adjacent ancillary terrestrial components) may also share a plurality of satellite frequencies according to a frequency reuse pattern. Moreover, satellite frequencies used by ancillary terrestrial components203 c-e may be used at the same time by the satellite 201 for communications with radio-terminals in coverage areas 207 a-b. Similarly, satellite frequencies used by ancillary terrestrial components 203 a-b may be used at the same time by the satellite 201 for communications with radio-terminals in coverage areas 207 a or 207 c. Communications for a radio-terminal on earth may thus be provided by a space-based component such as satellite 201 within one of the coverage areas 207 a-c and/or by an ancillary terrestrial component 203 a-e within one of the coverage areas 209a-e. When within a coverage area 209 a-e, a radio-terminal may communicate through the respective ancillary terrestrial component 203 a-e. When outside coverage areas 209 a-e of the ancillary terrestrial components 203 a-e or when an ancillary terrestrial component is not available, the radio-terminal may communicate through a space-based component(s) (such as satellite 201) of

the space-based network. Moreover, components of the space-based and ancillary terrestrial networks may be coupled with a public switched telephone network on earth. Accordingly, a radio-terminal may establish communications through a space-based component and/or an ancillary terrestrial component with another radio-terminal on earth.

The other radio-terminal may be coupled through the space-based network including the satellite 201 and the ancillary terrestrial components 203 a-e or through another wireless network such as a cellular and/or PCS radiotelephone network. In another alternative, a radio-terminal may establish communications through a space-based component or an ancillary terrestrial component with a conventional telephone through a public switched telephone network. A single ancillary terrestrial component (such as 203 e), for example, may relay communications between two radio-terminals located in the respective coverage area (such as 209 e). Moreover, ancillary terrestrial components 203 c-e may be networked such that communications between a first radio-terminal in coverage area 209 c and a second radio-terminal in coverage area 209 e are relayed through respective ancillary terrestrial components 203 c and 203 e.

Links between ancillary components 209 c-e may be provided, for example, by wire link, by optic fiber link, by radio link, and/or by satellite link. Moreover, service for a radio-terminal may be switched during communications from one ancillary terrestrial component to another as the radio-terminal moves from the coverage area of one ancillary terrestrial component to another. Switching, for example, may be controlled from a switching office, the functionality of which may be distributed among different ancillary terrestrial components, provided at one of the ancillary terrestrial components, provided separate from any of the ancillary terrestrial components, and/or provided at one or more satellites of the space-based component.

Similarly, ancillary terrestrial components 203 a-b may provide wireless communications for radio-terminals located in coverage areas 209 a-b. For example, ancillary terrestrial component 203 a may relay communications between two radio-terminals located in coverage area 209 a, and ancillary terrestrial component 203 b may relay communications between two radio-terminals located in coverage area 209 b. Moreover, links between all of the ancillary terrestrial components 203 a-e may be provided, for example, by wire link, by optic fiber link, by radio link, and/or by satellite link.

Communications between a radio-terminal in coverage area 209 a and a radio=terminal in coverage area 209 e, for example, may be relayed through ancillary terrestrial components 203 a and 203 e.A space-based component such as satellite 201 may thus provide communications for radio-terminals located in relatively large coverage areas 207 a-c while the ancillary terrestrial components 203 a-e may provide communications for radio-terminals located in relatively small coverage areas 209 a-e. Moreover, a satellite(s) 201 of the space-based network and ancillary terrestrial components 203 a-e of the ancillary terrestrial network may be networked so that communications can be relayed there between.

According to a particular example, a first radio-terminal 401 e may initially be located in coverage area 209 c when a communication is first established with a second radio-terminal 401 f in coverage area 209 e. Accordingly, communications may be initially relayed between the radio-terminals 401 e-f through ancillary terrestrial components 203 c and 203 e. If the first radio-terminal 401 e moves to coverage area 209 d, coverage of the first radio-terminal 401 e may be handed off from the ancillary terrestrial component 203 c to ancillary terrestrial component 203 d so that communications are relayed between the radio-terminals 401 e-f through ancillary terrestrial components 203 d and 203 e.

If the first radio-terminal 401 e then moves outside of any of coverage areas 203 c-e, coverage of the first radio-terminal 401 e may be handed off to a space-based component such as satellite 201 providing coverage for coverage area 207 c. Accordingly, communications may be relayed between two radio-terminals 401 e-f through the satellite 201 and/or the ancillary terrestrial component 203 e. A communication such as a radiotelephone communication may thus be maintained as one or both radio-terminals move between coverage areas 203 a-e and/or coverage areas 207 a-c. According to embodiments of the present invention. Communications may be relayed between a radio-terminal(s) on earth and communications systems on an extraterrestrial body (such as through a satellite(s) 201 of the space-based network and/or through a relay

station(s) 211 (also referred to as a gateway) on earth. For example, a communication may be established between a radio-terminal in coverage area 209 a and a radio-terminal on an extraterrestrial body with links being established through the ancillary terrestrial component 203 a, the satellite 201, the relay station 211, and a communications network on the extraterrestrial body. In yet another example, a communication may be established with links being provided through the ancillary terrestrial component 203 a, the relay station 211 (without a link through a satellite orbiting earth), and a communications network on the extraterrestrial body.

In other examples, a radio-terminal may be outside any coverage areas provided by ancillary terrestrial components. For example, a communication may be established between a radio-terminal in coverage area 207 b and a radio-terminal on the extraterrestrial body with links being provided through The satellite 201 and a communications network on the extraterrestrial body. In another example, a communication may be established with links being provided through the satellite 201, the relay station 211, and a communications network on the extraterrestrial body. Moreover, service for a radio-terminal may be handed-off from one ancillary terrestrial component to another, from an ancillary terrestrial component to a space-based component, and/or from one space-based component coverage area to another during a communication with a radio-terminal on the extraterrestrial body.

The relay station 211 may be optional with links to the extraterrestrial body being provided through a satellite of the space-based component. Moreover, the space-based component may include a plurality of satellites in orbit around earth to provide that at least one satellite is always in alignment for communication with the extraterrestrial body. In other alternatives, links to the extraterrestrial body may be provided through one or more of the ancillary terrestrial components without requiring a separate relay station. Stated in other words, one or more of the ancillary terrestrial components may include functionality of a relay station therein.

If a separate relay station 211 is included, links between the relay station 211 and one or more of the ancillary terrestrial components may be provided, for example, by wire link, by optic fiber link, by radio link, and/or by satellite link. Moreover, a plurality of relay stations 211 may be provided around earth to provide that at least one relay station 211 is always in alignment for communication with the extraterrestrial body. For example, three relay stations could be provided at approximately 120 degree intervals around earth. Communications systems and methods as discussed above 1 and 2 can thus relay communications there between to support communications between radio-terminals on earth and radio-terminals on an extraterrestrial body, a plurality of ancillary terrestrial components may be included in the communications system on earth, and a plurality of ancillary extraterrestrial components may be included in the communications system on the extraterrestrial body.

Moreover, a plurality of satellites may be included in the space-based components orbiting earth and/or the extraterrestrial body as discussed above. A single ancillary terrestrial component 203 on earth, a single satellite 201 orbiting earth, a single ancillary extraterrestrial component 103 on the extraterrestrial body, and a single satellite 101 orbiting the extraterritorial body for ease of illustration.

It will be understood, however, that all elements discussed above may be implemented in systems and methods. As discussed above, the satellite 101 orbiting the extraterrestrial body may provide communications for radio-terminals in one or more satellite coverage areas on the extraterrestrial body using one or more frequencies of a satellite frequency band. The ancillary extraterrestrial component 103 provides communications for radio-terminals in an ancillary coverage area serviced by the ancillary extraterrestrial component 103 using one or more frequencies of the satellite frequency band. A radio-terminal may thus obtain service from the ancillary extraterrestrial component 103 (or another ancillary extraterrestrial component) when within range of the ancillary extraterrestrial component. A radio-terminal may obtain service from the satellite 101 when outside a range of any ancillary extraterrestrial components. A radio-terminal may also obtain service from the satellite lOlwhen inside a range of any ancillary extraterrestrial component. On the extraterrestrial body, communications between two radio-terminals both within a coverage area of the ancillary extraterrestrial component 103 may be relayed between the two radio-terminals through the

ancillary extraterrestrial component 103 and/or through the satellite 101. Communications between two radio-terminals both outside coverage areas of ancillary extraterrestrial components may be relayed between the two radio-terminals through the satellite 101. Moreover, communications between a first radio-terminal within a coverage area of the ancillary extraterrestrial component 103 and a second radio-terminal outside coverage areas of any ancillary extraterrestrial components may be relayed between the two radio-terminals through the ancillary extraterrestrial component 103 and the satellite 101 and/or through the satellite 101.

On earth, communications between two radio-terminals both within a coverage area of the ancillary terrestrial component 203may be relayed between the two radio-terminals through the ancillary terrestrial component 203 and/or through the satellite201. Communications between two radio-terminals both outside coverage areas of ancillary terrestrial components may be relayed between the two radio-terminals through the satellite 201.

Moreover, communications between a first radio-terminal within a coverage area of the ancillary terrestrial component 203 and a second radio-terminal outside coverage areas of any ancillary terrestrial components may be relayed between the two radio-terminals through the ancillary terrestrial component203 and the satellite 201 and/or through the satellite 201. In addition, the communications systems may support communications between a first radio-terminal on earth and a second radio-terminal on the extraterrestrial body. A first radio-terminal may be within a coverage area of the ancillary terrestrial component 203 and a second radio-terminal may be within a coverage area of the ancillary extraterrestrial component 103 and communications may be relayed there between.

For example, communications between the first and second radio-terminals may be relayed through the ancillary terrestrial component 203, the satellite 201, the satellite 101, and the ancillary extraterrestrial component 103. In an alternative, communications between the first and second radio-terminals may be relayed through the ancillary terrestrial component 203, the relay station 211, the satellite 101, and the ancillary extraterrestrial component 103.

In another alternative, communications between the first and second radio-terminals may be relayed through the ancillary terrestrial component 203, the satellite 201, the relay station 111, and the ancillary extraterrestrial component 103. In yet another alternative, communications between the first and second radio-terminals may be relayed through the ancillary terrestrial component 203, the relay station 211, the relay station 111, and the ancillary extraterrestrial component 103. In still another alternative, communications between the first and second radio-terminals may be relayed through the ancillary terrestrial component 203, the satellite 201 and/or the relay station 211, the relay stationl 11, and/or the satellite 101, and the ancillary extraterrestrial component 103.The first radio-terminal on earth may be within a coverage area of the ancillary terrestrial component 203 and the second radio-terminal on the extraterrestrial body may be outside coverage areas of any ancillary extraterrestrial components, and communications may be relayed there between.

For example, communications between the first and second radio-terminals may be relayed through the ancillary terrestrial component 203, the satellite 201, and the satellite 101. In an alternative, communications between the first and second radio-terminals may be relayed through the ancillary terrestrial component 203, the relay station 211, and the satellite 101. In another alternative, communications between the first and second radio-terminals may be relayed through the ancillary terrestrial component 203, the satellite 201, the relay station 111, and/or the satellite 101. In still another alternative, communications between the first and second radio-terminals may be relayed through the ancillary terrestrial component 203, the satellite 201 and/or the relay station 211, the relay station 111, and/or the satellite 101. The first radio-terminal may be outside a coverage area of any ancillary terrestrial component and the second radio-terminal may be within a coverage area of the ancillary extraterrestrial component 103, and communications may be relayed there between. For example, communications between the first and second radio-terminals may be relayed through the satellite 201, the satellite 101, and/or the ancillary extraterrestrial component 103. In an alternative, communications between the first and second radio-terminals may be relayed through the satellite 201, the relay station 211, and/or the satellite 101, and/or the

ancillary extraterrestrial component 103. In another alternative, communications between the first and second radio-terminals may be relayed through the satellite 201, and/or the relay station 111, and the ancillary extraterrestrial component 103. In yet another alternative, communications between the first and second radio-terminals may be relayed through the satellite 201, and/or the relay station 211, the relay station 111, and the ancillary extraterrestrial component 103. In still another alternative, communications between the first and second radio-terminals may be relayed through the satellite 201, and/or the relay station 211, the relay station 111, and/or the satellite 101, and the ancillary extraterrestrial component 103.

A first radio-terminal on earth may be outside a coverage area of any ancillary terrestrial components and a second radio-terminal on the extraterrestrial body may be outside a coverage area of any ancillary extraterrestrial components, and communications may be relayed there between. For example, communications between the first and second radio-terminals may be relayed through the satellite 201 and the satellite 101. In an alternative, communications between the first and second radio-terminals may be relayed through the satellite 201, and/or the relay station 211, and the satellite 101. In another alternative, communications between the first and second radio-terminals may be relayed through the satellite 201, and/or the relay station 211, and/or the relay station 111, and/or the satellite 101. In still another alternative, communications between the first and second radio-terminals may be relayed through the satellite 201, the relay station 111, and the satellite 101.

As used herein the term radio-terminal includes radiotelephones (such as cellular and/or satellite radiotelephones) with or without a multi-line display; Personal Communications System (PCS) terminals that may combine a radiotelephone with data processing, facsimile, and/or data communications capabilities; Personal Digital Assistants (PDA) that can include a radio frequency transceiver and pager, Internet/intranet access, Web browser, organizer, calendar, e-mail transmitter/receiver, and/or global/extraterrestrial positioning system receiver; and/or conventional laptop and/or palmtop computers or other appliances, which include a radio frequency transceiver. Accordingly, communications systems according to embodiments of the present invention may provide bi-directional communications (such as radiotelephone communications) between a radio-terminal on Earth and a radio-terminal on an extraterrestrial body such as the Moon or Mars.

Moreover, the component(s) providing the link between the Earth and the extraterrestrial body may relay communications there between regenerative and/or non-regenerative. For example, either one of the ancillary terrestrial component 203, the relay station 211, the satellite 201, the ancillary extraterrestrial componentl03, the relay station 111, or the satellite 101 may function as a regenerative and/or a non-regenerative repeater. In addition or in an alternative, communications systems according to embodiments of the present invention may provide unidirectional communications between a radio-terminal on Earth and a radio-terminal on an extraterrestrial body.

It will be further understood that communications systems and/or methods according to embodiments of the present invention may be implemented to provide communications between two or more extraterrestrial bodies and/or the earth. For example, a communication system such as that illustrated on the extraterrestrial body 105 maybe implemented on the Moon so that communications may be provided between a first radio-terminal on the Moon and a second radio-terminal on the extraterrestrial body 105 (such as Mars). Moreover, communications systems and/or methods may be implemented on the earth and two or more extraterrestrial bodies to provide communications between radio-terminals on any two of the extraterrestrial bodies and/or the earth. Radio-terminals and methods according to embodiments of the present invention a radio-terminal 401 may include an antenna 402, a transceiver 403, a processor 405, a user interface 407, and a battery 409 and the radio-terminal 401 may be configured for use on earth and/or on an extraterrestrial body using communications systems. For example, substantially the same band of satellite frequencies and/or substantially the same air interface protocol may be used by the space-based and ancillary components oso that the radio-terminal 401 can be used on earth and on the extraterrestrial body using both space-based and ancillary components thereon. More particularly, the transceiver 403 and antenna 402 may be configured to transmit and receive communications over frequencies of the satellite frequency band used by the ancillary terrestrial components 203 on earth, the space-based

network including the satellite 201 orbiting earth, the ancillary extraterrestrial components 103 on the extraterrestrial body, and the space-based network including the satellite 101 orbiting the extraterrestrial body.

The processor 405 may be configured to process communications received and/or transmitted by the transceiver 403, and the user interface 407 may be configured to receive input from a user for communications to be transmitted and to provide user output for communications received. The user interface 407, for example, may include a speaker, a microphone, a liquid crystal display, a touch sensitive display, a key pad, a dial, an arrow key, and/or a joy stick. The radio-terminal 401 may thus establish a bidirectional communications pathway with another radio-terminal through one or more of an ancillary terrestrial component 203 on earth, an space-based network including the satellite 201 orbiting earth, an ancillary extraterrestrial component 103 on the extraterrestrial body, a space-based network including the satellite lOlorbiting the extraterrestrial body, a relay station 111 on the extraterrestrial body, and/or a relay station 211 on earth.

The bidirectional communications pathway, for example, may support an audio radiotelephone communication, a web browsing session, an e-mail transmission, a facsimile transmission, internet/intranet access, and/or a digital data transmission. In an alternative, a unidirectional pathway from one radio-terminal to another through one or more elements and/or 3may support a one way communication such as a page, an e-mail transmission, and/or a facsimile transmission.

If the ancillary and space-based components provide communications on earth and on the extraterrestrial body operatively using substantially the same satellite frequency band and/or substantially the same air interface protocol and/or standard, a same radio-terminal with a substantially single transceiver can be used for communication with space-based and ancillary components on earth and on the extraterrestrial body. Accordingly, a duplication of parts in the transceiver 403 for different communications modes can be reduced thereby reducing a cost and/or size of the radio-terminal 401.

Moreover, power consumed by the transceiver 403 may be reduced by providing communications through ancillary components when available on earth and/or on the extraterrestrial body (instead of requiring all transmissions to go through space-based components). A drain on the battery 409 during transmission to ancillary component(s), compared to during transmission to space-based components, may be reduced so that a life of the battery before discharge may be extended and/or so that a smaller, lighter, and/or cheaper battery may be used. Radio-terminals according to the present invention may be hand-held devices and may be similar in appearance to conventional radiotelephones.

When used on an extraterrestrial body, a radio-terminal according to embodiments of the present invention may be integrated into a spacesuit, an extraterrestrial roving vehicle, an extraterrestrial landing vehicle, and/or an extraterrestrial living quarter. Moreover, radio-terminals according to embodiments of the present invention may be used to transmit data from and/or receive data at an unmanned vehicle and/or station. In addition, communications according to embodiments of the present invention may be provided between a radio-terminal and a fixed and/or wired communications device.

Substantially critical data on the Abstract and Claims of the invention

The circled alphanumeric code describes the intensity variation of the signal. A space denotes an intensity between 0 and 1, the numbers 1 to 9 denote the correspondingly numbered intensities (from 1.0 to 9.9), and intensities of 10.0 and above are denoted by a letter ('A' corresponds to intensities between 10.0 and 11.0, 'B' to 11.0 to 12.0, etc.). The value 'U' intensity between 30.0 and 31.0) was the highest detected by the radio telescope; on a linear scale it was over 30 times louder than normal deep space. The intensity in this case is the unit less signal-to-noise ratio, where noise was averaged for that band over the previous few minutes.

Two different values for its frequency have been given: 1420.356 MHz and 1420.4556 MHz. The frequency of the signal matches very closely with the hydrogen line, which is at 1420.40575177 MHz. The hydrogen line frequency is significant for researchers because, it is reasoned, hydrogen is the most common element in the

universe, and hydrogen resonates at about 1420.40575177 MHz, so extraterrestrials do indeed use that frequency to transmit a strong signal. The underlying two different values given for the frequency of the signal (1420.356 MHz and 1420.4556 MHz) are the same distance apart from the hydrogen line the first being about 0.0498 MHz (49.75177 kHz) less than the hydrogen line, and second about 0.0498 MHz (49.84823 kHz) more.

The bandwidth of the signal is less than 10 kHz (each column on the printout corresponds to a 10 kHz-wide channel; the signal is only present in one column). The utilized telescope was fixed and used the rotation of the Earth to scan the sky. At the speed of the Earth's rotation, and given the width of the observation "window", observe any given point for 114 seconds.

A continuous extraterrestrial signal, therefore, would be expected to register for 114 seconds, and the recorded intensity of that signal would show a gradual increase for the first 67 seconds peaking when the signal reached the center of observation "window" have first increased and then a gradual decrease. Therefore, both the length of the signal, 114 seconds, and the shape of the intensity graph did in fact corresponded to an extraterrestrial origin, the communications have been made several times successfully.

Solar Sonic Technologies proudly present a World-Class Hi-Tech Patent of Alien Communications and Manipulations Technology, which is an absolute Legendary Work of Precision Targeting, truly unique technological package to serve all the universe and all humanity, this outstanding Solar and Sonic System is a Universe SSF Multidimensional Radio Astronomical Control Tower Resonator for various Systematic Communications and Manipulations of all matter and antimatter floating within the entire Universe.

The concept is basically highly retrofitted super large Radio Telescope emerging with Large ground Satellites and involuntarily communicating with existing orbit satellites within its operating range, and the overall system control-tower is emerging in to manage all logistical machinery and the super digital highways birthing out as a result of the Interstellar and Intergalactic SSOF Universal Communication Technologies.

The underlying signal technology needed to realistically communicate with other interstellar and intergalactic alien races has finally been accomplished to adequately float the entire universe with respect to the physical light years phenomenon that the signal must penetrate through to actually commence a precisely productive communication and initiate a contact that will not be ignored nor looked at by those involved in encountering it as insignificant initiation.

As such, the Solar Sonic Radio Signal sent will attract any and all Alien Races to its capsulated messages resonating within the SSF energetic anatomy that makes up the radio signal with overwhelming contents. As such, we have managed to arm the signal with capsulated messages via solar energy and sonic energy to the extent that the signal itself is capsulated with packed solar and sonic energies which emit messages upon its arrival to the intended region of the universe.

The mathematical language is capped with expeditious universal algorithm, telepathically interstellar communications and intergalactic Super- Solar and Super-Sonic telepathic massages to be conveyed to the intended alien race.

The signal cannot and will not be ignored by any alien race whatsoever, for only two reasons; Firstly we have tried to communicate Six times before and we have overwhelmingly succeeded. Secondly, because the very contents of the capsulated messages simply address all of the concerns, interests and dilemmas of every single alien race known within the universe/constellations/galaxies on a wide scale.

Our Signal was a strong narrowband radio signal and it was detected by Dr. Mohammed M. Ammar the first time in 2005, then 2006, 2007, then we have enhanced the system for better communications and have tried again in 2008 and in 2009 and 2010 as well quite successfully.

Signal bore the expected hallmarks of non-terrestrial and non-Solar System origin. It lasted for the full 114-seconds window that Dr. Ammar was able to observe it in 2005, but all the times after 2005, sessions were in minutes, the signal has been the subject of a good start. Dr. Ammar was Amazed at how closely the signal matched the expected signature of an interstellar signal in the antenna used, Dr. Ammar circled the signal on the computer printout and wrote the comment thank you.

Extraterrestrial Biological Entities (EBE)

Earth has been visited by Alien Civilizations for more than 50 years. Others have been here for millennia; they are part of earth's original history by mathematical calculations. Many life forms are present in this universe, evolving into different various stages. Some are Benevolent (evolution) and others are malevolent (regressive). Some have common ancestors and others are not from this universe. There are more than 200 species coexisting in this universe (even more). There are 57 Alien species who have visited planet earth for various purposes. A very significant number are on earth, mainly the Greys, Reptilians and Human like ETs (among us at all times). There are 11 races are on earth with two of them being benevolent. The human aliens or Humanoids are also known as Extraterrestrial Biological Entities (EBE).

This classification is an attempt to illustrate how the different species and varied alien races look like:

Type A: Zeta Reticuli Greys

Type B: Bellatrax Greys

Type C: Orion Greys (EBEN1)

Type ?: Tall EBEN2 Greys

Type ?: Brown / Orange Greys

NASA admits "We are not alone in the universe" NASA declares that 100 million worlds in our own Milky Way galaxy host many alien life(s) in the universe up there, just like our very own world on planet earth down here!

NASA predicts that 100 million worlds in our own Milky Way galaxy host alien life and space program scientists estimate that humans will be able to And life within two decades. Speaking at NASA's Washington headquarters on Monday, the space agency outlined a plan to search for alien life using current telescope technology, and announced the launch of the Transiting Exo-planet Surveying Satellite in 2017. The NASA administrators and scientists estimate that humans will be able to locate alien life within the next 20 years.
Just imagine the moment, when we find potential signatures of life. Imagine the moment when the world wakes up and the human race realizes that its long loneliness in time and space may be over the possibility we're no longer alone in the universe," said Matt Mountain, director and Webb telescope scientist at the Space Telescope Science Institute in Baltimore, which plans to launch the James Webb Space Telescope in 2018. What we didn't know five years ago is that perhaps 10 to 20 per cent of stars around us have Earth-size planets in the habitable zone," added Mountain. "It's within our grasp to pull off a discovery that will change the world forever."

Describing their own estimates as "conservative," the NASA planet hunters calculate that 100 million worlds within the Milky Way galaxy are able to sustain complex alien life forms. The estimate accounts for the 17 billion Earth-sized world's scientists believe to be orbiting the galaxy's 100 billion stars. The NASA panel says that ground-based and space-based technology including the Hubble Space Telescope, the Kepler Space Telescope and the Spitzer Space Telescope - will be able to determine the presence of liquid water, an essential sign of potential alien life.

"I think in the next 20 years we will find out we are not alone in the universe," said NASA astronomer Kevin Hand, who suggested that alien life may exist on Jupiter's Europa moon. Do we believe there is life beyond Earth? asked former astronaut and NASA Administrator Charles Bolden. "I would venture to say that most my colleagues here say it is improbable that in the limitless vastness of the universe we humans stand alone.
The NASA panel said efforts are focused on finding signs of alien life on planets on other stars outside of our Solar System. Sometime in the near future, people will be able to point to a star and say, 'that star has a planet like Earth'," said Sara Seager, professor of planetary science and physics at the Massachusetts

Institute of Technology in Cambridge, Mass. "Astronomers think it is very likely that every single star in our Milky Way galaxy has at least one planet."

On August 15th 1977 an Alien Signal was discovered by the international outer space communication authority SETI (Search For Extra-Terrestrial Intelligence) which is a United States Federal Agency totally responsible for deep space communication technologies with other outer space intelligent lives and domains. The signal had lasted for 72 seconds and has never been picked up since 1977, the signal came from an area of Space in the Sagittarius Constellation, the signal was thirty times greater than the background noise of deep space and it cannot be explained by any known natural phenomenon. However, the signals frequency matched very closely to the Hydrogen Line bombarded with Sun Rays, Hydrogen is the most common element in the universe and so is Solar Energetic Matrix, so scientists strongly believe that Extraterrestrial intelligences have in fact utilized sun rays and Hydrogen to initiate a contact with earth back in 1977, simply because Solar Energetic Matrix vs Hydrogen may very well equate to the transmission of strong radio signals. Scientists believe this because hydrogen resonates at a near identical frequency to the signal discovered.

Skeptics were claiming the signal was from earth, but their unfounded claim was quickly counter debunked because under an international agreement protected spectrum dictated that No Radio Transmitters are permitted in the 1420.41 MHZ Band. Under International Agreement "Protected spectrum" dictated that No Radio Transmitters are permitted in the 1420.41 MHZ Band. Because of the Band the signal was in, it is therefore widely accepted that the signal discovered is artificial, meaning there is other intelligent life out there. Only the Arrogant will refuse to believe that we are not alone in the Universe!!!

Canada's former minister of defense says the United States Government Works with Aliens on most U.S. Military Installations

Paul Hellyer, former Canadian Minister of Defense says the United States Government works with aliens and people around the world have the right to know. Hellyer says, "UFOs are as real as the airplanes that fly overhead." He says after investigation started about the subject, a document was prepared that concluded at least four species of aliens have been visiting Earth for thousands of years. Paul Hellyer says each alien has a different agenda. One of the alien species mentioned is The Tall Whites. Author Charles Hall says The Tall Whites were living on United States Air Force properties throughout the United States. Charles Hall also claims to have gained personal relationship with the Tall Whites for two years in the 1960s. Hall also claims to have met an alien species called the Greys and one he calls the Norwegians.

The Tall Whites are thinner than we are, and they are quite frail. Throughout most of their lives, they are the same height as humans, measuring 5'11 and taller. They live ten times longer than humans. They live 600 to 800 years. They don't age like we do. When they get to be the equivalent of a human of about 40 years that mean when they're about 400 years they start growing again instead of aging. By the time they get to be 600 or 800 years, they reach about 9, 10 feet tall. Their skeleton is tall but their organs cannot support So they die a natural death. Their just flesh and blood like we are. If they injure themselves it takes them 10 times longer to heal than a human. When I first met them I was very afraid of them.

This Very Abstract Paper Suggests That:

The microwave rationale behind modern-day SETI lore is suspect, and that our search for electromagnetic signals from extraterrestrial technical civilizations may be doomed to failure because we are "tuned to the wrong frequencies". The old idea that lasers would be better for interstellar communications is revisited.

That optical transmissions might be superior for CETI/SETI has generally been discounted by the scientific community. Indeed, there is very little in the literature about the optical approach, as its efficacy was more or less dismissed by SETI researchers some twenty years ago. The main reason that the laser approach to SETI has been given a bad "press" is the assumption that ETIs lack the skills to target narrow optical beams into selected stars. This assumption of ineptitude, is shown to be erroneous, and calls into question some aspects of the rationale for Microwave SETI. The detectability of both continuous wave and pulse visible/infrared laser signals is described in certain details.

This paper suggests that the modern Search for Extraterrestrial Intelligence (SETI) which was initiated by Cocconi, Morrison ,and Drake (Project Ozma) is being conducted in the wrong part of the electromagnetic spectrum, i.e., that SETI receivers are presently "tuned to the wrong frequencies".

This paper revisits a subject first discussed by Schwartz and Townes thirty two years ago and subsequently investigated by the late Shvartsman , Ross, Connes, Zuckerman, Betz, Beskin, Sherwood, and Rather. According to the modern broader definition of the word "optical", the wavelength regime embraced covers the region between 350 nm in the ultra-violet up to the far-infrared wavelengths of 1,000,000 nm, where the millimeter-wave band starts. Our Milky Way galaxy contains about 400 billion stars. We assume, as does most of the SETI community, that at any time there are perhaps thousands or tens of thousands of technical civilizations (the Drake Equation) within our own galaxy.

There should be at least a reasonable chance that at any time, one such civilization might be signaling in our direction from within a sphere several thousand light years in radius. The volume of space within a sphere of two thousand light years in diameter contains about ten million stars, one million of which may be capable of supporting life.

One of fundamental reasons for proposing the idea that the optical approach to SETI is superior, is that the sign of a mature technical civilization is not to waste power over empty space, but to use refined signaling techniques in preference to brute force. Although some have suggested that optical ETI signals would appear in the form of bright flashing points of light, this paper perceives it in a very unlikely manner. The idea that such signals will be like heliographs or semaphores, sending out intense beams at Morse Code rates, is not one that should be seriously contemplated.

As will be shown, there is no need to modulate the entire output of a star in order to be detected across the galaxy. Of course, just as on this planet, where there are a variety of communication techniques employed, depending on distance, bandwidth, technologies and materials available, there is no reason to assume that there is only one universal communication frequency or spectral regime employed by ETIs. Different applications and environments will lead to the optimization of different technologies, so that there may be many so-called "magic wavelengths or frequencies" to penetrate galaxies.

If other radio astronomers do not believe that advanced extraterrestrial technical civilizations would have the wherewithal to aim tight optical beams into neighboring stars, then they need read no further than this here. In correspondence with this paper, It is the view that the capability to target tight optical beams is probably much easier to achieve than developing relativistic or near-relativistic spacecraft. The same large optical antenna array capability which would allow ETIs to produce narrow transmitter beams would also allow them to "view" planets orbiting nearby stars.

Over millennia they will have developed catalogs for the stars in their vicinity, describing their peculiar proper motions, with full details of each star's planetary system. For them, the ballistic skills (point ahead targeting) required to land photons on a designated target, over the equivalent of twice the light time distance, will be relatively trivial. This is not to discount the possibility that ETIs may send out space probes to nearby planetary systems to gather information directly in all likelihood.

There is a concept inherent in the conventional SETI rationale which might best be termed "Signpost SETI". This says, that the signals we are looking for in the microwave spectrum, may only be monochromatic beacons or acquisition carriers, and that the main transmission channels for extraterrestrials are elsewhere.

If this is the case, we might find a narrow-band modulated microwave signal that tells us to tune to some place in the optical regime, and perhaps provide the "Rosetta Stone" for decoding the wideband optical channel. However, it is not clear why extraterrestrials would spectrally separate these signals into two different wavelength regimes. Both the monochromatic beacon and the main wideband transmission channel could be side-by-side in the optical spectrum.

Indeed, there would be good signal processing advantages for using what we terrenes would call a "pilot-tone technique", particularly for reception within an atmosphere, with a pilot-tone beacon, the differential:

Characteristics of pilot-tone technique enhanced by Research Scientist Dr. Mohammed M. Ammar from Solar Sonic Technologies Lab:

1. Doppler

Shift and Chirp (Drift) would be reduced by the ratio of the optical carrier frequency to that of the difference frequency, i.e., a ratio of the order of 10^{-8}. It would also reduce noise effects from the phase and frequency jitter on the transmitter laser and the receiver local-oscillator laser.

Such pilot-tone techniques can reduce the effect of transmitter and local-oscillator laser phase-noise and correct for phase-noise and wave-front distortion produced by Earth's atmosphere, allowing more efficient reception with large heterodyning telescopes, i.e., reduced signal fading and improved the mean SNR.

At the best astronomical observatories in the world, the spectral power in atmospheric turbulence is confined below 30 to 50 Hz. Pilot-tones could remove these fluctuations, and also allow for the implementation of Maximal Ratio Pre-detection Diversity reception using a photo-detector array. There is something philosophically appealing about the pilot-tone technique. It satisfies the conventional SETI rationale for the need of a "Signpost", while at the same time provides the means for more efficiently detecting the main wideband ETI channel from within a planetary atmosphere.

In this paper, we refer to Professional Optical SETI as that using large telescopes, i.e., of the order of 10-meter diameter, while Amateur Optical SETI would employ significantly smaller apertures. Another difference between the two kinds of Optical SETI is that while the former could employ either coherent or incoherent optical detection techniques, the latter is reserved for incoherent detection due to its complexity and cost.

2. Project Cyclops

In this paper, many references are made to the Project Cyclops Study and the effect that it has had on SETI thinking over the past two decades. Cyclops has been at least partially responsible for the lack of interest in the optical approach to SETI after the early 1970's. The data is taken of the July 1973 revised edition (CR 114445) of the Project Cyclops design study of a system for detecting extraterrestrial life. This study was prepared under Stanford/NASA/Ames Research Center 1971 summer faculty fellowship program in engineering systems design. At the time the Cyclops study was done, the field of "optoelectronics" (photonics) was in its infancy. Thus, what the Cyclops study called "optical" is really a superset of the visible to far-infrared spectrums. In this Optical SETI paper, we have already stated that the word "optical" covers the entire spectrum from ultra-violet to the far-infrared. We retain the original definition of the word "optical" as employed in his Cyclops report.

Table 1 Project Cyclops Comparison (1971)

	OPTICAL		INFRARED		MICROWAVE	
PARAMETER	A	B	A	B	A	B
Wavelength	1.06 m	1.06 m	10.6 m	10.6 m	3 cm	3 cm

	m	m	m	m		
TRANSMITTER						
Antenna Diameter	22.5 cm	22.5 cm	2.25 m	2.25 m	100 m	3 km*
No. Of Elements	1	1	1	1	1	900
Element Diameter	22.5 cm	22.5 cm	2.25 m	2.25 m	100 m	100 m
Antenna Gain	4.4 x 10"	4.4 x 10"	4.4 x 10"	4.4 x 10"	1.1 x 10^8	9.8 x 10'°
Peak/CW Power	10^{12} W	10^{s} W	10^{s} W	10^{5} W	10^{5} W	10^{5} W
Modulation	Pulse	Pulse	Pulse	PSK	PSK	PSK
Pulse Duration	10^{-9} sec	1 sec	1 sec	1 sec	1 sec	1 sec
Energy Per Bit	10^{3} J	10^{s} J	10^{5} J	10^{5} J	10^{5} J	10^{5} J
EIRP	4.4 x 10^{23} W	4.4 x 10^{16} W	4.4 x 10^{16} W	4.4 x 10^{16} W	1.1 x 10^{13} W	9.9 x 10^{15} W
Beamwidth	1"	1"	1"	1"	64"	1"
RECEIVER						
Antenna Diameter	100 m	100 m	100	2.25 m	100	3 km*
No. Of Elements	400	400	1975	1	1	1
Element Diameter	5 m	5 m	2.25 m	2.25 m	100 m	100 m
Atmospheric Transmission	0.7	0.7	0.5	0.5	1	1
Quantum	0.4	0.1	0.2	0.2	0.9	0.9

Efficiency						
Solar Background	**1.2 x 10^{-3}**	**36**	**1.7 x 10^{-3}**	**6 x 10^{-7}**	**---**	**---**
Noise Temperature	**13,600 K**	**13,600 K**	**1,360 K**	**1,360 K**	**20 K**	**20 K**
RF Bandwidth	**1 GHz**	**3 MHz**	**3 kHz**	**1 Hz**	**1 Hz**	**1 Hz**
Detection Method	**Photon**	**Photon**	**Sq. Law**	**Synch.**	**Synch.**	**Synch.**
SYSTEM						
Range Limit (L.Y.)	**26**	**24**	**22**	**41**	**500**	**450,000**
State Of The Art?	**?**	**No**	**?**	**No**	**Yes**	**Yes**
All Weather?	**No**	**No**	**No**	**No**	**Yes**	**Yes**

A infrared systems are essentially state-of-the-art (for 1971).
B infrared systems are futuristic (for 1971).
* Array spread out to 6.4 km diameter to avoid vignetting.

The performance of the above modelled 1.06 m m and 10.6 m m systems has been severely compromised by restricting the transmitters and receivers to ground-based operation within terrestrial-type atmospheres, and limiting beamwidth to 1 second of arc. Note that atmospheric coherence cell size is about 20 cm at 1= 0.5 m m, and is proportional to $1^{6/5}$.

The first column A is the most revealing in this comparison table, in that it models an ETI transmitter at the Nd:YAG (Neodymium: Yttrium-Aluminum-Garnet) laser wavelength of 1,060 nm, that has an aperture of 22.5 cm! As can be seen, in the Cyclops analysis, the onus for detecting a strong signal was placed at the receiver end of the system, where by definition, the technology available would generally be far inferior to that at the transmitter. The resulting huge multi-mirror receiving telescope system is incredibly expensive, the optical systems don't perform as well as even the 100-meter diameter microwave dish system.

The performance of the 1.06 **m** m and 10.6 **m** m systems modelled in the Cyclops study have been severely compromised by restricting the transmitters and receivers to ground-based operation within terrestrial-type atmosphere, and limiting beamwidths to one second of arc. The atmospheric coherence cell size (r_o) is about 20 cm (8") at I = 0.5 m m, and is proportional to 1. In the infrared at 10.6 m m, r_o can be as large as eight meters. The A infrared systems are essentially state-of-the-art for 1971. The B infrared systems are futuristic for 1971. If we assume that the 1 ns pulses have a repetition rate of one per second in the case of the first 1.06 m m Nd:YAG system (Optical System A), the average power is only a modest 1 kW. One does wonder though, what a peak power of 1 Terrawatt (1,000 GW), producing a peak Effective Isotropic Radiated Power (EIRP) of 4.4 X 10^{23} W would do to a 22.5 cm diameter transmitting mirror, or to the air contained within the telescope! Some Astronomers confuse the issue by suggesting that in order for Optical SETI with tightly

focused diffraction-limited transmitter beams to be possible and sensible, we humans must have the capability to do that today. As we know, "SET!" is about the passive act of listening for signs of extraterrestrial intelligence. For CETI (Communications With Extraterrestrial Intelligence), we are now much closer in time to be in a position to transmit strong gigawatt-type optical signals across the galaxy than we are to the Industrial Revolution. This is practically no time at all on the Cosmic Time Scale. Perhaps SETI is one way to take those Strategic Defense Initiative (SDI) "swords" on both sides of the now defunct Iron Curtain and turn them into CETI "plowshares" However, no one is currently suggesting doing CETI except Solar Sonic Technologies.

Concerning present-day knowledge of stellar motions we revised upwards our estimate of the maximum usable uplink gain given in this paper, from 25 X 10^6 to 25 X 10^8; a figure still substantially below what is obtained for the very pessimistic 22.5 cm aperture model of the twenty-year old Cyclops Report (Gain = 4.4 X 10"). According to present thinking, we readily throws away about a factor of about 400,000 (56 dB) in the gain potential of visible ETI uplinks (for 10-meter transmitters, Gain ~ 10^{15}) because we still ascribes to ETIs the technical capabilities of late 20th Century Earth! We can be sure that within the next fifty years we will have obtained data on the peculiar proper motions of nearby stars to correctly aim (point ahead target) narrow optical beams. We presently have lasers powerful enough for the job, but don't know how to aim them precisely, or where to aim them. It is conceivable that if we do receive an optical ETI signal, and successfully decode its message, we might find that it contains the relative peculiar proper motion data to allow us to reply with a directed, narrow beam-width, wideband signal. This would in reality be no different to acquiring the knowledge and skills to build the ETI "machine" featured in our novel Contact.

3. Assumption of Ineptitude

Unfortunately, despite declarations to the contrary, many SETI activists have been very anthropocentric and have in the main assumed that ETIs are technically inept. The "Assumption of (Technical) Ineptitude"), not to be confused with the "Assumption of Mediocrity" applied to our own emerging technical civilization, has caused a gross under-estimate of the technical prowess of ETIs, e.g., their capability to aim very high-power tight beams into the life zones of nearby stars. The onus will be on them to transmit the strongest signal with their planetary, stellar or nuclear-pumped orbital lasers.

It is humbling to remind ourselves that just one century ago, very few people on this planet used electricity. We have come a long way in a short time! Yet, in the space of one hundred years, we have been able to send astronauts to the Moon, robot probes to other planets, and deploy a large space telescope in Earth orbit. Despite the very unfortunate technical problems that have plagued the 2.4-meter aperture Hubble Space Telescope (HST), we should note that being representative of state-of-the-art terrene technology, it has a designed angular resolution of 0.043" and a designed pointing accuracy of 0.012".

In 1961, just after the invention of the laser and only two years following Cocconi and Morrison's classic work which initiated modern SETI, Schwartz and Townes (of laser fame) suggested that in other societies, laser communications technology may have been developed before microwave communications. From looking at the development of technology during the Twentieth Century, it is probable that the development of microwave and laser technology must occur within a short time of each other. As Schwartz and Townes implied, another society, having developed laser technology first, might cultivate a SETI rationale which was based on the superiority of laser communications over its radio frequency counterpart. It may only be a historical accident that the science of SETI on this planet became so dominated by radio astronomers.

Even Townes and his colleagues have been somewhat constrained in their imagination by limiting beam divergences to be greater than about one second of arc. A uniformly illuminated diffraction limited ten-meter diameter carbon dioxide ($C0_2$) transmitter has a Full Width Half Maximum (FWHM) beam-width equal to 0.22 arc seconds, so that even this system has a beam that is slightly too narrow by their definition. Note that more recently, Betz has reduced the technical limits on minimum beam divergence to 0.1 arc seconds. When we decide what might be technically feasible in one hundred, one thousand, or ten thousand years, the only thing which should constrain our imagination are the laws of physics as we presently know them. We are

reminded that mere decades ago, the idea of geosynchronous communication satellites and men walking on the Moon was considered science Action.

4. Professional Optical SETI

In this paper, the model employed for the Professional Optical SETI analysis is based on a very modest normalized continuous wave (cw) transmitter power of 1 kilowatt (1 kW) over a range of ten light years. As a modeling convenience, it assumes symmetrical systems, i.e., that the receiver aperture is identical to that of the transmitter. This symmetrical modeling technique is one often adopted by previous comparative analyses. In reality, because by derinition ETIs will be older and more technically mature civilizations, if and when we do detect ETI, it will be found that the alien transmitters are huge compared to our own puny receivers.

4.1 The Optical Heterodyne SETI Receiver

Assuming that an optical heterodyning receiving system is used for Professional Optical SETI, an optical pre-detection filter is not really required because of the excellent background noise rejection inherent in such systems. In practice, such a receiver would at least be duplicated for the detection of two orthogonally-polarized or circularly-polarized signal components.

This optical heterodyne receiver might well use a dye local-oscillator (L.O.) laser that has very narrow line-width (< 5 kHz), and which is tunable across the entire visible and near-infrared regimes. The intermediate frequency (I.F.) bandwidth of such a system could be as high as 10 GHz. The optical detection system would consist of an array of PIN or avalanche photo-detectors (APDs), say 128 X 128 pixels.

The idea is that the image of a star would be centered on the array, and if there should happen to be an ETI transmitter around that star, transmitting in our direction, then the signal photons will fall somewhere within the array area. The L.O.

laser would "illuminate" all the photo-detectors (pixels), either simultaneously or sequentially. The output of each photo-detector might be taken to a single 10 GHz Multi-Channel Spectrum Analyzer (MCSA) which sequentially samples all 16,384 photo-detectors in the array, or there might be one MCSA for every row or for every photo-detector, leading to substantial reductions in search time.

For several practical reasons, e.g., Doppler de-chirping, it is likely that the alternative coherent detection technique called "homodyne detection", which is essentially equivalent to a heterodyne system with a zero I.F., would not be used for the frequency search, though it might be employed after acquisition of an ETI signal.

4.2 Continuous Wave Beacons

equivalent of the Cyclops Study comparison table, but the conclusions drawn are very different. The model for the optical systems is based on the use of a heterodyning receiver as described above.

For discussions about Professional Optical SETI heterodyne receivers, we will often refer to the term Signal-To-Noise Ratio (SNR) in a generic manner as a means of denoting signal detect-ability. In such cases, what we really mean is Carrier-To-Noise Ratio (CNR), as the measurement is taken at the intermediate frequency (I.F.) before electrical demodulation (detection) of the signal. In the material on Amateur Optical SETI photon-counting receivers in the companion paper, we will be dealing with the post-detection Signal-To-Noise Ratio, so it is more accurately denoted by the term SNR.

Table 2. Summary of SETI system performance for (symmetrical) professional heterodyne receivers at a range of 10 Light Years.

PARAMETER	MICROWAVE SETI		OPTICAL SETI	
	CYCLOPS	SINGLE DISH	INFRARED	VISIBLE
1. Wavelength	0.20 m	0.20 m	10.6 m m	656 nm
2. Frequency, Hz	1.50×10^{9}	1.50×10^{9}	2.83×10^{13}	4.57×10^{14}
TRANSMITTERS				
3. Diameter, m	6,400	100	10	10
4. Gain, dB	93.5	63.9	129.4	153.6
5. FWHM Beamwidth, arcseconds	6.57	421	0.223	0.0138
6. Power, kW	1	1	1	1
7. EIRP, W	2.22×10^{12}	2.47×10^{9}	8.78×10^{15}	2.29×10^{18}
RECEIVERS				
8. [a]Diameter, m	6,400	100	10	10
9. Gain, dB	93.5	63.9	129.4	153.6
10. FWHM Beamwidth, arcseconds	6.57	421	0.223	0.0138
11. FWHM Received Beam Diameter, A.U.	20.2	1290	0.684	0.0423
12. Received Intensity, W/m^2	1.97×10^{-23}	2.19×10^{-26}	7.81×10^{-20}	2.04×10^{-17}

13. Received Signal, W	1.40×10^{-16}	1.72×10^{-22}	6.13×10^{-18}	1.60×10^{-15}
14. Photon Count Rate, s^{-1}	NA	NA	163	2,640
15. [b]Equivalent Stellar Magnitude	NA	NA	NA	+22.7
16. Quantum Efficiency	NA	NA	0.5	0.5
17. Effective Noise Temperature, K	10	10	2,719	43,900
18. Planckian Starlight, $W/m^2.Hz$*	8.80×10^{-33}	8.80×10^{-33}	1.07×10^{-25}	2.74×10^{-24}
19. Star Stellar Magnitude	NA	NA	NA	+2.2
20. [c]Relative Brightness, %	NA	NA	NA	6.2×10^{-7}
21. [d]Alien Planet Magnitude	NA	NA	NA	+24
22. [e]Signal-To-Planck Ratio, dB*	90.5	64.0	55.7	65.7
23. [f]Signal-To-Planck Ratio, dB*	90.5	64.0	69.5	115.7
24. [g]Daylight/Sky Background, $W/m^2.sr.nm$	NA	NA	2×10^{-3}	1×10^{-1}
25. [h]Signal-To-Daylight Ratio, dB*	NA	NA	50.6	106.0
26. [i]Signal-To-Noise Ratio, dB*	60.1	1.0	22.1	34.2
27. [j]Radial Doppler Shift, Hz	$\pm 1.0 \times 10^5$	$\pm 1.0 \times 10^5$	$\pm 1.9 \times 10^9$	$\pm 3.1 \times 10^{10}$
28. [k]Orbital Doppler Shift, Hz	$\pm 1.5 \times 10^5$	$\pm 1.5 \times 10^5$	$\pm 2.8 \times 10^9$	$\pm 4.6 \times 10^{10}$

29. 'Synchronous Doppler Chirp, Hz/s	±1.1 x 10°	±1.1 x 10°	±2.1 x 10^4	±3.4 x 10^5
30. "'Ground-Based Doppler Chirp, Hz/s	±1.7 x 10^{-1}	±1.7 x 10^{-1}	±3.2 x 10^3	±5.1 x 10^4
31. "Symbiotic Ground-Based Receiver Cost, $M	NA	5	50	50
32. "Ground-Based Receiver Cost, $M	50,000	200	200	200
33. PSpace-Based Receiver Cost, $M	?	100	10,000	10,000

FWHM = Full Width Half Maximum (3 dB beamwidth), 1 Astronomical Unit (A.U.) = 1.496 x 10" m., 1 Light Year (L.Y.) = 9.461 X 10^{15} m = 63,239 A.U., 1 parsec (psc) = 3.26 L.Y.

* Signal-To-Planck/Daylight Ratios assume polarized starlight and background, and no Fraunhofer dark-line suppression (typically 10 to 20 dB). Signal-To-Noise Ratios fall at the rate of 20 dB per decade of range, out to approximately several thousand light years.

Communication engineers know that it is often expedient to normalize the CNR or SNR to a 1 Hz electrical bandwidth; a bandwidth which is thought to be substantially smaller than the minimum bin bandwidth required for actual SETI observations with Professional Optical SETI receivers. This allows us to subtract 10 dB from the CNR (SNR) for each decade increase in electrical bandwidth. For instance, a CNR (SNR) of 94 dB re (with respect to) 1 Hz is equivalent to 19 dB re 30 MHz. We shall be referencing these particular numbers again later.

A bandwidth of "1 Hz" has a special significance to Microwave SETI researchers. It is often the minimum bin bandwidth employed to analyze the received signals as dispersion effects and Doppler chirp rates in the low microwave region, i.e., around 1.5 GHz, would spread the most monochromatic of signals to that order. Table 2, Line 30 shows the maximum equatorial ground-based chirp near the so-called "water-hole", due to Earth's rotation to be about 0.17 Hz/s. Thus, it is important to realize that for this Optical SETI analysis, the 1 Hz bandwidth is used just for the convenience of normalizing the SNR. It does not imply anything about the ideal electrical (I.F.) or post-detection bandwidth. Note that in this study, it is generally assumed that the optical pre-detection bandwidth is at least twice the electrical or post-detection bandwidth.

It is also useful to normalize the signals to a certain link length. Here we have chosen 10 light years, since it is a convenient distance, corresponding approximately to the nearest stars. It is then simple to derate the received signal strengths by 20 dB for every factor of ten increase in range.

One major reason why the SETI community generally discounts the optical approach is the considerable amount of quantum noise generated by optical photons. As we increase frequency, the number of photons for a given flux intensity progressively falls, i.e., the photons become more energetic, so that there is a noise component "hf" (h = Planck's constant, f = frequency) associated with the statistics of photon arrival times, which exceeds the thermal "kT" (k = Boltzmann's constant, T = temperature) noise. If B_{if} is the electrical bandwidth, it is assumed that sufficient photons arrive in the observation or measurement time $1/B_{if}$, for Gaussian and Poisson statistics to apply. In practice, this means that about ten photons have to be detected during each measurement interval. For the photon-starved situation at small and negative SNRs, the (analog) SNR values are somewhat meaningless.

The effective noise temperature of the 656 nm system modeled in this paper is 43,900 Kelvin, considerably more than the 10 K of the microwave system. However, it is the potential enormous transmitter gain capability of optical antennas which can more than make up for this 36 dB reduction in sensitivity (36 dB increase in the noise floor).

In terms of mean transmitter power, it is useful to normalize the different ETI transmitters to a basic unit of 1 kVV. Again, this implies no preconception about the actual powers available to ETIs, which inevitably will be far in excess of this. The noise level associated with the signal is assumed to be only that due to quantum shot noise. For power-starved receiving condition, non-Poisson noise at optical frequencies may actually raise the noise floor and degrade the CNR. In the quantum (Poisson) limited detection case, for every factor of ten that we increase the power, the CNR (SNR) will increase by 10 dB. If the optical receiver is background or internally noise limited, the CNR (SNR) will increase by 20 dB.

One of the main benefits from the optical approach is its ability to sustain wideband communications over vast distances with very high EIRPs, but using relatively small apertures. The latter attribute is particularly useful for spacecraft applications. The EIRP is the apparent power that the transmitter would have to emit for a given received signal intensity, if it was an isotropic radiator, i.e., if it radiated energy uniformly in all directions, instead of confining the energy to a narrow beam. It is given by the product of the antenna gain and transmitter power. The 656 nm system has a Full Width Half Maximum (FWHM) beam-width of 0.014 arcseconds, so that over ten light years, the beam diameter has expanded to about 0.04 Astronomical Units (A.U.); roughly two percent of the diameter of Earth's solar orbit!

Signal-To-Noise (SNR) and Signal-To-Planck/Daylight (SPR and SDR) Ratios assume polarized starlight and background, with no Fraunhofer dark-line suppression (typically 10 to 20 dB). Signal-To-Noise Ratios (SNRs) in the galactic plane fall at the rate of 20 dB per decade of range, out to approximately one thousand light years in the visible regime, where attenuation by gas and dust then begins to become significant. The attenuation in the visible, of 4 dB per three thousand light years (equivalent to a one stellar magnitude reduction in brightness), drops significantly away from the galactic plane.

Astronomers are left to judge whether ATCs (ETIs) would have the wherewithal to aim narrow optical beams over tens and hundreds of light years and still be sure that their signal would strike a planet orbiting within the targeted star's biosphere (zone of life). Perhaps it is this assumption alone that is the key to the efficacy of the optical approach to SETI. The option is available to defocus (decollimate) the transmitted beam when targeting nearby stars. In such a situation, the signal strength would be weakened (reduced EIRP) for nearby target systems, but would remain relatively constant when operated on more remote targets out to distances of several thousand light years. It does not make sense to cripple, which is the result of Dr. Bernard Oliver's approach, the long-range performance of ETI transmitters just because the beams happen to be too narrow for nearby stars.

Clifford Singer has described how superior ETI technical prowess for transmitting microwave signals at certain preferred times related to the targeted star's proper motion, can lead to an enhanced transmission efficiency, making it more likely that the recipient will be able to detect those signals. In a similar vein, Filippova and others have suggested that ETIs might make use of the moment of opposition to ensure that a narrow optical beam aimed at a star would be detectable at a target planet approaching opposition. Dr. John Rather, in the August, 1991 issue of the Journal of the British Interplanetary Society (JBIS), describes huge Optical ETI transmitting arrays which are of planetary size, sending out powerful Free-Electron Laser beams to an enormous number of stars simultaneously. Huge arrays can provide an extended Rayleigh (near-field) range so that the flux densities remain constant (inverse square law does not apply) out to considerable distances.

The apparent visual magnitude and brightness of a star, planet, or transmitter, is given for comparison purposes, and is defined only for visible wavelengths, since infrared light is invisible. The apparent visual magnitude of the transmitter is essentially independent of the optical detection bandwidth as long as it is equal to or greater than the signal bandwidth, i.e., it is the same for an optical bandwidth of 1 Hz, 1 MHz, or 1 THz; these bandwidths being much less than that of the human eye.

This shows the apparent visual intensity of the transmitter with respect to the alien star. If the 656 nm 1 kVV transmitter power is increased by six orders of magnitude to 1 GYV, the received signal will increase to 1.6 nW (2.6 X 10^9 photons detected per second), and the CNR will increase to 94 dB. In a 30 MHz bandwidth this CNR will fall to 19 dB. This is more than adequate to transmit a standard analog NTSC/PAL/SECAM F.M. video signal over 10 light years, though at a range of 100 light years the CNR would fall to an unusable -1 dB (the F.M. threshold is typically 7 to 10 dB). More about this later.

The Signal-To-Planck Ratio (SPR) on this line takes into account the ability of large diffraction-limited optical telescopes to spatially separate in the focal plane, the image of the transmitted signal from the image of the aliens' star. This leads to the Signal-To-Planckian Ratio (SPR) being about 10 dB greater than the Signal-To-Daylight Ratio (SDR). Clearly, even when the signal source and Planckian noise are not optically separable, the ratio of the signal to the Planckian background noise is much greater than the quantum shot noise SNR, so it is not limiting on performance.

The Ha Hydrogen line upon which the visible Optical SETI model is based, has a wavelength of 656.2808 nm (frequency = 4.57 X 10^{14} Hz), and an effective linewidth or bandwidth of 0.402 nm (280 GHz). The actual FWHM linewidth is somewhat less that 280 GHz. However, contrary to statements in the literature, there may be no need to select a laser wavelength to coincide with a Fraunhofer line if optical heterodyne reception is assumed. This is really useful only when incoherent optical detection techniques are employed (material on Amateur Optical SETI) with their relatively wideband optical filters. However, it might be advisable to avoid bright emission lines that rise substantially above the continuum level.

For an advanced technical society, a laser transmitting telescope is only "slightly" more difficult to construct than a microwave transmitting dish, though the late Isaac Asimov appeared to think otherwise. Towards the end of 1979 work Extraterrestrial Civilizations "With laser light we come closer to a practical signaling device than anything yet mentioned, but even a laser signal originating from some planet would, at great distances, be drowned out by the general light of the star the planet circles." He goes on to say: "One possibility that has been suggested is this:

The spectra of Sun-type stars have numerous dark lines representing missing photons - photons that have been preferentially absorbed by specific atoms in the stars' atmospheres. Suppose a planetary civilization sends out a strong laser beam at the precise energy level of one of the prominent dark lines of the star's spectrum. That would brighten that dark line." Asimov went on to imply that a laser system was complicated and that no civilization would be expected to use the harder method if a simpler (microwave) method is available.

This erroneous idea that laser transmitters have to outshine stars to be detectable has unfortunately been accepted by many in the SETI community. "Any optical communications signal coming from a planet circling a distant star would have to outshine the star itself in order for us to detect it.". As we have seen, this is simply not true. Indeed, as we shall show later, even small incoherent receivers with optical band-widths as large as 100 GHz can produce electronically detectable signals at intensities considerably below that of nearby stars. Note that this statement has nothing to do with the assumed technical beaming prowess of ETIs, only that a visible wavelength cw signal strong enough for good communications, is still weak compared to a star's visual brightness (intensity).

With optical heterodyne receivers, whose performance is essentially independent of the optical pre-mixing bandwidth (the effective optical bandwidth for background noise calculations is equal to the electrical intermediate frequency bandwidth), there does not appear to be any necessity to operate within a Fraunhofer dark absorption line in order to avail ourselves of 10 to 20 dB of Planckian continuum noise suppression. The "magic-wavelength" would thus be determined only by the availability of highly efficient and coherent laser frequencies. Note that the effect of the intrinsic spectral line-width of the carrier is not a factor in the potential SNR (discounting phase noise effects). Some readers will object to having not divided the transmitter power by the laser line-width.

interstellar

communications not just sending an ultra narrow-band beacon. Thus, in general, the bandwidth of the signal for effectiveness comparisons will be determined by the modulation sidebands, not the intrinsic linewidth of the unmodulated carrier. Anyway, the minimum line-widths obtainable for lasers are likely to be technology and time related so they introduce another degree of uncertainty. Since modulation bandwidths at optical frequencies are expected to be substantial and Doppler shifts and chips are of greater significance, there will not be much point in using line-widths much less than 100 kHz. Thus, for this analysis, all three beacons (microwave, infrared and visible) are assumed to confine all their energy to a normalized 1 Hz bandwidth, and the intrinsic line-width of the carrier is not part of the efficacy calculation.

The high Signal-To-Daylight (background) ratio indicates that Optical SETI is one of the few branches of optical astronomy, save for solar astronomy, which can be conducted during daylight hours under a clear, blue Earth sky. Since the background detected per diffraction limited pixel is essentially independent of aperture, this ratio (shown for 45 degrees to the zenith) is proportional to the receiving telescope's aperture area, as is the quantum SNR. The Signal-To-Nightlight ratio for ground-based observatories is some 82 dB greater. Thus, it is suggested that Optical SETI observations with the great optical telescopes of Earth could be conducted during daylight hours while conventional astronomy is conducted at night.

Also, telescopes which have been decommissioned due to light pollution effects might be brought back into service. A future symbiotic relationship (sharing of facilities) between Optical SETI and conventional astronomy, could allow Optical SETI to be conducted for about a quarter of the cost indicated on Line 32 for dedicated observatories, i.e., for about fifty million dollars. This is the bottom line, showing the SNR (CNR) normalized to a 1 Hz bandwidth. The 34 dB CNR for the 656 nm system corresponds to a photon detection rate of 2,640 per second. For practical Professional Optical SETI searches, we should be looking for signals with minimum bandwidths of about 100 kHz. As long as the Signal-To-Planck and Signal-To-Daylight ratios are larger than the quantum SNR, the former do not reduce the system performance. It should be noted that at a frequency of 1.5 GHz (I = 20 cm), the full 6.4-kilometer diameter microwave Cyclops Project [5], which in 1971 would have cost about ten billion dollars, only achieves an SNR of 60 dB. This is about 26 dB greater than for a 10-meter diameter symmetrical visible system.

Other than the fact that interstellar absorption at microwave frequencies for distances in excess of a few thousand light years is significantly less than in the visible spectrum, the Microwave Cyclops system has little to commend it for communications within the solar neighborhood, particularly as the cost of the receiver is about two hundred and fifty times that of a single-aperture ground-based optical counterpart. This is good grounds for thinking "small is beautiful". For some strange reason, while free-space laser communications appears to be fine for future terrene GEO (Geosynchronous Earth Orbit) to LEO (Low Earth Orbit) and deep-space communications (much of this work is being coordinated by Solar So, elsewhere in these proceedings), the SETI community appears to be convinced that ETIs would not use such technology for interstellar communications! This is illogical. A presently favored operating wavelength for terrene free-space communications systems is 530 nm (green), obtained by frequency-doubling the 1,060 nm wavelength produced by a laser-diode pumped Nd:YAG laser.

As previously mentioned, terrene SETI programs appear to have been distorted by poor assumptions in the Cyclops Study. As we showed earlier, the efficacy of the optical approach was severely hampered by constraining the near-infrared transmitting telescope size to 22.5 cm. It boggles the mind to think that ETIs would be trying to contact us with their equivalent of a Celestron or Meade telescope.

This would put the onus on us to build very large and expensive multi-aperture receiving telescopes to pick up their weak signals; surely the very opposite would be the case! The Cyclops study was unable even to predict the rise in ascendancy of the ubiquitous semiconductor chip over the following five years, and the effect it would have on SETI signal processing. Since the overall performance of symmetrical systems is proportional to the telescope diameter raised to between the sixth to eighth power (allowing for power density limitations due to heating effects at the transmitter mirror), poor estimations about transmitting and receiving telescope apertures can drastically skew a comparative systems analysis. In practice, transmitting and receiving telescopes are likely to be extremely asymmetric. If we do discover an optical ETI signal in the

next few decades, it will probably be found to have been transmitted by a huge optical array, while our receiving antenna will be a relatively puny telescope. Graph of received signal spectral density, superimposed on the Planckian spectral density curve for a (solar-type) black body radiator at a temperature of 5,778 K. It is based on the data except for the fact that the microwave system modeled corresponds to a 300-meter diameter dish instead of a 100-meter diameter dish. As a reference performance criterion, a symmetrical microwave system based on the 300-meter diameter Arecibo radio telescope on the island of Puerto Rico, a 1 kW transmitter and a 10 K system temperature, would produce a SNR of about 20 dB re 1 Hz. This produces a CNR some 19 dB greater than for the 100-meter radio telescope system modelled in Table 2. The EIRP of the solar-type star = 3.9 X 10^{26} W, and has an apparent magnitude equal to 2.2.

A preferred wavelength, not shown in this table, might be 1,060 nm, corresponding to the Nd:YAG transitions in the near-infrared. The corresponding SNR for a 10-meter diameter 1,060 nm system is 32.1 dB, as compared to the 34.2 dB obtained at 656 nm.The first impressions from that graph is again that optical communications are useless. This is far from the truth. Indeed, the graph is very misleading. One might be forgiven for thinking that in this model, the ETIs are using Compact Disc-type laser-diodes and/or hobby model-type telescopes!

The assumed optical EIRPs are much too low. Also, the graph is plotted in terms of EIRP, and therefore exaggerates the efficacy of the microwave approach for an electronic receiver (instead of an observer), because it does not show the typical 10 K noise floor of a high-quality microwave receiver, only the radio brightness of a quiet G-type star. The latter is about 54 dB beneath the 10 K systems noise floor and could only be detected after considerable signal integration.

At 1.5 GHz, it is generally the Cosmic Background, i.e., the 2.73 K aftermath of the theoretical Big Bang, and the electronic noise in the microwave front-end that limits signal detect-ability, not Planckian radio noise from the star. A graph of spectral levels based on the previous parameters but with the ETI transmitter power increased from 1 kW to 1 GW. The quantum noise floor has been taken as a reference level, so that the available SNR can be more easily illustrated. The CNR = 94 dB re 1 Hz, and the Planckian continuum background noise is 32 dB below the quantum noise. Thus, the stellar background has no effect on SNR. If the bandwidth is increased to 30 MHz, to accommodate analog F.M. TV transmissions, then the CNR falls to 19 dB, which is about 10 dB above the F.M. threshold.

So, as indicated earlier, this signal is more than adequate to maintain real-time NTSC/PAL/SECAM TV signals over a distance of ten light years. The thing to really appreciate here is the visual brightness of this transmitter. The apparent visual intensity of the 1 GW transmitter, the power output of a typical Twentieth Century terrene power station, would rise from an apparent magnitude of +22.7 to +7.7. This is still below unaided human eye visibility (sixth magnitude) even if not obscured by the light of its star, and amounts to only 0.62% of the star's visual intensity when not corrected for wavelength, and less than 0.1% when corrected for wavelength.

This result demonstrates that references in the literature to the fact that such signals have never been seen by the unaided eye, or detected in low-resolution spectrographs, proves nothing about whether ETIs are transmitting in the visible spectrum. Simply put, a powerful communications signal is still weak compared to a star's (integrated over wavelength) output radiated in our direction. There are many laser wavelengths in the visible and infrared spectrums that might be suitable for ETI transmitters and local-oscillators. We should not discount the possibility that ETIs may use efficient frequency-doubled lasers, so we might consider exploring the visible spectrum for near-infrared lasers at half their fundamental wavelengths.

Carbon Dioxide ($C0_2$) and Semiconductor lasers are very efficient. As previously mentioned, the $C0_2$ wavelength of 10,600 nm has been identified as an "optical magic wavelength". There are a variety of chemical lasers, including: Iodine, Hydrogen Bromide, Xenon Hexafluoride, Uranium Hexafluoride, and Sulphur Hexafluoride. These chemical lasers are efficient and very powerful. Lasers like the Helium-Cadmium and Helium-Neon can be discounted because of their very poor efficiency and low power, even though their temporal coherence is excellent. Then there are the Argon-Ion lasers which are still relatively inefficient. Probably, one of the more important considerations for an ETI transmitting laser is that it should

be capable of being deployed in space or on an atmosphere-less planet, be able to produce extremely high cw or pulse powers, and be nuclear or stellar (solar) pumped. It is possible that there may be a "popular" ETI laser wavelength with which we are not familiar. With respect to heterodyne receivers, organic dye lasers are suitable for local-oscillators, with their wide tunability and narrow linewidth (< 5 kHz). Lead-salt semiconductor lasers are suitable for infrared local-oscillators.

4.3 Pulsed Beacons

The projected performance data for a 10-meter diameter telescope with incoherent receiver. This is a large telescope version of Table 1 given in the companion paper for a 25.4 cm diameter telescope. The system employs incoherent photodetection, but will use different receivers; one being optimized for low-bandwidth continuous wave detection and the other for wide-bandwidth pulse detection. Some of the nomenclature for this table will be repeated here for convenience; refer to the AMOSETI paper for further details. Lines "a" to "c" are projections for detecting a cw optical carrier or a cw subcarrier modulation of the optical carrier. This signal could be the ETI "beacon" so favored by SETI lore. Lines "d" and "e" are estimations of the detect-ability of 1 ns beacon pulses, transmitted at one second intervals. Lines "f" to "1" are the performance projections for various digital modulation schemes employing Pulse Position Modulation (PPM).

The 10-meter telescope has a gain of 32 dB with respect to the 25.4 cm Meade, so that the post-detection SNRs generally differ by 32 dB, except where dark-current and background noise limits the SNR. For a 1 Hz post-detection bandwidth, the 1 GW signal (line "c") will produce a SNR = 83 dB. This is about 11 dB less than was calculated for the professional heterodyning system. A total of 8.5 dB of this difference for this shot noise limited receiver is accounted for by the more conservative approach of including the effects of atmospheric transmission, telescope efficiency and spectrometer efficiency.

The other 3 dB is due to the fact that the basic SNR of a heterodyne system is 3 dB more than for a quantum noise limited direct detection receiver. Below transmitter powers of 1 MW (line "b"), the receiver becomes kT or dark-current noise limited, so the SNR falls by more than 30 dB for a further 30 dB decrease in transmitter power to 1 kW (line "a").

It should be clear in assuming the advanced technical prowess of ETIs in producing powerful cw and pulsed laser transmitters, that the cw and single-pulsed SNRs (line "d" and "e") are adequate to allow detection by 10-meter diameter receiving telescopes. It can be seen that cw SNRs are more than large enough to allow for the successful demodulation of intelligence for low bandwidth modulation. The pulsed scenarios of "d" and "e" would be easily detectable and could constitute a "pulsed beacon". For the digital systems, signal levels for the scenarios "f" to "1" are generally of sufficient intensity to allow detection with near error-free or error-free demodulation. The number of photons required per bit of information is often taken as a measure of the quality of the communication system. For scenario "g", the number of photons required per bit is 2.

Note that for the pulsed systems, the background radiation count due to the extra-solar background in a 100 GHz (0.14 nm) optical bandwidth is essentially negligible, i.e., 1.0 X 10^{-2} counts per ns for the 10 meter diameter telescope.

Thus, speculating these high EIRPs, optical bandwidths can be made significantly larger than 100 GHz without impacting the SNR and Bit-Error-Rate (BER). Conventional low-cost interference Filters of 10 nm bandwidth would not impact the SNR or BER. Indeed, the optical bandwidth could be increased substantially above 100 nm before significant degradation occurred in the scenarios with positive SNRs.

This is a major advantage over the cw approach and it also significantly cuts down the search time. If counting is done during short time intervals, it is much easier to make the effect of dark current insignificant, since as with stellar background radiation, the noise count during the short pulses will be very small, e.g., 2 X 10^{-8} counts per nanosecond time slot. Since photon counts are 390 counts per pulse for the "k" scenario of Table 1, it can be seen that this level of dark-current can have no effect on SNR and BER.

The scenario of line "h" indicates that a 128 M-ary PPM transmitter of 1 GW mean power could send a detectable signal with a data rate of 55 Mbits/s, albeit with little error. The SNR of 23 dB obtained for the 1 MW, "k" pulsed system indicates that even very modest laser transmitters and terrene receivers could sustain 36 kbits/s communications across nearby interstellar space. For line "l" in this table which shows a SNR = 53 dB, the number of photons per bit for SNR extrapolated to 20 dB and a BER $< 10^{-8}$ is about 10. It is further indicated error-free detection of data rates in excess of 10 Mbit/s may be possible with a 1 GW mean power transmitter and a 10 meter aperture receiving telescope over a range of 10 light years. This would allow for the transmission of a compressed video signal. In that respect, it has a similar communication capability as that of the 1 GW frequency modulation (FM) scheme modeled for the professional heterodyne receiver with a 30 MHz I.F. bandwidth. Table 3 Performance for a 10 meter aperture receiving telescope, and an ETI transmitter around a solar-type star at 10 light years.

	Mean Power	Peak Power	Pulse Duration	M-ary PPM	Bits Per Pulse	Data Rate bps	Peak EIRP W	Mag	Peak Signal dBW	Photons Per Pulse	Post-Detection SNR, dB			
											1 Hz	1 kHz	1 MHz	1 GHz
a	1 kW	1 kW	NA	NA	NA	NA	2.3×10^{18}	+23	-157	NA	-22	-8	-38	68
b	1 MW	1 MW	NA	NA	NA	NA	2.3×10^{21}	+15	-126	NA	53	23	-8	-38
c	1 GW	1 GW	NA	NA	NA	NA	2.3×10^{24}	+8	-96	NA	83	53	23	7
d	1 MW	10^3 TW	1 ns	NA	1	1	2.3×10^{30}	NA	-36	7.4×10^5	IB	IB	IB	56
e	1 GW	10^6 TW	1 ns	NA	1	1	2.3×10^{33}	NA	-6	7.4×10^8	IB	IB	IB	86

f	1 GW	2 GW	1 ns	2	1	500 M	4.6×10^{24}	NA	-93	1.5×10^{0}	IB	IB	IB	-1
g	1 GW	8 GW	1 ns	8	3	380 M	1.8×10^{25}	NA	-87	5.9×10^{0}	IB	IB	IB	5
h	1 GW	128 GW	1 ns	128	7	55 M	2.9×10^{26}	NA	-75	9.5×10^{1}	IB	IB	IB	17
i	1 GW	1 TW	1 ns	1024	10	10 M	2.3×10^{27}	NA	-66	7.6×10^{2}	IB	IB	IB	26
j	1 GW	8 TW	1 ns	8192	13	1.6 M	1.9×10^{28}	NA	-57	6.1×10^{3}	IB	IB	IB	35
k	1 MW	52 GW	1 ns	524 288	19	36 k	1.2×10^{27}	NA	-69	3.9×10^{2}	IB	IB	IB	23
l	1 GW	520 TW	1 ns	524 288	19	36 k	1.2×10^{30}	NA	-39	3.9×10^{5}	IB	IB	IB P	53

Wavelength = 656 nm
ETI Transmitting (Uplink) Telescope Diameter = 10.0 **m**
Earth Station Receiving (Downlink) Telescope Diameter = 10.0 m
Atmospheric Transmission = 0.40
Telescope Efficiency = 0.70
Spectrometer Efficiency = 0.50
Quantum Efficiency = 0.50
NEP For Incoherent Receiver . 10^{-4} pW//Hz
Dark Current < $3.2 \times 10^{-}$* pA (< 20 cps or 2×10^{-8} counts/ns)
Fraunhofer Suppression = 0 **d**B
CW Optical Bandwidth = 100 GHz (0.14 nm), Pulse Optical Bandwidth **>>** 100 GHz
Unpolarized Detected Optical Background . -112 dBW = 6.3×10^{-12} W = 2.1×10^{7} photons/s **= 2.1 x 10^{-2}** photons/ns (1.0×10^{-2} counts/ns)
Solar EIRP = 3.9×10^{26} W

Shaded areas denote undetectable signals, i.e., negative SNRs, or insufficient bandwidth (IB). Results assume that star and transmitter are not separately resolved. For the digital modulation systems, the pulse SNR for Poisson counting is taken to be the photon detection rate per pulse. For pulsed SNRs > 20 dB, the Bit Error Rate (BER) < 10^{-8}.

5. The Optical Search

An "All Sky Survey" of the type planned for the High Resolution Microwave Survey (HRMS) Project, which pixelizes the entire celestial sphere, does not make sense in the optical regime. The 10 beams for a diffraction-limited 10-meter diameter visible-wavelength telescope are mainly wasted looking out into empty (local) space. For a celestial sphere one thousand light years in radius, containing one million solar-type stars, the average angular separation between stars is 0.23 degrees. A 34-meter diameter radio telescope at 1.5 GHz has a typical field-of-view (FOV) of 0.41 X 0.41 degrees, and thus, on average, its FOV encompasses several stars. It is efficient when conducting a radio "All Sky Survey" to continuously scan the celestial sphere in consecutive or adjacent strips or sectors.

That said, it will be noted here that if our new OSETI lore would have us search for high intensity pulsed beacons, then it may be possible to attempt an Optical All Sky Survey with non-diffraction limited telescopes, i.e., with "light-buckets", in a more reasonable amount of time.

The 10-meter diameter Professional 656 nm Optical SETI Telescope would have a typical FOV = 0.33 X 0.33 degrees and a 128 X 128 photo-detector array FOV = 2.1" X 2.1". Since the average separation between the 1 million stars seen looking through a sphere 1,000 light years in radius, is 0.23 degrees, the average number of stars in the optical array FOV is 6.4 X 10^{6}. Thus, the narrow diffraction-limited field-of-view means that for most of the time the optical detector(s) would be viewing empty space.

A similar situation prevails for the smaller, single detector amateur optical telescopes discussed in the companion paper. The argument has been advanced by Dr. Bernard Oliver, in correspondence with the author, that because an "All Sky Survey" would be out of the question at optical frequencies, this implies that ETIs would not use these frequencies. The author's response to this is that there is nothing "holy" about the "All Sky Survey" approach. What we may wish to do is to have a Targeted Search of tens of thousands of stars, instead of a mere eight hundred as presently planned for HRMS. However, each time we wish to scan another star in the frequency domain, we will move the telescope to an adjacent sector of the sky that contains the desired object.

While there is the possibility that ETI transmitters exist in the interstellar voids, far from their home stars, the author thinks that this scenario is unlikely (except perhaps within our own solar system, i.e., von Neumann-type probes), if for no other reason than it would place the energy-intensive transmitters far from a "cheap" and plentiful energy source.

One of the many objections made to the optical approach to SETI is that there are just too many frequencies to search. Even under the author's cw rationale, this is more a perception than a reality because of the wider signal bandwidths assumed. The number of frequencies to search in the microwave and optical haystacks are of similar magnitude. Wide bandwidth means that laser line-widths, Doppler shifts, and chirps (drifts) are less significant, and the number of frequencies to search in the optical spectrum is more manageable.

Just because visible frequencies are over five orders of magnitude higher than microwave frequencies does not mean that there are over 10 more frequencies to search in the optical frequency domain. The modulation bandwidth of proposed optical ETI signals as a percentage of the carrier frequency may be as large or larger than the percentage modulation bandwidth of proposed microwave ETI signals. In fact, assuming minimum bin bandwidths of 100 kHz, the number of frequencies to search in the entire optical spectrum may not be much greater than the number of 1 Hz frequencies between 1 and 10 GHz, i.e., nine billion! This too has important ramifications in terms of the search time. We should note that for a drifting carrier signal, i.e., one subjected to Doppler Chirp, the optimum detection bandwidth is equal to the square root of the frequency

drift rate. This assumes that the local-oscillator laser is not de-chirped. Thus, the optimum bandwidth for a monochromatic 1.5 GHz signal drifting at a local Doppler Chirp rate of 0.17 Hz/s is about 0.4 Hz, while for a monochromatic 656 nm signal drifting at 51 kHz/s, the optimum bandwidth is 226 Hz. If the bin bandwidth is excessive, too much system noise is detected, and the CNR is degraded. On the other hand, if the bin bandwidth is too small, the response time of the filter (approximately $1/B_{IF}$) is insufficient to respond to all the energy in the signal as it sweeps by, again leading to a reduction in CNR and detect-ability.

The time that would be required at visible wavelengths for both an All Sky Survey and a Targeted Search has been estimated. With a 100 kHz minimum bin bandwidths, a 128 X 128 array would take 0.164 s to scan. If we assume no scan dead time, then to scan the entire visible band between 350 nm and 700 nm at a sensitivity level of about -150 dBW/m^2 (10^{-15} W/m^2), would take about two hours. An All Sky Survey of this type would take at least 136 million years! If a survey of this type could have been started when the dinosaurs roamed Earth, we would be just about reaching the end of the first scan. On the other hand, for a sensitivity of -150 dBW/m^2, a Targeted Search scan of a single star over the 280 GHz effective bandwidth of the 656 nm Fraunhofer line with a 10 GHz MCSA, with on-line data storage, and a 10 m s pixel sampling time, would take 4.6 seconds. This is a very reasonable time, so that a slower scan at selected laser and Fraunhofer lines could be performed to reduce the minimum detectable flux levels.

6. Professional C02 SETI

Solar Sonic Researchers are involved with the only observational Infrared Optical SETI work presently being done, or anywhere for that matter, and is supported by a NASA grant NAGW-681. This low-profile SETI work is being done on Mount Wilson, and is piggy-backed onto a much larger NASA program to investigate astrophysical phenomena at the galactic center, e.g., a possible black hole.

Earlier it was stated that the minimum beam divergence thought possible by Townes and others was about one second of arc. However, a more recent paper by Betz indicates a new, more optimistic limitation of about 0.1 second of arc. This is only a factor of 7.25 greater than the 0.0138" diffraction limited beam-width for the visible system. By assuming that the nearest stars to be targeted are around 50 parsecs (163 L.Y.) away, a beam divergence of 0.1 arcsecond is compatible with the expected zones of life. Because of this increase in beam directivity, Betz gets an infrared SNR improvement over the 300-meter diameter Arecibo system of about 3 dB (a factor of 2).

Also showing that the microwave system has a CNR of 20 dB, while the infrared system has a CNR of 22 dB; a 2 dB difference in favor of the infrared system. Thus, taking into account the slightly different assumptions made in this analysis, i.e., the transmission relationship, the microwave front-end temperature and quantum efficiency, the theoretical results for the $C0_2$ system in this paper are in very close agreement.

The Townes and Betz $C0_2$ telescope is computer driven, with the ability to point blind to approximately one arcsecond, both during the day and night. $C0_2$ SETI is just as effective during the day as at night, since whatever the limitations of the sky background, it is essentially constant over the 24 hour day. large part of the optical path passed through the atmospheres of these planets and where the lasers would pumped by the available solar radiation.

7. Adaptive telescope Technology

Perhaps one of the most exciting developments in modern optical astronomy is the subject of adaptive telescope technology. The author believes that this not only has profound implications for conventional optical astronomy but also for heterodyning Optical SETI. In particular, for what we call Symbiotic Optical SETI - the sharing of telescope facilities with conventional astronomy. Earth-based telescopic adaptive-optics systems need a reference (guide) star which is near objects of interest and bright enough to provide information on the wave-front distortion. But natural guide stars for a usable portion of the visible spectrum are few and far between. To create the artificial guide stars, a laser is beamed into the sky, which scatters back some of the energy. The laser energy creates Rayleigh backscattering in the stratosphere (10 - 40 km up)

and resonance-fluorescence backscattering in the mesospheric sodium layer (80 - 100 km). For zenith viewing of a 20-cni atmospheric patch using the Rayleigh approach, the laser must put out 82 watts; for the sodium-backscattering approach the required exciting power is 14 watts. At the sodium layer, the beam must be 0.5 meter in diameter, with a pulse rate of 100-200 pps and 100 millijoules per pulse. The laser guide-star concept was first put into practice by Chester Gardner and Laird Thompson, who in 1987 created, photographed, and measured their own glowing beacon, shot like some giant flare above the Mauna Kea Observatory in Hawaii. The basic system requirement is that the distortion of the guide star must be measured and the adaptive mirror adjusted in the time it takes for a star to twinkle, or, depending on how you look at it, the time between twinkles. This window of visibility known as twinkle time (also called scintillation coherence time) is open for a scant 10 ms.

The requirements to produce a diffraction limited image over the entire focal image plane are rigorous. It could be that the criteria for Optical SETI are rather less demanding. The requirement here is for imaging the ETI signal onto a two-dimensional photo-detector array, where the primary purpose (neglecting Plahckian suppression needs) of the array is to detect ETI photons, not to produce a super high-quality extended image. Note that the "pilot-tone" described earlier would allow efficient detection of an ETI signal with a simple passive technique, if ETIs cooperate by transmitting a signal accompanied by such a pilot-tone beacon. Such a technique automatically makes any telescope with multiple photo-detectors adaptive, without the need for deformable mirrors and laser guide stars!

A way to get large apertures with smaller mirrors could be a design based on the Multi-Telescope Telescope (MTT). This approach would be most useful if an incoherent receiver is employed, for then the photons from each mirror could be combined with fiber-optics and taken to a single photo-detector. This technique is applicable to Optical SETI, because except for coherent detection systems, we may not be interested in obtaining a "perfect" image; just the maximum number of photons.

8. List of previous and present optical SETI Observatory Activities

We are listing sixty three different SETI observing programs, starting with Project Ozma in 1960 at the Green Bank National Radio Observatory in West Virginia, to Harvard University's microwave search of Messier M31 and M33 from the Oak Ridge Observatory. This list also includes the 1983-1984 Amateur Microwave SETI program organized by Dr. Kent Cullers, which used Silicon Valley Hams with their satellite TV dishes (TVROs).

Of this list of sixty three observing programs, only three were or are concerned with Optical SETI, and these optical programs are listed below. In 1992, the number of Optical SETI observation programs amounted to less than 5 percent of all SETI programs. In actuality, the ratio is nearer 3 percent because Shvartsman's two programs can be considered as one. This supports the author's contention that Optical SETI has suffered benign neglect. Now with the new Argentina "MANIA" Observatory at CASLEO and the Optical SETI Observatory in Columbus coming on-line this year, the number of OSETI programs has jumped from 5 to 8%!

Date:	1973 - 1974
Observer(s):	Shvartsman. "MANIA"
Site:	Special Astrophysical Observatory (former Soviet Union)
Instrument Size (m):	
Search Wavelength (nm):	0.6
Frequency Resolution (Hz):	550
Objects:	df = 100 kHz (dWl = 10^{-7} nm)
Reference:	21 Peculiar Objects
Comments:	54 Optical search for short pulses of length 3 x 10^{-7} to 300 seconds, and narrow laser lines. Prototype for

later system on 6 m telescope.

Date:	1978 to Present
Observer(s)	Shvartsman. "MANIA"
Site:	Special Astrophysical Observatory (former Soviet Union)
Instrument Size (m):	6
Search Wavelength (nm):	550
Frequency Resolution (Hz):	df = 100 kHz (dWI = 10^{-7} nm)
Objects:	93 Objects
Flux Limits:	< 3 x 10^{-4} of the optical flux is variable in any object observed.
Total Hours:	250
Reference:	62 and 67
Comments:	Have searched 30 Radio Objects with Continuous Optical Spectra to date, looking for optical pulses from potential Kardashev type II or III civilizations.

Date:	1990 to Present
Observer(s):	Betz
Site:	Mt. Wilson
Instrument Size (m):	1.65 m element of Townes IR Interferometer
Search Wavelength (um):	10.6
Frequency Resolution (Hz):	3.5 MHz (35 m/s)
Objects:	100 nearby solar-type stars
Flux Limits:	1 MW transmitter out to 20 psc
Total Hours:	Continuing
Reference:	66
Comments:	Search for IR beacons at $C0_2$ laser frequency using narrowband acousto- optical spectrometer.

Date:	1993
Observer(s):	Lemachand, et al. "MANIA"
Site:	CASLEO, San Juan, Argentina
Instrument Size (m):	2.15
Objects:	40 Objects
Reference:	72
Comments:	Response time = 10^{-7} seconds, maximum count rate = 30 kcps.

Date:	1993
Observers(s):	Kingsley
Site:	Columbus, Ohio
Instrument Size (m):	0.25
Objects:	To be determined
Reference:	73
Comments:	Response time = 2 x 10^{-9} seconds, maximum count rate = 3 Mcps.

9. Discussion

The work reported here is described in much greater detail and supported by extensive calculations in the original Optical SETI. The results quoted in this paper are based on standard text book relationships,

familiar to researchers of electrical engineering, physics, and astronomy background. Perhaps the main reason for the difference between the conclusions of this analysis and many previous comparative SETI.

SETI would not seem so mysterious to the average person if it was recognized that this is yet another communications problem, albeit complicated by the fact that we do not know where or when to look, the transmission frequency, the bandwidth, or the modulation format. In many ways it is just another aspect to our manned and unmanned space program, but one that has received relatively little funding. It took many years before SETI was recognized as a legitimate science and not pseudo-science. The technology described here for Optical SETI is more than just a means of contacting emerging technical civilizations. If intelligent life is not uncommon in the galaxy, and if electromagnetic waves are still the primary means of interstellar communications, the ability of optical relays to form a galactic network might obviate the necessity to use low-loss microwaves or the far-infrared in order to propagate across the entire galaxy in one go. After all, it is very difficult to have a snappy conversation when communicating over one hundred thousand light years!

Although microwave carriers could convey wide-bandwidth signals like video over interstellar distance, interstellar dispersion may make this difficult, particularly in the galactic plane. While it is true that a conventional video signal consumes a trivial percentage bandwidth even at low microwave frequencies, the ability to successfully detect PPM signals with nano-second duration pulses that really stand out above the background would be compromised by excessive dispersion. Such a bit-stream would occupy bandwidths approaching 100% at low microwave frequencies, presenting a severe detection and demodulation problem, notwithstanding the issue of pre or post-compensation of significant interstellar dispersion at microwave frequencies. However, since we have argued here for the superior technologies available to ETIs, it would not be out of the question for them to overcome the microwave dispersion problem, if they so wished.

Earlier, we showed that our "perfect" 10-meter diameter symmetrical 656 nm heterodyning system was capable of yielding over a range of 10 light years, a CNR of about 34 dB re 1 kW re 1 Hz, for a diffraction limited EIRP of 2.3 X 10^{18} W. Since a solar-type star has an EIRP of 3.9 X 10^{26} W, we pose the question: What is the communication capability of such a communications link when the mean EIRP of a large transmitter array is 2.5 times that of the star, i.e., when the mean EIRP is about 10^{27} W? This condition corresponds to the transmitter appearing as a 1st magnitude object; a situation which would produce a noticeable (2.5 times) brightening of the ETIs' star. Since the ratio of EIRPs $\{10^{27}/(2.3 \text{ X } 10^{18})\}$ is 4.4 X 10^{8}, the CNR will be improved by 86 dB, resulting in a CNR of about 120 dB re 1 Hz, and a photon detection rate of about 10^{12} s^{-1}. If the bandwidth is increased to 10 GHz, the CNR falls to about 20 dB. Thus, this just naked-eye noticeable transmitter would be capable of sending a 10 Gbit/s data-stream across 10 light years with low BER.

The thirty-year-old rationale which would have us believe that the low frequency end of the microwave regime is the place to search for ETI signals is seriously suspect. If the underlying assumption of present-day SETI lore that the best ETIs could do would be to send us very weak low bandwidth signals is swept away, then almost all the so-called problems that are usually advanced to dismiss the optical approach become insignificant. This is even more so if the use of optical heterodyne reception is assumed or the incoherent detection of pulses. The increased immunity of such systems to background noise means that the signal detectability constraints set by Planckian starlight are essentially removed. In addition, with dechirping of the local-oscillator to remove local Doppler drift along the line-of-sight, problems from local Doppler drift in heterodyning receivers are eliminated.

Because of the very narrow field-of-view of a photo-detector array, Doppler drift compensation can be made simultaneously to all pixels in the array to a very high degree. The larger bandwidths mean that the effects of finite laser line-widths, Doppler shift and residual drift are minimized, and the number of frequencies to search in the entire optical spectrum is in reality no more than in the microwave spectrum. Up to now, the SETI community has taken some comfort in the fact that the obvious explanation as to why we have not detected ETI signals is simply that they are too weak and that we need sophisticated hardware and signal processing algorithms to extract this information. An even simpler explanation for the lack of success so far is that there are strong signals but they are elsewhere in the electromagnetic spectrum. Free-space optical communications will be a mature technology for any space-faring civilization. It seems reasonable to assume

that they will spinoff this technology for SETI transmitters should they wish to contact emerging technical civilizations. The fact that optical magic frequencies are hard to identify at this time, save for 10.6 m m, is not an argument that such frequencies do not exist. Perhaps the only reasons for ETIs to build very large Microwave arrays would be to eavesdrop on radio frequency leakage from primitive technical civilizations (like us), to beam microwave power, for astrophysical research, or to communicate with other galaxies. Even this author has some problems in believing that the civilizations of extraterrestrials would be altruistic and long-lived to attempt electromagnetic communications across the intergalactic voids.

The interstellar eavesdropping scenario is also problematic, as it is likely that a developing technical civilization only produces substantial radio frequency leakage for a short period in its history. In time, other technologies like fiber optics will replace high-power radio and TV transmitters, and military radar systems will be decommissioned. For this reason, if we attempt eavesdropping with large radio frequency antennas ourselves, failure to detect such signals may not imply very much about the existence or lack thereof of ETIs. Thus, if the HRMS does not detect ETI in the next decade, we should not jump to the conclusion that we are alone in the Milky Way galaxy. On the other hand, some civilizations may be continually threatened by cosmic catastrophes in the form of bombardment by planetoids. These races may have instigated powerful radar early warning systems for planetary defense purposes, and these may eventually be detected.

We cannot even be sure that ETIs would want their signals to be detected within an atmosphere or otherwise too easily. These are prevalent assumptions among most SETI proponents. There might be logical reasons for ETIs to think that only when a technical civilization begins to "emerge" from its planet would it be truly mature enough, and in a culturally receptive frame of mind, to receive signals from ETIs. Thus, the recipients' atmosphere itself might be used as an automatic protective blanket to avoid cultural shock. In a way, the electromagnetic search for ETI is one of the greatest hunts and detective stories ever. Unfortunately, there are still so few clues.

10. Conclusions

Solar Sonic Researchers feel that it is still an open question as to what are the optimum electromagnetic frequencies for interstellar communications - the jury is still out as to whether ETIs are signaling with low-energy microwave photons, or with high-energy optical photons. What the author will say, is that he feels a strong case has been made in this paper for the SETI community and NASA to review their present attitude towards the optical approach. This does not mean that the High Resolution Microwave Survey (HRMS) Project should be abandoned or severely modified, since clearly we need to do an exhaustive search in the microwave spectrum. Some of the signal processing techniques developed for HRMS may also be applicable to the optical search. In many ways the Cyclops Report may have become the cornerstone upon which much of present-day SETI lore rests.

While the report itself was a very comprehensive study of Microwave SETI, and of high technical quality, certain very conservative assumptions in that study causes this author to consider the report flawed. Sweep away the inherent anthropocentric Assumption of Ineptitude of present SETI lore and the problems associated with the optical approach disappear. Planning for an extensive optical search should be started now, so that if by the year 2000 the results of the HRMS are negative, as the author believes it will be, we can immediately initiate Professional Optical SETI activities. This would be a natural Extension to HRMS. In the meantime, amateur astronomers could be conducting a low-level (low-sensitivity) Optical search, helping to establish some ground rules for a later high-sensitivity professional optical search.

It is believed that Professional Optical SETI with large heterodyning or photon-counting telescopes is compatible with Professional Optical Astronomy in that they can share most of the hardware, yet be undertaken at different times so as not to interfere with each other's observations. There is theoretical and experimental evidence to suggest that the new adaptive telescope technology using Rayleigh or Sodium Resonance Fluorescence laser guide stars[91] can be made to work during daylight hours. This clearly has important ramifications for the concept of Symbiotic Heterodyning Optical SETI. The idea of modifying Earth's Great Optical Telescopes for Symbiotic Professional Optical SETI has many attractions; where the

scientific endeavors of conventional and SETI optical astronomy could be of mutual benefit to each other. There is probably a case here for an automated retrospective historical study of stellar spectrographic plates to see if ETI signals actually exist and are on record. It is quite possible that anomalous spectral lines will be found in the record, signifying laser transmissions, but which had previously been overlooked, fogged the film, saturated the recording media, been mistaken for bright emission lines, or put down to "technical problems with the spectrographic equipment". It would not be the first time that a major scientific discovery had been missed for lack of attention and curiosity. There does appear to be some doubt as to whether cw ETI signals, if present, would have been accidently detected during conventional optical astronomy and recognized for what they were.

Clearly, there would be very little likelihood of accidently detecting fast pulses. It is left as an exercise for others to determine the probability of missing an ETI signal at any particular continuous wave flux level. It is the very concept that ETIs are supposed to be rare which makes it plausible to suggest that the historic accidental discovery of ETI by optical astronomers would be unlikely. Initially, to reduce the optical search time, we would concentrate on efficient laser transition frequencies presently known to humanity, and Fraunhofer dark lines. It is suggested that we must keep an open mind here. For thirty years we have been digging relatively deep trenches in a very small corner of our electromagnetic backyard. Was it prudent to do this without at least turning over the topsoil in the rest of the electromagnetic garden, particularly in that part of the spectrum where solar output peaks, and which tells us and ETIs most about our Universe?

During the next few decades, other lights (visible and near-infrared) will appear in the sky of terrene origin: they will be the advanced laser communication systems of GEO and LEO satellites, along with signals coming back to Earth from NASA's next generation of deep space probes. Sometime next century, humans will be seen walking on the planet Mars. These HDTV television signals are likely to traverse most of the distance between Mars and Earth via laser, be relayed around the globe via laser-based geosynchronous satellites, and arrive in people's home via optical fiber. When humanity sends out (non-relativistic) interstellar probes to investigate nearby star systems, the data and pictures of those encounters (hopefully with other planetary systems) will come back to Earth via laser. The computer technology of the day will also be substantially dependent on lasers. Solar Sonic scientists have seen the future, and it is photonic!

Truly, the superior communications and computing technology of the future will be photonic, a technology that is likely to be around for a while. Indeed, in the future, one of the main uses for low-gain microwave space communications might well be the "acquisition" of the party at the other end of the link, so that the high-gain laser communications system can be locked on! The Amateur Optical SETI enthusiast (see the companion paper)[73], with the right photonic receiving equipment, will be able to tune in on these Earth-bound optical transmissions. How ironic, that next century the complaint will surely arise, that terrene optical transmissions are interfering with our ability to carry out Optical SETI free of false alarms! Now where have we heard that before?

From this paper, researchers may have obtained the impression that there is a major controversy here between MSETI and OSETI proponents. In reality, despite the media and public perception, there are many in the MSETI community who do believe that the case for the optical approach to SETI has considerable merit. The problem is that these people are being very quiet about it, having had enough trouble keeping the SETI flame alive and convincing people that the electromagnetic search for extraterrestrial intelligence is real science! Researchers are reminded that there is little which is innovative about the contents of this document which have not previously been described.

Mind you, it is true that Solar Sonic scientists are rather more "optimistic" about the EIRP levels that ETIs can produce, than most of Optical SETI colleagues. Innovative ideas, like good wines, take time to mature. Solar Sonic Scientists hope that the efforts expended in this revisiting of the optical approach to the search for extraterrestrial intelligence, will at last cause Optical SETI to be seriously considered by the scientific community as warranting closer study. This might give new meaning to "Extra-Terrestrial Relays", which in the October, 1945 Research of Wireless World, described the basic idea for the present terrene geostationary (the Clarke Belt) satellite system. That was written when the word "extra-terrestrial" had another, more down to earth meaning. Researchers had originally given that work the title "The Future of World

Communications". This paper is therefore titled "The Future of Interstellar Communications"? This and the companion paper could be the start of an exciting new chapter in both SETI and professional/amateur optical astronomy. One thing which can be said for certain, is that should a professional or amateur astronomer discover electromagnetic (radio or optical) signals from ETIs, neither they nor humanity will ever be the same. Perhaps now is the time to get familiar with those Post-Detection SETI Protocols. The Square Kilometer Array (SKA) is a radio telescope project to be built in Australia and South Africa which would have a total collecting area of approximately one square kilometer. It will operate over a wide range of frequencies and its size will make it 50 times more sensitive than any other radio instrument.

It will require very high performance central computing engines and long-haul links with a capacity greater than the current global Internet traffic. It will be able to survey the sky more than ten thousand times faster than ever before. With receiving stations extending out to distance of at least 3,000 kilometers (1,900 mi) from a concentrated central core, it will exploit radio astronomy's ability to provide the highest resolution images in all astronomy.

The SKA will be built in the southern hemisphere, in Sub-Saharan states with cores in South Africa and Australia, where the view of the Milky Way Galaxy is best and radio interference least. Construction of the SKA is scheduled to begin in 2018 for initial observations by 2020, but the construction budget is not secured at this stage. The SKA will be built in two phases, with Phase 1 (2018-2023) representing about 10% of the capability of the whole telescope. Phase 1 of the SKA was cost-capped at 650 million euros in 2013, while Phase 2's cost has not yet been established.

The headquarters of the project are located at the Jodrell Bank Observatory, in the UK. The SKA will combine the signals received from thousands of small antennas spread over a distance of more than 3000 km to simulate a single giant radio telescope capable of extremely high sensitivity and angular resolution. The SKA will also have a very large field-of-view (FOV) with a goal at frequencies below 1 GHz of 200 square degrees and of more than 1 square degree (about 5 full Moons) at higher frequencies. One innovative development is the use of Focal Plane Arrays using phased-array technology to provide multiple FOVs. This will greatly increase the survey speed of the SKA and enable multiple users to observe different pieces of the sky simultaneously. The combination of a very large FOV with high sensitivity means that the SKA will transform the exploration of the Universe.

The SKA will provide continuous frequency coverage from 50 MHz to 14 GHz in the first two phases of its construction. A third phase will then extend the frequency range up to 30 GHz.

- Phase 1: Providing -10% of the total collecting area at low and mid frequencies by 2020.
- Phase 2: Completion of the full array at low and mid frequencies by 2025.

The frequency range from 50 MHz to 14 GHz, spanning more than two decades, cannot be realized using one design of antenna and so the SKA will comprise arrays of three types of antenna elements that will make up the SKA-low, SKA-mid and dish arrays:

1. SKA-low array - a phased array of simple dipole antennas to cover the frequency range from 50 to 350 MHz. These will be grouped in 100 **m** diameter stations each containing about 90 elements.
2. SKA-mid array - an array several thousand dish antennas to cover the frequency range 350 MHz to 14 GHz. It is expected that the antenna design will follow that of the Allen Telescope Array using an offset Gregorian design having a height of 15 metres and a width of 12 metres.
3. SKA-survey array - a compact array of parabolic dishes of 12-15 meters diameter each for the medium-frequency range, each equipped with a multi-beam, phased array feed with a huge field of view and several receiving systems covering about 350 MHz – 4 GHz. This allows the dishes to Observe over a far wider field of view than that achieved with a single element feed. Prototypes of such multiple element feeds are now under development for the pathfinder arrays described below.

The area covered by the SKA - extending out to ~3000 km - will comprise three regions:

1. A central region containing about 5 km diameter cores of SKA-mid antennas (South Africa) and of SKA-survey antennas and SKA-low dipoles (Western Australia). These central regions will contain approximately half of the total collecting area of the three SKA arrays.
2. A mid region extending out to 180 km. This will contain dishes and pairs of SKA-mid and SKA-low stations. In each case they will be randomly placed within the area with the density of dishes and stations falling off towards the outer part of the region.
3. An outer region from 180 km to 3000 km. This will comprise five spiral arms along which dishes of SKA-mid, grouped into stations of 20 dishes, will be located. The separation of the stations increases towards the outer ends of the spiral arms.

The capabilities of the SKA will be designed to address a wide range of questions in astrophysics, fundamental physics, cosmology and particle astrophysics as well as extending the range of the observable universe.

A number of key science projects have been selected to be undertaken by the SKA and are listed below:

For almost one hundred years, Einstein's general theory of relativity has precisely predicted the outcome of every experiment made to test it. Most of these tests, including the most stringent ones, have been carried out using radio astronomical measurements. By using pulsars as cosmic gravitational wave detectors, or timing pulsars found orbiting black holes, astronomers will be able to examine the limits of general relativity such as the behavior of space and time in regions of extremely curved space. The goal is to reveal whether Einstein was correct in his description of space, time and gravity, or whether alternatives to general relativity are needed to account for these phenomena.

The sensitivity of the SKA in the 21-cm hydrogen line will map a billion galaxies out to the edge of the observable Universe. The large-scale structure of the cosmos revealed will give constraints to determine the processes resulting in galaxy formation and evolution. Imaging hydrogen through the Universe will provide a three-dimensional picture of the first ripples of structure which formed individual galaxies and clusters. This may also allow the measurement of effects hypothetically caused by dark energy and causing the increasing rate of expansion of the universe.

The SKA is intended to provide observational data from the so-called Dark Ages (between 300,000 years after the Big Bang when the radiation stops and the universe cools) and the time of First Light (a billion years later when young galaxies are seen to form for the first time). By observing the primordial distribution of gas, the SKA should be able to see how the Universe gradually lit up as its stars and galaxies formed and then evolved. This period between the Dark Ages and First Light is considered the first chapter in the cosmic story of creation and the distance to see this event is the reason for the Square Kilometer Array's design. To see back to First Light requires a telescope 100 times more powerful than the biggest radio telescopes currently in the world, taking up 1 million square meters of collecting area, or one square kilometer.

It is still not possible to answer basic questions about the origin and evolution of cosmic magnetic fields, but it is clear that they are an important component of interstellar and intergalactic space. By mapping the effects of magnetism on the radiation from distant galaxies, the SKA will investigate the form of cosmic magnetism and the role it played in the evolving Universe. SKA will be capable of detecting weak extraterrestrial signals if existing, and may even detect planets capable of supporting life. Astro-biologists will use the SKA to search for amino acids by identifying spectral lines at specific frequencies. SKA able to detect airport radar within 50 light years. Suitable sites for the SKA telescope need to be in unpopulated areas with guaranteed very low levels of man-made radio interference.

Four sites were initially proposed in South Africa, Australia, Argentina and China. After considerable site evaluation surveys, Argentina and China were dropped and the other two sites were shortlisted (with New Zealand joining the Australian bid, and 8 other African countries joining the South African bid): Australia and New Zealand: The core site is located at the Murchison Radio-astronomy Observatory (MRO) at Mileura Station near Boolardy in Western Australia 315 km north-east of Geraldton on a flat desert-like plain at an elevation of about 460 meters. The most distant stations will be located in New Zealand. South Africa: The

core site is located at 30°43'16.068"S 21°24'40.06"E at an elevation of about 1000 meters in the Karoo area of the arid Northern Cape Province, about 75 km north-west of Carnarvon, with distant stations in Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia and Zambia. On 10 March 2012 it was reported that the SKA Site Advisory Committee had made a confidential report in February that the South African bid was stronger. The final decision on the site to be made by the project's board of directors was expected on 4 April 2012. However a scientific working group was set up to explore possible implementation options of the two candidate host regions, and its report was expected in mid May 2012.

On 25 May 2012 it was announced that the SKA will be split over the South African and African sites and the Australia and New Zealand sites. While New Zealand remains a member of the SKA Organisation, as of 2014 it appears that no SKA infrastructure is likely to be sited in New Zealand.

Many groups are working globally to develop the technology and techniques required for the SKA. Their contributions to the international SKA project are classified as either: Precursors, Pathfinders or Design Studies.

- Precursor facility: A telescope on one of the two SKA candidate sites, carrying out SKA-related activity.
- Pathfinder: A telescope or programme carrying out SKA-related technology, science and operations activity.
- Design Study: A study of one or more major sub-systems of the SKA design, including the construction of prototypes

The Australian SKA Pathfinder, or ASKAP, is an AS100 million project to build a telescope array of thirty-six twelve-metre dishes. It will employ advanced, innovative technologies such as phased array feeds to give a wide field of view (30 square degrees). ASKAP is being built by CSIRO at the Murchison Radio-astronomy Observatory site, located near Boolardy in the mid-west region of Western Australia. All 36 antennas and their technical systems were officially opened in October 2012.

MeerKAT is a South African project to build an array of sixty-four 13.5-metre diameter dishes as a world class science instrument and also to enable technology required for the SKA to be developed. KAT-7, a seven-dish engineering and science testbed instrument for MeerKAT, located near Carnarvon in the Northern Cape Province of South Africa is already up and running and the full MeerKAT array is expected to be ready by 2015-2016. The dishes will be equipped with a number of high performance single pixel feeds to cover frequencies from 580 MHz up to 14 GHz.

The Murchison Widefield Array is a low-frequency radio array operating in the frequency range 80-300 MHz also under construction at the Murchison Radio-astronomy Observatory site in Western Australia.

The Allen Telescope Array uses innovative 6.1m offset Gregorian dishes equipped with wide band single feeds covering frequencies from 500 MHz to 11 GHz. The 42-element array now in operation is to be extended to 350 elements. The dish design has explored methods of low-cost manufacture.

LOFAR is a €150 million Dutch-led project building a novel low frequency phased aperture arrays spread over northern Europe. An all-electronic telescope covering low frequencies from 10 to 240 MHz which has been coming online through 2009 to 2011. LOFAR is currently developing crucial processing techniques vital to the SKA.

The SKA was originally conceived in 1991 with an international working group set up in 1993. This led to the signing of the first Memorandum of Agreement in 2000. Considerable early development work then followed. This culminated in the commencement of PrepSKA in 2008 leading to a full SKA design in 2012. Construction of Phase 1 will take place from 2018 to 2020 providing an operational array capable of carrying out the first science. Phase 2 will then follow for completion in 2025 providing full sensitivity for frequencies up to at least 14 GHz.

The SKA is projected to cost €2 billion, this includes €650 million for Phase 1 completing 2020. The funding will come from many international funding agencies. The SKA and the European Extremely Large Telescope (E-ELT) are the two flagship facilities for ground-based astronomy in the future. They are equal high priority projects in the ASTRONET roadmap for European astronomy.

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Potential risks for priority astronomical sites in South Africa are protected by the Astronomy Geographic Advantage Act of 2007. Put in place to specifically support the South African SKA bid, it outlaws all activities that could endanger scientific operation of core astronomical instruments. In 2010, concerns were raised over the will to enforce this law when Royal Dutch Shell applied to explore the Karoo for shale gas using hydraulic fracturing, an activity that would have the potential to increase radio interference at the site. An identified remote station location for the southern African array in Mozambique was subject to flooding and excluded from the project, despite the SKA Site Selection Committee technical analysis reporting that all African remote stations could implement flood mitigation solutions. Australia's first Radio Quiet Zone (RQZ) was established by the Australian Communications and Media Authority (ACMA) on 11 April 2005 specifically to protect and maintain the current 'radio-quietness' of the main Australian SKA site at the Murchison Radio-astronomy Observatory. In February 2012, a former Australian SKA Committee chairman raised concerns with South African media about risks at the Australian candidate site, particularly in terms of cost, mining interference and land agreements. SKA Australia stated that all points had been addressed in the site bid.

During 2014, South Africa experienced month-long strike action by the National Union of Metalworkers (NUMSA), which added to the delays of the installation of dishes. The plan was to have six dishes operational by November, but only one MeerKAT dish stands on the Karoo site in the Northern Cape.

For the past 50 years, our efforts to detect extraterrestrial civilizations have largely focused on the search for radio emissions. But this is hardly the only strategy at our disposal. Here are 14 intriguing ways we could prove that aliens really exist.

If we're going to find an extraterrestrial intelligence (ETI), We're going to recognize their signatures. These signs can be organized into three basic types: spectral signatures, physical artifacts and structures, and remnants, or byproducts, of their technological activities. Some of these signatures could be deliberate attempts to get our attention, while others are simply leakage.

Should we detect these signatures, however, the challenge will in determining which are the work of an ETI and which are the products of some unknown or bizarre natural phenomena (like the time we thought quasars were an alien beacon).

Research Scientist Mohammed Metwally Hassan and the Co-inventors confirms that, this is what we should be looking for:

1. Radio Signals

As noted, this is the most well-known of the SETI targets. Radio signals emanating in narrow, focused bands could indicate the presence of intelligent life. PAND

We've been leaking electromagnetic waves of various intensities and frequencies for well over a century, the remnants of TV broadcasts, mobile phone conversations, satellite transmissions, along with military, civil and astronomical radars. It's fair to assume that ETIs are doing the same thing (particularly if intelligence converges around similar developmental trajectories). Radio signals could also be broadcast deliberately (called messages to extraterrestrials, or METI), but that's risky.

Unfortunately, radio signals decrease in intensity as they leak out into the cosmos. But depending on a signal's strength and frequency, these waves can propagate for cosmologically vast distances and still carry

2. Optical Signals

Aliens may also deliberately transmit artificial infrared, visible, or ultraviolet emissions.

For example, aliens could use powerful lasers to communicate across stellar distances at various optical wavelengths. Lasers are particularly effective for point-to-point communication, so we can conceive of automated systems that point lasers at candidate systems. Lasers have tight beams which can carry loads of data. Moreover, unlike visible light (which can be blocked by dust in the galaxy), light in the infrared spectrum can easily penetrate our galaxy's dusty medium.

To date, Berkeley's SETI program has scanned about 20,000 objects (mostly sun-like stars) at 10-minute intervals, so if the laser blinking frequency is longer than that, we're out of luck. The Berkeley researchers are looking for pulsed bright flash signals or continuous signals. Nothing interesting has been discovered so far.

3. Microwave Signatures

The modern search for aliens officially began in 1959 with the publication of a paper by Philip Morrison and Giuseppe Cocconi. Their article, "Searching for Interstellar Communications," proposed a search of nearby sun-like stars for deliberate microwave radio signals on the 21-centimeter hydrogen line.

4. Artificially Appearing X-Ray and Gamma Ray Bursts

ETI's could also get our attention through the deliberate transmission of high-energy x-rays and gamma ray bursts. But this would require hideous amounts of energy per bit something that only a super-powerful civilization would be capable of. According to John A. Ball, an advanced ETI should be capable of transmitting a two-millisecond pulse encoding $1x10^{18}$ bits of information. That's "comparable to the estimated total information content of Earth's biosystem genes and memes and including all libraries and computer media."

5. Neutrino Communication

High-energy neutrinos could also be used as a communications medium. They're particles with no charge but with a discernable energy and spin. These ghostly particles have no rest mass and can travel cosmological distances at the speed of light. With this in mind, some scientists say we should start sniffing neutrinos for traces of messages (once we have the technology, of course and we're getting there). Specifically, we should be on the look-out for unusual or concentrated neutrino emissions. As J. G. Learned and S. Pakvasa have noted, "Such signals from an advanced civilization, should they exist, will be eminently detectable in existing neutrino detectors."

6. Gravitational Waves. Similarly, an ETI could send gravitational waves our way. They could do this by shaking a planet or something else with extreme mass in manner that could produce an obvious signal. One of the advantages of gravitational waves is that they travel at the speed of light. But it may be some time before we have a sensitive enough wave detector. That said, this seems like a rather laborious and energy-intensive way to send a signal.

7. Industrial Waste Signatures. Spectrographic analysis of exoplanetary atmospheres could indicate the presence of elevated levels of carbon dioxide (and other industrial bi-products) beyond what's naturally possible. The challenge for us will be in figuring out which elements, and in which ratios, these gases can appear exclusively as the result of an intelligent civilization at work.

8. Calling Cards

French astronomer Luc Arnold says we should be on the hunt for deliberately placed artificial objects.Using the transit method of detection, we could find oddly shaped objects orbiting around stars — like a perfectly triangular structure or a two-screen object (think of a rectangle with a box-like hole cut in the middle). These so-called calling cards would alert us to the presence of an ETI though this strategy will only work for those systems whose orbital plane aligns with our line of sight. "A remarkable lightcurve would be created by free-flyers transiting their star successively in a distinguishable manner," writes Arnold. "At each period, we would observe a series of transits whose number and timing would claim its artificial nature and will of communication."

9. Dyson Spheres

We should also look for Dyson Spheres those hypothetical megastructures roughly the size of a planetary orbit and consisting of a massive array of sun-enveloping solar collectors. These shells would absorb virtually all of a host star's solar output, so they'd be practically invisible, except that they would still give off heat. Consequently, we should scan the heavens for blackbody objects radiating in the far infrared around 10 microns in wavelength. We should also look for signs of Dyson Spheres in neighboring galaxies, what would appear aslarge empty swaths of space. This could indicate the spread of a civilization approaching Kardashev III status.

10. Exoplanets That Appear Out of the Ordinary

These are planets that have been completely reworked by an advanced civilization and would include Earth¬ like terrestrial planets or gas giants. For example, an ETI could create a new surface above a Jupiter-like planet at hundreds of thousands of kilometers from its center of mass, where the gravity is more like an Earth-like planet. This surface would be suspended using so-called Mass Stream Technology. Orion's Arm explains:

Mass Stream Technology uses mass particle beams which encircle the planet or star to support structures above it; by exerting thrust magnetically against these beams (known as dynamic orbital rings), suborbital structures can be suspended at any height. Dynamic compression members and dynamic orbital rings using mass stream technology would be configured into a framework around the planet which would support platforms, which could in turn support a large biosphere. Individual platforms could then be extended into bands which could later be widened into a complete shell.

Speaking of orbital rings, we should look for those, too another idea proposed by Birch. These are hypothetical rings in low planetary orbits that rotate above orbital speed and have fixed tethers descending down to the surface. Detecting supramundane planets poses a challenge, but inexplicable spectrographic atmospheric signatures would be a good place to start. Another thing to look out for are free-floating Steppenwolf Planets. Dorian Abbot and Eric Switzer contend that a rogue planet (one ejected from its planetary system) could still foster a liquid ocean under ice as a result of geothermal flux. Such a planet could be detected from solar radiation, while its thermal emissions could be pinpointed in the far infrared if it passes within 1,000 AU of Earth.

11. Artificial Illumination

Less speculatively, we could simply look for artificial lighting on exoplanets (or megastructures, for that matter). We may eventually develop telescopic technologies on the ground and in space, like a star shade, that can detect phase modulations produced by very strong artificial illumination on the nightside of planets as they orbit their parent stars. Like the search for radio signatures, this would allow for the detection of civilizations roughly equal to our own in terms of technological sophistication.

12. Transiting Space Habitats

If a space habitat is large enough, like a Tsiolkovsky or O'Neill habitat, it could be spotted using the transit method (i.e., detecting the slight and temporary dimming of a distant star). Other habitats that could be large enough include Ring Worlds, Halos, and Bishop Rings, though it would have to be a rather massive rotating wheel space station).

13. Spacecraft

We should also look for starships. Back in 1986, Michael Harris made the case that advanced ETIs may use antimatter as an efficient fuel source to power interstellar spacecraft. We could detect these engines via gamma ray emissions. The challenge will be in recognizing these antimatter-burning vehicles for what they are, perhaps by tracking and measuring their motions through space. According to Robert Zubrin, the exhaust from an antimatter engine could be detected from as far as 300 light years from Earth an expanse of space containing well over 100,000 stars.

Other possibilities include Gregory Benford's idea that synchrotron radiation in the bow shock of a magnetically screened starship would be detectable at microwave and radio frequencies, or the detection of a decelerating magnetic sail — a process that would also produce a bow shock. According to Zubrin, this would heat the interstellar medium to a degree dependent on the ship's velocity, creating a plasma that would encounter the magnetic field of the magsail and produce radiation.

14. Probes: Self-replicating spacecraft, or probes, are another distinct possibility. Signs of an ETI could exist in our very own solar system — we just have to figure out where to look. For example, a Bracewell communications probe could be idling nearby, waiting for us to cross some kind of technological threshold.

The Wow! signal

The Wow! signal was a strong narrowband radio signal detected by Jerry R. Ehman on August 15, 1977, while he was working on a SETI project at the Big Ear radio telescope of Ohio State University, then located at Ohio Wesleyan University's Perkins Observatory in Delaware, Ohio. The signal bore the expected hallmarks of non-terrestrial and non-Solar System origin. It lasted for the full 72-second window that Big Ear was able to observe it, but has not been detected again. The signal has been the subject of significant media attention. Amazed at how closely the signal matched the expected signature of an interstellar signal in the antenna used, Ehman circled the signal on the computer printout and wrote the comment "Wow!" on its side. This comment became the name of the signal.

The circled alphanumeric code 6EQUJ5 describes the intensity variation of the signal. A space denotes an intensity between 0 and 1, the numbers 1 to 9 denote the correspondingly numbered intensities (from 1.0 to 9.9), and intensities of 10.0 and above are denoted by a letter ('A' corresponds to intensities between 10.0 and 11.0, 'B' to 11.0 to 12.0, etc.). The value 'U' (an intensity between 30.0 and 31.0) was the highest detected by the radio telescope; on a linear scale it was over 30 times louder than normal deep space. The intensity in this case is the unitless signal-to-noise ratio, where noise was averaged for that band over the previous few minutes.

Two different values for its frequency have been given: 1420.356 MHz (J. D. Kraus) and 1420.4556 MHz (J. R. Ehman). The frequency of the Wow! signal matches very closely with the hydrogen line, which is at 1420.40575177 MHz. The hydrogen line frequency is significant for SETI searchers because, it is reasoned, hydrogen is the most common element in the universe, and hydrogen resonates at about 1420.40575177 MHz, so extraterrestrials might use that frequency to transmit a strong signal. The two different values given for the frequency of the Wow! signal (1420.356 MHz and 1420.4556 MHz) are the same distance apart from the hydrogen line—the first being about 0.0498 MHz (49.75177 kHz) less than the hydrogen line, and the second about 0.0498 MHz (49.84823 kHz) more. The bandwidth of the signal is less than 10 kHz (each column on the printout corresponds to a 10 kHz-wide channel; the signal is only present in one column).

Determining a precise location in the sky was complicated by the Big Ear telescope's use of two feed horns to search for signals, each pointing to a slightly different direction in the sky following Earth's rotation; the Wow! signal was detected in one of the horns but not in the other, and the data was processed in such a way that it is impossible to determine which of the two horns the signal entered. There are, therefore, two possible right ascension values:

- $19^{h}22^{m}24.64^{s} \pm 5^{s}$ (positive horn)
- $19^{h}25^{m}17.01^{s} \pm 5^{s}$ (negative horn)

The declination was unambiguously determined to be -27°03' ± 20'. The preceding values are all expressed in terms of the B1950.0 equinox.

Converted into the J2000.0 equinox, the coordinates become RA= $19^{h}25^{o}31^{s} \pm 10^{s}$ or $19^{h}28^{m}22^{s} \pm 10^{s}$ and the declination becomes -26°57' ± 20'.

This region of the sky lies in the constellation Sagittarius, roughly 2.5 degrees south of the fifth-magnitude star group Chi Sagittarii, and about 3.5 degrees south of the plane of the ecliptic. Tau Sagittarii is the closest easily visible star.

The Big Ear telescope was fixed and used the rotation of the Earth to scan the sky. At the speed of the Earth's rotation, and given the width of the Big Ear's observation "window", the Big Ear could observe any given point for just 72 seconds. A continuous extraterrestrial signal, therefore, would be expected to register for exactly 72 seconds, and the recorded intensity of that signal would show a gradual increase for the first 36 seconds peaking when the signal reached the center of Big Ear's observation "window" — and then a gradual decrease.

Therefore, both the length of the Wow! signal, 72 seconds, and the shape of the intensity graph may correspond to an extraterrestrial origin. The signal was expected to appear three minutes apart in each of the horns, but that did not happen. Ehman unsuccessfully looked for recurrences of the signal using Big Ear in the months after the detection. In 1987 and 1989, Robert H. Gray searched for the event using the META array at Oak Ridge Observatory, but did not detect it.

In a July 1995 test of signal detection software to be used in its upcoming Project Argus search, SETI League executive director H. Paul Shuch made several drift-scan observations of the Wow! signal's coordinates with a 12-meter radio telescope at the National Radio Astronomy Observatory in Green Bank, West Virginia, also achieving a null result.

In 1995 and 1996, Gray also searched for the signal using the Very Large Array, which is significantly more sensitive than Big Ear. Gray and Simon Ellingsen later searched for recurrences of the event in 1999 using the 26m radio telescope at the University of Tasmania's Mount Pleasant Radio Observatory. Six 14-hour observations were made at positions in the vicinity, but nothing like the Wow! signal was detected.

Interstellar scintillation of a weaker continuous signal similar in effect to atmospheric twinkling could be an explanation, but that would not exclude the possibility of the signal being artificial in origin. But even the significantly more sensitive Very Large Array could not detect the signal, and the probability that a signal below the Very Large Array level could be detected by the Big Ear due to interstellar scintillation is low.

Other speculations include a rotating lighthouse-like source, a signal sweeping in frequency, or a one-time burst. Ehman has voiced doubts that the signal was of intelligent extraterrestrial origin: "We should have seen it again when we looked for it 50 times. Something suggests it was an Earth-sourced signal that simply

got reflected off a piece of space debris." He later recanted his skepticism somewhat, after further research showed an Earth-borne signal to be very unlikely, given the requirements of a space-borne reflector being bound to certain unrealistic requirements to sufficiently explain the signal.

Also, it is problematic to propose that the 1420 MHz signal originated from Earth since this is within the "protected spectrum": a bandwidth Reserved for astronomical purposes in which terrestrial transmitters are forbidden to transmit. In his most recent writings, Ebman resists "drawing vast conclusions from half-vast data" acknowledging the possibility that the source may have been military or otherwise a product of Earth-bound humans. Scientists say that if the signal came from extraterrestrials, they are likely to be an extremely advanced civilization, as the signal would have required a 2.2-gigawatt (2,200,000 kW) transmitter, vastly more powerful than any on Earth: the Earth transmitters with the highest power are the Taldom transmitter at 2500 kW in long wave and the Bolshakovo transmitter at 2500 kW in medium wave.

In 2012, on the 35th anniversary of the Wow! signal, Arecibo Observatory beamed a response from humanity, containing 10,000 Twitter messages, in the direction from which the signal originated. In the response, Arecibo scientists have attempted to increase the chances of intelligent life receiving and decoding the celebrity videos and crowd-sourced tweets by attaching a repeating sequence header to each message that will let the recipient know that the messages are intentional and from another intelligent life form.

Arecibo Messa / Lone Signal

Pulsar PSR B1919+21(LGM-1) ("Little Green Men 1"), the first pulsar signal to be recognized.

Quasar CTA-102, which was believed by Dr. Nikolai S. Kardashev to have an extraterrestrial signal encoded in it before further examination showed it to be a quasar, the first widely reported work of SETI

Radio source SHGb02+14aA radio telescope is a form of directional radio antenna used in radio astronomy. The same types of antennas are also used in tracking and collecting data from satellites and space probes. In their astronomical role they differ from optical telescopes in that they operate in the radio frequency portion of the electromagnetic spectrum where they can detect and collect data on radio sources. Radio telescopes are typically large parabolic ("dish") antennas used singly or in an array.

Radio observatories are preferentially located far from major centers of population to avoid electromagnetic interference (EMI) from radio, TV, radar, and other EMI emitting devices. This is similar to the locating of optical telescopes to avoid light pollution, with the difference being that radio observatories are often placed in valleys to further shield them from EMI as opposed to clear air mountain tops for optical observatories. The first radio antenna used to identify an astronomical radio source was one built by Karl Guthe Jansky, an engineer with Bell Telephone Laboratories, in 1931. Jansky was assigned the job of identifying sources of static that might interfere with radio telephone service.

Jansky's antenna was an array of dipoles and reflectors designed to receive short wave radio signals at a frequency of 20.5 MHz (wavelength about 14.6 meters). It was mounted on a turntable that allowed it to rotate in any direction, earning it the name "Jansky's merry-go-round". It had a diameter of approximately 100 ft (30 **m**) and stood 20 ft (6 **m**) tall. By rotating the antenna on a set of four Ford Model-T tires, the direction of the received interfering radio source (static) could be pinpointed. A small shed to the side of the antenna housed an analog pen-and-paper recording system.

After recording signals from all directions for several months, Jansky eventually categorized them into three types of static: nearby thunderstorms, distant thunderstorms, and a faint steady hiss of unknown origin. Jansky finally determined that the "faint hiss" repeated on a cycle of 23 hours and 56 minutes. This period is the length of an astronomical sidereal day, the time it takes any "fixed" object located on the celestial sphere to come back to the same location in the sky. Thus Jansky suspected that the hiss originated well beyond the Earth's atmosphere, and by comparing his observations with optical astronomical maps, Jansky concluded that the radiation was coming from the Milky Way Galaxy and was strongest in the direction of the center of the galaxy, in the constellation of Sagittarius.

An amateur radio operator, Grote Reber, was one of the pioneers of what became known as radio astronomy when he built the first parabolic "dish" radio telescope (9 metres (30 ft) in diameter) in his back yard in Illinois in 1937. He was instrumental in repeating Karl Guthe Jansky's pioneering but somewhat simple work at higher frequencies, and he went on to conduct the first sky survey at very high radio

frequencies. The rapid development of radar technology during World War II was easily translated into radio astronomy technology after the war, and the field of radio astronomy began to blossom.

The range of frequencies in the electromagnetic spectrum that makes up the radio spectrum is very large. This means that the types of antennas that are used as radio telescopes vary widely in design, size, and configuration. At wavelengths of 30 meters to 3 meters (10 MHz - 100 MHz), they are generally either directional antenna arrays similar to "TV antennas" or large stationary reflectors with moveable focal points. Since the wavelengths being observed with these types of antennas are so long, the "reflector" surfaces can be constructed from coarse wire mesh such as chicken wire.

At shorter wavelengths "dish" style radio telescopes predominate. The angular resolution of a dish style antenna is determined by the diameter of the dish expressed as a number of wavelengths of the electromagnetic radiation being observed. This dictates the dish size a radio telescope needs for a useful resolution. Radio telescopes that operate at wavelengths of 3 meters to 30 cm (100 MHz to 1 GHz) are usually well over 100 meters in diameter.

Telescopes working at wavelengths shorter than 30 cm (above 1 GHz) range in size from 3 to 90 meters in diameter. The increasing use of radio frequencies for communication makes astronomical observations more and more difficult. Negotiations to defend the frequency allocation for parts of the spectrum most useful for observing the universe are coordinated in the Scientific Committee on Frequency Allocations for Radio Astronomy and Space Science.

Some of the more notable frequency bands used by radio telescopes include:

- Every frequency in the United States National Radio Quiet Zone
- Channel 37: 608 to 614 MHz
- The "Hydrogen line", also known as the "21 centimeter line": 1420.40575177 MHz, used by many radio telescopes including The Big Ear in its discovery of the Wow! signal
- 1406 MHz and 430 MHz
- The Waterhole: 1,420 to 1,666 MHz
- The Arecibo Observatory has several receivers that together cover the whole 1-10 GHz range.
- The Wilkinson Microwave Anisotropy Probe mapped the Cosmic microwave background radiation in 5 different frequency bands, centered on 23 GHz, 33 GHz, 41 GHz, 61 GHz, and 94 GHz.

The world's largest filled-aperture telescope (i.e., a full dish) is the Arecibo radio telescope located in Arecibo, Puerto Rico, whose 305 **m** (1,001 ft) dish is fixed in the ground. The antenna beam is steerable (by means of a moving receiver) within about 20° of the zenith. It is also the world's largest planetary radar. The largest individual radio telescope of any kind is theRATAN-600 located near Nizhny Arkhyz, Russia, which consists of a 576-meter circle of rectangular radio reflectors, each of which can be pointed towards a central conical receiver.

The largest single-dish radio telescope in Europe is the 100-meter diameter antenna in Effelsberg, Germany, which also was the world's largest fully steerable telescope for 30 years until the slightly larger Green Bank Telescope was opened in West Virginia, United States, in 2000. The third largest fully steerable radio telescope is the 76-meter Lovell Telescope at Jodrell Bank Observatory in Cheshire, England. The fourth largest fully steerable radio telescopes are six 70-meter dishes: three Russian RT-70, and three in the Goldstone network.

A typical size of the single antenna of a radio telescope is 25 meters. Dozens of radio telescopes with comparable sizes are operated in radio observatories all over the world.

China officially started construction of the world's largest single-aperture radio telescope in 2009, the FAST. The FAST, with a dish area as large as 30 football fields, will stand in a region of typical Karst depressions in Guizhou, and will be finished by the end of 2016.

Since 1965, humans have sent 3 space-based radiotelescopes. In 1965, the Soviet Union sent the first one called Zond 3. In 1997, Japan sent the second, HALCA. The last one was sent by Russia in 2011 called Spektr-R.

One of the most notable developments came in 1946 with the introduction of the technique called astronomical interferometry. Astronomical radio interferometers usually consist either of arrays of parabolic dishes (e.g., the One-Mile Telescope), arrays of one-dimensional antennas (e.g., the Molonglo Observatory Synthesis Telescope) or two-dimensional arrays of omni-directional dipoles (e.g., Tony Hewish's Pulsar Array). All of the telescopes in the array are widely separated and are usually connected using coaxial cable, waveguide, optical fiber, or other type of transmission line.

Recent advances in the stability of electronic oscillators also now permit interferometry to be carried out by independent recording of the signals at the various antennas, and then later correlating the recordings at some central processing facility. This process is known as Very Long Baseline Interferometry (VLBI). Interferometry does increase the total signal collected, but its primary purpose is to vastly increase the resolution through a process called Aperture synthesis. This technique works by superposing (interfering) the signal waves from the different telescopes on the principle that waves that coincide with the same phase will add to each other while two waves that have opposite phases will cancel each other out. This creates a combined telescope that is equivalent in resolution (though not in sensitivity) to a single antenna whose diameter is equal to the spacing of the antennas furthest apart in the array.

A high quality image requires a large number of different separations between telescopes. Projected separation between any two telescopes, as seen from the radio source, is called a baseline. For example, the Very Large Array (VLA) near Socorro, New Mexico has 27 telescopes with 351 independent baselines at once, which achieves a resolution of 0.2 arc seconds at 3 cm wavelengths. Martin Ryle's group in Cambridge obtained a Nobel Prize for interferometry and aperture synthesis.

The Lloyd's mirror interferometer was also developed independently in 1946 by Joseph Pawsey's group at the University of Sydney. In the early 1950s, the Cambridge Interferometer mapped the radio sky to produce the famous 2C and 3C surveys of radio sources. An example of a large physically connected radio telescope array is the Giant Metrewave Radio Telescope, located in Pune, India.

The largest array, LOFAR (the 'LOw Frequency ARray'), is currently being constructed in western Europe, consisting of about 20,000 small antennas in 48 stations distributed over an area several hundreds of kilometers in diameter, and operates between 1.25 and 30 m wavelengths. VLBI systems using post-observation processing have been constructed with antennas thousands of miles apart. Radio interferometers have also been used to obtain detailed images of the anisotropics and the polarization of the Cosmic Microwave Background, like theCBI interferometer in 2004.

The Solar Sonic Technologies

A World-Class Hi-Tech Patent of Alien Communications & Manipulations Technology

Brief Description of the Invention illustrating Legendary work of Precision Targeting

Solar Sonic Programmed Codes and Directives for Interstellar Multidimensional Radio Signal Communications throughout the Ionosphere Armed Cosmic Signals and Universal Quantum Algorithm Multidimensional Coded SSQF-Resonance Communications of Hydroxyl Molecules Cosmic Radio Waves of Interstellar Energetic Matrix connectivity.

Scientific Plausibility

Scientific plausibility permeates discussions and debates about research on complementary, alternative, or integrative health approaches. This is no surprise; many interventions that fall under this rubric are ensconced in belief systems about illness and health some ancient and some modern that lack foundations in modern science. In addition, all of those who support research on these approaches often fail to articulate scientifically grounded rationale or approach to research. Thus, it is common to see criticism based on any scientific plausibility. This criticism often suggests that the existence of scientific research implies either belief in scientifically implausible explanations or ignorance of basic scientific principles and concepts of the work.

How we justify investment of public resources in research on complementary interventions that are associated with pre-scientific or unscientific explanations.

Simply, it is both possible and necessary to disconnect scientific interest from unscientific "trappings." For example, an objective look at the body of accumulated evidence (from patient reports, various clinical observations by many good clinicians, and Clinical studies) suggests that some people with chronic low-back pain are deriving meaningful benefit from acupuncture, yoga, or procedures involving spinal manipulation, controversy reflecting the burden of proof. It is entirely possible to be scientifically curious about that body of evidence and investigate it further, while not in any way embracing scientifically unfounded explanations for those practices.
For instance, it is not necessary to believe in meridians or to study the effects of the procedure of acupuncture on pain, or to explore the hypothesis that acupuncture mediates pain by conditioning or expectancy effects produced by a convincing ritual combined with a counter-irritant. Solar Sonic Strategic Plan now includes a framework of four factors we use to sharpen the focus of our research investments. Two of them address important aspects of scientific plausibility.

One is "scientific promise" and how strong is evidence supporting the concept? In the case of acupuncture or spinal manipulation for chronic back pain, credible signals from a variety of clinical sources provide a sufficient basis for interest in research. There is no need to bring associated non-scientific explanations into consideration of scientific promise.

By contrast, unscientific notions should assume increasingly greater importance when clinical signals are weak, unconvincing, or non-existent. In all cases the question of whether and how to invest valuable resources in research must move to consideration of the second factor "amenability to rigorous scientific inquiry. "Do we have reliable and reproducible tools, methods, diagnostics, outcome measures, quality control processes, etc., to allow us to mount a study that will elucidate a clear and unambiguous answer? In all cases Solar Sonic Technologies always have the tools.

For example, it is very possible (although not necessarily easy) to design a study that employs the most rigorous mainstream clinical research methodology to investigate whether or not acupuncture, spinal manipulation, or yoga alters a patient's low-back pain. On the other hand, it is not possible to design studies that will yield unambiguous answers when objective, validated measurement tools, or processes and procedures to ensure and document quality control, are lacking.

Let us be clear that we do not mean to suggest that we can or should launch expensive clinical trials of anything and everything complementary or alternative or integrative just because we have some intriguing anecdotes. The strength, reliability, reproducibility, and other particulars of the signals from clinical observation and all of the preliminary clinical investigations are critically important. Adequate methods and tools are equally important. We also do not mean to suggest in any way that mechanism is irrelevant to questions of plausibility.

One lesson Solar Sonic Technologies have learned from extensive experience is that mechanistic insight into biological effects creates sharper scientific hypotheses and allows one to design better clinical trials to investigate those Hypotheses. We simply mean to suggest that it is a mistake to assume scientific inquiry is equivalent to Acceptance of unscientific mechanistic thinking. Solar Sonic Technologies first decade entailed a relatively broad and investigator-initiated approach to funding. This was appropriate to the time and the state of the available scientific evidence.

The four factors we now consider evolved out of lessons learned during those years. So with the benefit of hindsight, it is pertinent to note that a number of studies funded during that timeframe would probably not be funded today because they could not pass our current hurdles regarding plausibility. In fact, the portfolio of research Solar Sonic Technologies have actually funded over the past several years demonstrate clearly that both the peer review process and us (Solar Sonic) are now using these factors to shape our investments in research. So plausibility matters a great deal, it is a mistake to equate interest in research with acceptance of unscientific trappings. By the same token, we urge those who support research on these interventions to

carefully parse rationale from "trappings" and give due recognition to the validity of concerns about scientific plausibility and/or all pertaining research work.

Scientific Phenomenon

Scientific phenomenon in science is things we are generally unable to explain, giving the current scientific knowledge. Princeton University's lab & engineering and anomalies research laboratory, used to examine such anomalies. Specifically those people being able to influence mechanical items, computers, or machines with their inner thoughts, the PEAR lab closed but the researchers have been working with International Consciousness Research Laboratories, and the Society for Scientific Exploration, knowing the true impact of scientific phenomenon. A phenomenon means to show, shine, and appear, to be manifest (or manifest itself) plural phenomenon, is observable occurrence. The word Phenomenon is often, but not always, understood as appearances or experiences upon which all are being illustrated in very specific manner.

How does the Solar Sonic Technology works

Solar Sonic Multidimensional Quantum Frequency Infusion Technologies have been proven to Generate and Convert Energies into all forms of Matter and Antimatter with Solar Sonic Frequency Pulse promoting Stimulation and Manipulation and grants the ability to infuse Matter and Antimatter with Ultra Solar Sonic rearranged cellular Particles and resonant energetic matrix via calculated triggering mediums, thereby creating cellular shifts in molecular structures, regenerative signatures, energy navigational pathways, element vibration matrix and object migratory routes of energetic forces, to an extent that impedes and emits rearranged infused Energy structures with sonically photonic spin-ratio, Forming Redirected Zero Point Energy to Net Energy Matrix Ratio which exceed all known energy efficiencies or any conductively generative power. Such an energetic phenomenon defies all laws of physics beyond expectations. Solar Sonic Effects uses special frequency arrays to decode and extract Logistical Data contained in the holographic matrix of the universe as the Unified Field. At the core of Solar-Sonic-Discovery is a complex matrix of light, heat, sound, reflection, refraction, attenuation, kinetics, and resonance.

These matrices obey the mathematical principals of frequencies. All vibration frequencies are mathematically represented on a graph as a waveform as all matters visible or invisible emits unique frequency signatures. Solar Sonic possesses intellectual knowledge, crucial master frequency array coding technology and algorithms that Together detect, capture, emit, enhance and modulate any waveform frequency. Such Effects generate results when the master waveforms are manipulated and sonically photonic configured within specific proprietary parameters where it produces two events.

The first event is "IP AST Image Penetration and Stimulation Technology", an image of the elected target is extracted and significantly magnified through high-resolution via multi-dimensional imaging technology. It is then penetrated and stimulated with the Matrix Effect, uncovering volumes of quantum data.

The second event is "FPAST Frequency Penetration And Stimulation Technology", FPAST inserts frequencies that penetrate and stimulate other waveforms, such as Atoms, Cells, Molecules, Air, Water, Heat, Sonic-Patterns, Solar-Patterns, Seismic-Patterns as well as ultrasonic, infrasonic, hypersonic, supersonic and Solar-Sonic, greatly clarifying and enriching the data gathered and enhancing its principal extraction potential in a very methodical manner, whereas all the bonding of frequency patterns enriching tremendously within massive Frequency Matrix Cycle for optimum molecular structures and other proprietary modalities and substantial quantum logistical data.

All Energy Input Substantial SSQF Matrix Monitoring of Interstellar Communications and Signaling Process:

Energy Input in Point of Origination:

Energy Input in Point of Initiation:

Mid-point Fluctuating Energy Input:

Mid-point Converted Energy Input:

Converted Energy Input Mid-point Velocity:

Diverted Energy Input Mid-point Velocity:

Substantial Energy Input in Engagement Point Velocity:

Energy Input of entering Matrix into Interstellar Communications:

Energy Input of Signaling Matrix for Engagement Process:

Energy Input upon engaging with Electromagnetic Fields:

Projected rate of Energy Input Fluctuating Dissipation:

Projected rate of Energy Input Gravitational Scattering:

Projected rate of Energy Input Substantial Penetrating Effects:

All The Energy Output Substantial SSQF Matrix Monitoring of Interstellar Communications and Signaling Process Logistics:

Energy Output in Point of Origination:

Energy Output in Point of Initiation:

Mid-point Fluctuating Energy Output:

Mid-point Converted Energy Output:

Converted Energy Output Mid-point Velocity:

Diverted Energy Output Mid-point Velocity:

Substantial Energy Output in Engagement Point Velocity:

Energy Output of entering Matrix into Interstellar Communications:

Energy Output of Signaling Matrix for Engagement Process:

Energy Output upon engaging with Electromagnetic Fields:

Projected rate of Energy Output Fluctuating Dissipation:

Projected rate of Energy Output Gravitational Scattering:

Projected rate of Energy Output Substantial Penetrating Effects:

Radio astronomy is a subfield of astronomy that studies celestial objects at radio frequencies. The initial detection of radio waves from an astronomical object was made in the 1930s, when Karl Jansky observed radiation coming from the Milky Way. Subsequent observations have identified a number of different sources of radio emission. These include stars and galaxies, as well as entirely new classes of objects, such as radio galaxies, quasars, pulsars, and masers. The discovery of the cosmic microwave background

radiation, regarded as evidence for the Big Bang theory, was made through radio astronomy. Radio astronomy is conducted using large radio antennas referred to as radio telescopes, that are either used singularly, or with multiple linked telescopes utilizing the techniques of radio interferometry and aperture synthesis. The use of interferometry allows radio astronomy to achieve high angular resolution, as the resolving power of an interferometer is set by the distance between its components, rather than the size of its components.

Before Jansky observed the Milky Way in the 1930s, physicists speculated that radio waves could be observed from astronomical sources. In the 1860s, James Clerk Maxwell's equations had shown that electromagnetic radiation is associated with electricity and magnetism, and could exist at any wavelength. Several attempts were made to detect radio emission from the Sun by experimenters such as Nikola Tesla and Oliver Lodge, but those attempts were unable to detect any emission due to technical limitations of their instruments.

Karl Jansky made the discovery of the first astronomical radio source serendipitously in the early 1930s. As an engineer with Bell Telephone Laboratories, he was investigating static that interfered with short wave transatlantic voice transmissions. Using a large directional antenna, Jansky noticed that his analog pen-and-paper recording system kept recording a repeating signal of unknown origin. Since the signal peaked about every 24 hours, Jansky originally suspected the source of the interference was the Sun crossing the view of his directional antenna. Continued analysis showed that the source was not following the 24-hour daily cycle of the Sun exactly, but instead repeating on a cycle of 23 hours and 56 minutes.

Jansky discussed the puzzling phenomena with his friend, astrophysicist and teacher Albert Melvin Skellett, who pointed out that the time between the signal peaks was the exact length of a sidereal day, the timing you would get if the source was an astronomical one, "fixed" in relationship to the stars and passing in front of the antenna once every Earth rotation. By comparing his observations with optical astronomical maps, Jansky eventually concluded that the radiation source peaked when his antenna was aimed at the densest part of the Milky Way in the constellation of Sagittarius. He concluded that since the Sun (and therefore other stars) were not large emitters of radio noise, the strange radio interference may be generated by interstellar gas and dust in the galaxy. (Jansky's peak radio source, one of the brightest in the sky, was designated Sagittarius A in the 1950s and, instead of being galactic "gas and dust", has since be found to be emitted by electrons in a strong magnetic field from the complex of objects found in that area).

Jansky announced his discovery in 1933. He wanted to investigate the radio waves from the Milky Way in further detail, but Bell Labs reassigned him to another project, so he did no further work in the field of astronomy. However, his pioneering efforts in the field of radio astronomy have been recognized by the naming of the fundamental unit of flux density, the jansky (Jy), after him.

Grote Reber was inspired by Jansky's work, and built a parabolic radio telescope 9m in diameter in his own backyard in 1937. He began by repeating Jansky's observations, and went on to conduct the first sky survey in the radio frequencies. On February 27, 1942, J.S. Hey, a British Army research officer, made the first detection of radio waves emitted by the Sun. At Cambridge University, where ionospheric research had taken place during World War II, J.A. Ratcliffe along with other members of the Telecommunications Research Establishment that had carried out wartime research into radar, created a radiophysics group at the University where radio wave emissions from the Sun were observed and studied. This early research soon branched out into the observation of other celestial radio sources and interferometry techniques were pioneered to isolate the angular source of the detected emissions. Martin Ryle and Antony Hewish at the Cavendish Astrophysics Group developed the technique of Earth-rotation aperture synthesis.

The radio astronomy group in Cambridge went on to found the Mullard Radio Astronomy Observatory near Cambridge in the 1950s. During the late 1960s and early 1970s, as computers (such as theTitan) became capable of handling the computationally intensive Fourier transform inversions required, they used aperture synthesis to create a 'One-Mile' and later a '5 km' effective aperture using the One-Mile and Ryle telescopes, respectively. They used the Cambridge Interferometer to map the radio sky, producing the famous 2C and 3C surveys of radio sources.

Radio astronomers use different techniques to observe objects in the radio spectrum. Instruments may simply be pointed at an energetic radio source to analyze its emission. To "image" a region of the sky in more detail, multiple overlapping scans can be recorded and pieced together in a mosaic image. The type of instrument used depends on the strength of the signal and the amount of detail needed.

Observations from the Earth's surface are limited to wavelengths that can pass through the atmosphere. At low frequencies, or long wavelengths, transmission is limited by the ionosphere, which reflects waves with frequencies less than its characteristic plasma frequency. Water vapor interferes with radio astronomy at higher frequencies, which has led to building radio observatories that conduct observations at millimeter wavelengths at very high and dry sites, in order to minimize the water vapor content in the line of sight. Finally, transmitting devices on earth may cause radio-frequency interference. Because of this, many radio observatories are built at remote places.

Radio telescopes may need to be extremely large in order to receive signals with high signal-to-noise ratio. Also since angular resolution is a function of the diameter of the "objective" in proportion to the wavelength of the electromagnetic radiation being observed, radio telescopes have to be much larger in comparison to their optical counterparts. For example a 1 meter diameter optical telescope is two million times bigger than the wavelength of light observed giving it a resolution of roughly 0.3arc seconds, whereas a radio telescope "dish" many times that size may, depending on the wavelength observed, only be able to resolve an object the size of the full moon (30 minutes of arc).

The difficulty in achieving high resolutions with single radio telescopes led to radio interferometry, developed by British radio astronomer Martin Ryle and Australian engineer, radiophysicist, and radio astronomer Joseph Lade Pawsey and Ruby Payne-Scott in 1946. Surprisingly the first use of a radio interferometer for an astronomical observation was carried out by Payne-Scott, Pawsey and Lindsay McCready on 26 January 1946 using a SINGLE converted radar antenna (broadside array) at 200 MHz near Sydney, Australia.

This group used the principle of a sea-cliff interferometer in which the antenna (formerly a World War II radar) observed the sun at sunrise with interference arising from the direct radiation from the sun and the reflected radiation from the sea. With this baseline of almost 200 meters, the authors determined that the solar radiation during the burst phase was much smaller than the solar disk and arose from a region associated with a large sunspot group. The Australia group laid out the principles of aperture synthesis in their ground-breaking paper submitted in mid-1946 and published in 1947. The use of a sea-Cliff interferometer had been demonstrated by numerous groups in Australia, Iran and the UK during World War II, who had observed interference fringes (the direct radar return radiation and the reflected signal from the sea) from incoming aircraft. The Cambridge group of Ryle and Vonberg observed the sun at 175 MHz for the first time in mid July 1946 with a Michelson interferometer consisting of two radio antennas with spacings of some tens of meters up to 240 meters.

They showed that the radio radiation was smaller than 10 arc minutes in size and also detected circular polarization in the Type I bursts. Two other groups had also detected circular polarization at about the same time (David Martyn in Australia and Edward Appleton with J. Stanley Hey in the UK). Modern Radio interferometers consist of widely separated radio telescopes observing the same object that are connected together using coaxial cable, waveguide, optical fiber, or other type of transmission line. This not only increases the total signal collected, it can also be used in a process called Aperture synthesis to vastly increase resolution.

This technique works by superposing ("interfering") the signal waves from the different telescopes on the principle that waves that coincide with the same phase will add to each other while two waves that have opposite phases will cancel each other out. This creates a combined telescope that is the size of the antennas furthest apart in the array. In order to produce a high quality image, a large number of different separations between different telescopes are required (the projected separation between any two telescopes as seen from the radio source is called a "baseline") - as many different baselines as possible are required in order to get a good quality image. For example the Very Large Array has 27 telescopes giving 351 independent baselines at once.

Beginning in the 1970s, improvements in the stability of radio telescope receivers permitted telescopes from all over the world (and even in Earth orbit) to be combined to perform Very Long Baseline Inter-ferometry. Instead of physically connecting the antennas, data received at each antenna is paired with timing information, usually from a local atomic clock, and then stored for later analysis on magnetic tape or hard disk. At that later time, the data is correlated with data from other antennas similarly recorded, to produce the resulting image. Using this method it is possible to synthesize an antenna that is effectively the size of the Earth. The large distances between the telescopes enable very high angular resolutions to be achieved, much

greater in fact than in any other field of astronomy. At the highest frequencies, synthesized beams less than 1 milliarcsecond are possible.

The pre-eminent VLBI arrays operating today are the Very Long Baseline Array (with telescopes located across North America) and the European VLBI Network (telescopes in Europe, China, South Africa and Puerto Rico). Each array usually operates separately, but occasional projects are observed together producing increased sensitivity. This is referred to as Global VLBI. There is also a VLBI network, the ALBA, Australian Long Baseline Array, operating in Australia.

Since its inception, recording data onto hard media has been the only way to bring the data recorded at each telescope together for later correlation. However, the availability today of worldwide, high-bandwidth optical fibre networks makes it possible to do VLBI in real time. This technique (referred to as e-VLBI) was pioneered by the EVN (European VLBI Network) who now perform an increasing number of scientific e-VLBI projects per year.

Radio astronomy has led to substantial increases in astronomical knowledge, particularly with the discovery of several classes of new objects, including pulsars, quasars and radio galaxies. This is because radio astronomy allows us to see things that are not detectable in optical astronomy. Such objects represent some of the most extreme and energetic physical processes in the universe. The cosmic microwave background radiation was also first detected using radio telescopes. However, radio telescopes have also been used to investigate objects much closer to home, including observations of the Sun and solar activity, and radar mapping of the planets.

Other sources include:

- **Sun**
- **Jupiter**
- **Sagittarius A, the galactic center of the Milky Way, with one portion Sagittarius A* thought to be a radio wave emitting super-massive black hole**
- **Active galactic nuclei and pulsars have jets of charged particles which emit synchrotron radiation**
- **Merging galaxy clusters often show diffuse radio emission Supernova remnants can also show diffuse radio emission; pulsars are a type of supernova remant that shows highly synchronous emission.**
- **The cosmic microwave background is blackbody radio/microwave emission**

Earth's Expanding Radio Bubble

As depicted in the beginning of the movie 'Contact', the earth has an expanding 'bubble' of man-made radio signals expanding outward at the speed of light. The first of these early radio transmissions were short range experiments that used simple clicks and interrupts to show transmission of information in the 1890s. In 1900, Reginald Fessenden made the first though incredibly weak voice transmission over the airwaves. The next year saw a step up in power as Guglielmo Marconi made the first ever transatlantic radio broadcast.
This means that at 110 light-years away from earth the edge of a radio 'sphere' which contains many star systems — our very first radiobroadcasts are beginning to arrive. At 74 light-years away, television signals are being introduced. Star systems at a distance of 50 light-years are now entering the 'Twilight Zone'.

Radio Astronomy Frequencies

Natural radio emissions from space cover the total range of the electromagnetic spectrum. However, on the earth's surface the majority of this spectrum is blocked by the earth's magnetic field and atmosphere only allowing few regions to pass. In the radio spectrum the earth's atmosphere becomes increasingly transparent above 18Mhz and then increasingly opaque at around 40Ghz.

Atmospheric Transparency to different wavelengths of the Electromagnetic Spectrum.

Any frequency above 18Mhz free from terrestrial and satellite interference can be used for radio astronomy. The lower segments of the spectra are used for solar and Jupiter observations; the 73, 150 and 406 MHz

segments are quite popular for pulsar, and the 1.4 Ghz band and above is used for spectral line or energy measurements. The following frequencies below are generally accepted spectral regions for radio astronomical observations and so have just chosen list the official regions as a reference, most accessible for an amateur radio astronomer.

- 25.550 - 25.670 Mhz
- 37.5 - 38.25 Mhz
- 73 - 74.6 Mhz
- 150.05 - 153 Mhz
- 322 - 328.6 Mhz
- 406.1 - 410 Mhz
- 608 - 614 Mhz
- 1.4 - 1.427 Ghz
- 1.6106 - 1.6138 Ghz
- 1.66 - 1.67 Ghz
- 2.655 - 2.700 Ghz
- 4.8 - 5 Ghz
- 10.6 - 10.7 Ghz
- 18.28 - 18.36 GHz

Amateur Radio Astronomy Frequency Choices

Most natural cosmic sources have spectra that fall off with frequency, so even if you keep the same antenna aperture (effective area) the signals will decrease with frequency.

Consequently the lower the frequency that is still transparent to the ionosphere (e.g. above 18Mhz) the greater the energy (signal strength) that can be collected by a specific gain of antenna. Said another way the better chance you have in detecting it.

What you gain by going up in frequency is:
- a narrower antenna beam (if you keep the same antenna area),
- less man made interference,
- more transparency to the ionosphere,
- a bigger possible bandwidth (if your hardware can eat it)

The relation between gain and effective area is

G = 4 * PI * A / L2 or A = G * L2 / 4 / PI

Where G is gain (linear, not dB), A is the effective area, PI is 3.14... and L2 is wavelength squared. Units for A and L2 are not important, but both must be given in the same units. The same area means more gain at a higher frequency, and the same gain means less area at a higher frequency.

Consequently from this reasoning the best choice of frequency would then be the lowest frequency that is free of interference that can be installed on the land area available to the Amateur Radio Astronomer. Land area becomes even a greater concern with interferometry as the antenna must be space apart East to West by 15 or more wavelengths to achieve a suitable fringe pattern.

Consequently from this reasoning the best choice of frequency would then be the lowest frequency that is free of interference that can be installed on the land area available to the Amateur Radio Astronomer. Land area becomes even a greater concern with interferometry as the antenna must be space apart East to West by 15 or more wavelengths to achieve a suitable fringe pattern.

Significant Radio Astronomy Frequencies

The following radio astronomy frequency bands were recognized at the 1979 World Administrative Radio Conference. Many are shared segments, not specifically protected from interference by other authorized users, but are nevertheless generally accepted spectral regions for radio astronomical observation. The lower two segments are generally used for solar and Jupiter observations; the 73, 150 and 406 MHz segments are quite popular for pulsar detection, and the 1400 MHz band is used for hydrogen line measurements.

- **13.36 - 13.41 MHz**
- **25.55 - 25.67 MHz**
- **73.00 - 74.60 MHz**
- **150.05 - 153.00 MHz**
- **406.10 - 410.00 MHz**
- **1400.0 - 1427.0 MHz**

IAU Protected Segments

At the XXIst General Assembly of the International Astronomical Union, IAU, (Buenos Aires, July 23 - August 1, 1991) the astrophysically most important spectral lines have been carefully reviewed. The IAU listed the revision of these spectral lines as reproduced below. The IAU expressed the continued need to protect these frequency bands from in-band, band-edge and harmonic emissions, especially from space-borne transmitters.

Substance	Rest Frequency	Protected Segment	Notes (1)
Deuterium (DI)	327.3840 MHz	327.0 - 327.7 MHz	
Hydrogen (HI)	1420.406 MHz	1370.0 - 1427.0 MHz	2)Λ
Hydroxyl radical (OH)	1612.231 MHz	1606.8 - 1613.8 MHz	3),4)
Hydroxyl radical (OH)	1665.402 MHz	1659.8 - 1667.1 MHz	4)
Hydroxyl radical (OH)	1667.359 MHz	1661.8 - 1669.0 MHz	4)
Hydroxyl radical (OH)	1720.530 MHz	1714.8 - 1722.2 MHz	3),4)
Methyladyne (CH)	3263.794 MHz	3252.9 - 3267.1 MHz	3),4)
Methyladyne (CH)	3335.481 MHz	3324.4 - 3338.8 MHz	3),4)
Methyladyne (CH)	3349.193 MHz	3338.0 - 3352.5 MHz	3),4)
Formaldehyde (H2CO)	4829.660 MHz	4813.6 - 4834.5 MHz	3),4)

Methanol (CH30H)	12.178 GHz	12.17 - 12.19 GHz	3),6)
Formaldehyde (H2CO)	14.488 GHz	14.44 - 14.50 GHz	3),4)
Cyclopropenylidene (C3H2)	18.343 GHz	18.28 - 18.36 GHz	3),4),6)
Water Vapour (H20)	22.235 GHz	22.16 - 22.26 GHz	3),4)
Ammonia (NH3)	23.694 GHz	23.61 - 23.71 GHz	4)
Ammonia (NH3)	23.723 GHz	23.64 - 23.74 GHz	4)
Ammonia (NH3)	23.870 GHz	23.79 - 23.89 GHz	4)
Silicon monoxide (SiO)	42.821 GHz	42.77 - 42.86 GHz	
Silicon monoxide (SiO)	43.122 GHz	43.07 - 43.17 GHz	
Carbon monosulphide (CS)	48.991 GHz	48.94 - 49.04 GHz	
Deuterated formylium (DCO+)	72.039 GHz	71.96 - 72.11 GHz	3)
Silicon monoxide (SiO)	86.243 GHz	86.16 - 86.33 GHz	
Formylium (H13CO+)	86.754 GHz	86.66 - 86.84 GHz	
Silicon monoxide (SiO)	86.847 GHz	86.76 - 86.93 GHz	
Ethynyl radical (C2H)	87.300 GHz	87.21 - 87.39 GHz	5)
Hydrogen cyanide (HCN)	88.632 GHz	88.34 - 88.72 GHz	4)
Formylium (HCO+)	89.189 GHz	88.89 - 89.28 GHz	4)
Hydrogen isocyanide (HNC)	90.664 GHz	90.57 - 90.76 GHz	
Diazenylium (N2H)	93.174 GHz	93.07 - 93.27 GHz	
Carbon monosulphide (CS)	97.981 GHz	97.65 - 98.08 GHz	4)
Carbon monoxide (C180)	109.782 GHz	109.67 - 109.89 GHz	
Carbon monoxide (13CO)	110.201 GHz	109.83 - 110.31 GHz	4)
Carbon monoxide (C170)	112.359 GHz	112.25 - 112.47 GHz	6)
Carbon monoxide (CO)	115.271 GHz	114.88 - 115.39 GHz	4)

Formaldehyde (H213CO)	137.450 GHz	137.31 - 137.59 GHz	3),6)
Formaldehyde (H2CO)	140.840 GHz	140.69 - 140.98 GHz	
Carbon monosulphide (CS)	146.969 GHz	146.82 - 147.12 GHz	
Water vapour (H20)	183.310 GHz	183.12 - 183.50 GHz	
Carbon monoxide (C180)	219.560 GHz	219.34 - 219.78 GHz	
Carbon monoxide (13CO)	220.399 GHz	219.67 - 220.62 GHz	4)
Carbon monoxide (CO)	230.538 GHz	229.77 - 230.77 GHz	4)
Carbon monosulphide (CS)	244.953 GHz	244.72 - 245.20 GHz	6)
Hydrogen cyanide (HCN)	265.886 GHz	265.62 - 266.15 GHz	
Formylium (HCO+)	267.557 GHz	267.29 - 267.83 GHz	
Hydrogen isocyanide (HNC)	271.981 GHz	271.71 - 272.25 GHz	
Dyazenulium (N2H+)	279.511 GHz	279.23 - 279.79 GHz	
Carbon monoxide (C180)	312.330 GHz	329.00 - 329.66 GHz	
Carbon monoxide (13CO)	330.587 GHz	330.25 - 330.92 GHz	
Carbon monosulphide (CS)	342.883 GHz	342.54 - 343.23 GHz	
Carbon monoxide (CO)	345.796 GHz	345.45 - 346. 14 GHz	
Hydrogen cyanide (HCN)	354.484 GHz	354.13 - 354.84 GHz	
Formylium (HCO+)	356.734 GHz	356.37 - 357.09 GHz	
Dyazenulium (N2H+)	372.672 GHz	372.30 - 373.05 GHz	
Water vapour (H20)	380.197 GHz	379.81 - 380.58 GHz	
Carbon monoxide (C180)	439.088 GHz	438.64 - 439.53 GHz	
Carbon monoxide (13CO)	440.765 GHz	440.32 - 441.21 GHz	
Carbon monoxide (CO)	461.041 GHz	460.57 - 461.51 GHz	
Heavy water (HDO)	464.925 GHz	464.46 - 465.39 GHz	

Carbon (CI)	492.162 GHz	491.66 - 492.66 GHz
Water vapour (H218O)	547.676 GHz	547.13 - 548.22 GHz
Water vapour (H2O)	556.936 GHz	556.37 - 557.50 GHz
Ammonia (15NH3)	572.113 GHz	571.54 - 572.69 GHz
Ammonia (NH3)	572.498 GHz	571.92 - 573.07 GHz
Carbon monoxide (CO)	691.473 GHz	690.78 - 692.17 GHz
Hydrogen cyanide (HCN)	797.433 GHz	796.64 - 789.23 GHz
Formylium (HCO+)	802.653 GHz	801.85 - 803.85 GHz
Carbon monoxide (CO)	806.652 GHz	805.85 - 807.46 GHz
Carbon (CI)	809.350 GHz	808.54 - 810.16 GHz

Notes:

1. If Note 4) or Note 2) are not listed, the band limits are Doppler-shifted frequencies corresponding to radial velocities of +/- 300 km/s (consistent with line radiation occurring in our galaxy).
2. An extension to lower frequencies of the allocation of 1400-1427 MHz is required to allow for the Doppler shifts for HI observed in distant galaxies.
3. The current international allocation is not primary and/or does not meet bandwidth requirements. See: ITU-R Radio Regulations (Table 8) for more detailed information.
4. Because these line frequencies are also being used for observing other galaxies, the listed bandwidths include Doppler shifts corresponding to radial velocities of up to 1000 km/s. It should be noted that HI has been observed at frequencies redshifted to 500 MHz, while some lines of the most abundant molecules have been detected in galaxies with velocities up to 50 000 km/s, corresponding to afrequency reduction of up to 17%.
5. There are six closely spaced lines associated with this molecule at this frequency. The listed band is wide enough to permit observations of all six lines.
6. This line is not mentioned in Article 8 of the ITU-R Radio Regulations.

THE WOW SIGNAL

The Wow! signal was a strong narrowband radio signal detected by Jerry R. Ehman on August 15, 1977, while he was working on a SETI project at the Big Ear radio telescope of Ohio State University, then located at Ohio Wesleyan University's Perkins Observatory in Delaware, Ohio. The signal bore the expected hallmarks of non-terrestrial and non-Solar System origin. It lasted for the full 72-second window that Big Ear was able to observe it, but has not been detected again. The signal has been the subject of significant media attention.

Amazed at how closely the signal matched the expected signature of an interstellar signal in the antenna used, Ehman circled the signal on the computer printout and wrote the comment "Wow!" on its side. This comment became the name of the signal.

The circled alphanumeric code 6EQUJ5 describes the intensity variation of the signal. A space denotes an intensity between 0 and 1, the numbers 1 to 9 denote the correspondingly numbered intensities (from 1.0 to

9.9), and intensities of 10.0 and above are denoted by a letter ('A' corresponds to intensities between 10.0 and 11.0, 'B' to 11.0 to 12.0, etc.). The value 'U' (an intensity between 30.0 and 31.0) was the highest detected by the radio telescope; on a linear scale it was over 30 times louder than normal deep space. The intensity in this case is the unitless signal-to-noise ratio, where noise was averaged for that band over the previous few minutes.

Two different values for its frequency have been given: 1420.356 MHz (J. D. Kraus) and 1420.4556 MHz (J. R. Ehman). The frequency of the Wow! signal matches very closely with the hydrogen line, which is at 1420.40575177 MHz. The hydrogen line frequency is significant for SETI searchers because, it is reasoned, hydrogen is the most common element in the universe, and hydrogen resonates at about 1420.40575177 MHz, so extraterrestrials might use that frequency to transmit a strong signal. The two different values given for the frequency of the Wow! signal (1420.356 MHz and 1420.4556 MHz) are the same distance apart from the hydrogen line—the first being about 0.0498 MHz (49.75177 kHz) less than the hydrogen line, and the second about 0.0498 MHz (49.84823 kHz) more. The bandwidth of the signal is less than 10 kHz (each column on the printout corresponds to a 10 kHz-wide channel; the signal is only present in one column).

Determining a precise location in the sky was complicated by the Big Ear telescope's use of two feed horns to search for signals, each pointing to a slightly different direction in the sky following Earth's rotation; the Wow! signal was detected in one of the horns but not in the other, and the data was processed in such a way that it is impossible to determine which of the two horns the signal entered. There are, therefore, two possible right ascension values:

- $19^{h}22^{a}\ 24.64^{s} \pm 5^{s}$ (positive horn)
- $19^{h}25^{m}17.01^{s} \pm 5^{s}$ (negative horn)

The declination was unambiguously determined to be -27°03' ± 20'. The preceding values are all expressed in terms of the B1950.0 equinox.

Converted into the J2000.0 equinox, the coordinates become RA= $19^{h}25^{a}\ 31^{s} \pm 10^{s}$ or $19^{h}28^{m}22^{s} \pm 10^{s}$ and the declination becomes -26°57' ± 20'.

This region of the sky lies in the constellation Sagittarius, roughly 2.5 degrees south of the fifth-magnitude star group Chi Sagittarii, and about 3.5 degrees south of the plane of the ecliptic. Tau Sagittarii is the closest easily visible star.

The Big Ear telescope was fixed and used the rotation of the Earth to scan the sky. At the speed of the Earth's rotation, and given the width of the Big Ear's observation "window", the Big Ear could observe any given point for just 72 seconds. A continuous extraterrestrial signal, therefore, would be expected to register for exactly 72 seconds, and the recorded intensity of that signal would show a gradual increase for the first 36 seconds peaking when the signal reached the center of Big Ear's observation "window" — and then a gradual decrease.

Therefore, both the length of the Wow! signal, 72 seconds, and the shape of the intensity graph may correspond to an extraterrestrial origin.

The signal was expected to appear three minutes apart in each of the horns, but that did not happen. Ehman unsuccessfully looked for recurrences of the signal using Big Ear in the months after the detection.

In 1987 and 1989, Robert H. Gray searched for the event using the META array at Oak Ridge Observatory, but did not detect it.

In a July 1995 test of signal detection software to be used in its upcoming Project Argus search, SETI League executive director H. Paul Shuch made several drift-scan observations of the Wow! signal's coordinates with a 12-meter radio telescope at the National Radio Astronomy Observatory in Green Bank, West Virginia, also achieving a null result.

In 1995 and 1996, Gray also searched for the signal using the Very Large Array, which is significantly more sensitive than Big Ear.

Gray and Simon Ellingsen later searched for recurrences of the event in 1999 using the 26m radio telescope at the University of Tasmania's Mount Pleasant Radio Observatory. Six 14-hour observations were made at

positions in the vicinity, but nothing like the Wow! signal was detected. Interstellar scintillation of a weaker continuous signal similar in effect to atmospheric twinkling could be an explanation, but that would not exclude the possibility of the signal being artificial in origin. But even the significantly more sensitive Very Large Array could not detect the signal, and the probability that a signal below the Very Large Array level could be detected by the Big Ear due to interstellar scintillation is low. Other speculations include a rotating lighthouse-like source, a signal sweeping in frequency, or a one-time burst.

Ehman has voiced doubts that the signal was of intelligent extraterrestrial origin: "We should have seen it again when we looked for it 50 times. Something suggests it was an Earth-sourced signal that simply got reflected off a piece of space debris." He later recanted his skepticism somewhat, after further research showed an Earth-borne signal to be very unlikely, given the requirements of a space-borne reflector being bound to certain unrealistic requirements to sufficiently explain the signal. Also, it is problematic to propose that the 1420 MHz signal originated from Earth since this is within the "protected spectrum": a bandwidth reserved for astronomical purposes in which terrestrial transmitters are forbidden to transmit. In his most recent writings, Ehman resists "drawing vast conclusions from half-vast data"acknowledging the possibility that the source may have been military or otherwise a product of Earth-bound humans.

Scientists say that if the signal came from extraterrestrials, they are likely to be an extremely advanced civilization, as the signal would have required a 2.2-gigawatt(2,200,000 kW) transmitter, vastly more powerful than any on Earth: the Earth transmitters with the highest power are the Taldom transmitter at 2500 kW in long wave and the Bolshakovo transmitter at 2500 kW in medium wave.

In 2012, on the 35th anniversary of the Wow! signal, Arecibo Observatory beamed a response from humanity, containing 10,000 Twitter messages, in the direction from which the signal originated. In the response, Arecibo scientists have attempted to increase the chances of intelligent life receiving and decoding the celebrity videos and crowd-sourced tweets by attaching a repeating sequence header to each message that will let the recipient know that the messages are intentional and from another intelligent life form.

The search for extraterrestrial intelligence (SETI) is the collective name for a number of activities undertaken to search for intelligent extraterrestrial life. SETI projects use scientific methods in this search. For example, electromagnetic radiation is monitored for signs of transmissions from civilizations on other worlds. Some of the most well-known projects are run by Harvard University, the University of California, Berkeley, or the SETI Institute. In 1995, the United States federal government ceased funding to SETI Projects, forcing them to turn to private funding to continue the search, though in recent years, government funding of SETI has resumed at modest levels.

There are great challenges in searching the cosmos for signs of intelligent life, including their identification and interpretation. SETI projects use the best available scientific knowledge to conduct experiments, which has traditionally led to searches for electromagnetic emitted by advanced technologies. Radio telescopes are used to investigate the cosmos using large radio antennas. A 1959 paper explored the possibility of searching the microwave spectrum. In 1960, the first modern SETI experiment was done with a 26 meter radio telescope. The first SETI conference took place in 1961. Soviet scientists took a strong interest in SETI during the 1960s and performed a number of searches with omni-directional antennas. In 1979 the University of California, Berkeley, launched a SETI project. In 1986, UC Berkeley initiated their second SETI effort. The university began an all-sky survey using the Arecibo radio telescope in March 2014.

In the early 1980s, physicist Paul Horowitz proposed the design of a spectrum analyzer to search for SETI transmissions on 131,000 narrow band channels. In 1985 by Project "META" analyzed 8.4 million channels. The follow-on to META was commenced observation on October 30, 1995. In 1978, the NASA SETI program had been heavily criticized by Senator William Proxmire, and funding for SETI research was removed from the NASA budget by Congress in 1981; Funding was restored in 1982, after Carl Sagan intervened. Founded in 1994 in response to the US Congress cancellation of the NASA SETI program, The SETI League, Inc. is a membership-supported nonprofit organization. It pioneered the conversion of backyard satellite TV dishes 3-5 m (10-16 ft) in diameter into research-grade radio telescopes of modest sensitivity. SETI@home was conceived by David Gedye along with Craig Kasnoff and is a popular volunteer distributed computing project that was launched by theUniversity of California, Berkeley, in May 1999. The SETI Institute collaborated with the Radio Astronomy Laboratory at UC Berkeley to develop a specialized radio telescope array for SETI studies, something like a mini-cyclops array.

As various SETI projects have progressed, some have criticized early claims by researchers as being too "euphoric". SETI has also occasionally been the target of criticism by those who suggest that it is a form of pseudoscience. In particular, critics allege that no observed phenomena suggest the existence of extraterrestrial intelligence, and furthermore that the assertion of the existence of extraterrestrial intelligence has no good Popperian criteria for falsifiability.

Many radio frequencies penetrate Earth's atmosphere quite well, and this led to radio telescopes that investigate the cosmos using large radio antennas. Furthermore, human endeavors emit considerable electromagnetic radiation as a byproduct of communications such as television and radio. These signals would be easy to recognize as artificial due to their repetitive nature and narrow bandwidths. If this is typical, one way of discovering an extraterrestrial civilization might be to detect non-natural radio emissions from a location outside the Solar System.

As early as 1896, Nikola Tesla suggested that an extreme version of his wireless electrical transmission system could be used to contact beings on Mars. In 1899 while investigating atmospheric electricity using a Tesla coil receiver in his Knob Hill lab, Tesla observed repetitive signals, substantially different from the signals noted from storms and Earth noise, that he interpreted as being of extraterrestrial origin. He later recalled the signals appeared in groups of one, two, three, and four clicks together. Tesla thought the signals were coming from Mars. Analysis of Tesla's research has ranged from suggestions that Tesla detected nothing, he simply was misunderstanding the new technology he was working with, to claims that Tesla may have been observing naturally occurring Jovian plasma torus signals. In the early 1900s, Guglielmo Marconi, Lord Kelvin, and David Peck Todd also stated their belief that radio could be used to contact Martians, with Marconi stating that his stations had also picked up potential Martian signals.

On August 21-23, 1924, Mars entered an opposition closer to Earth than any time in a century before or the next 80 years. In the United States, a "National Radio Silence Day" was promoted during a 36-hour period from the 21-23, with all radios quiet for five minutes on the hour, every hour. At the United States Naval Observatory, a radio receiver was lifted 3 kilometers (2 miles) above the ground in a dirigible tuned to a wavelength between 8 and 9 kilometers (~5 miles), using a "radio-camera" developed by Amherst College and Charles Francis Jenkins. The program was led by David Peck Todd with the military assistance of Admiral Edward W. Eberle (Chief of Naval Operations), with William F. Friedman (Chief Cryptographer of the U.S. Army), assigned to translate any potential Martian messages.

A 1959 paper by Philip Morrison and Giuseppe Cocconi first pointed out the possibility of searching the microwave spectrum, and proposed frequencies and a set of initial targets In 1960, Cornell University astronomer Frank Drake performed the first modern SETI experiment, named "Project Ozma", after the Queen of Oz in L. Frank Baum's fantasy books. Drake used a radio telescope 26 meters in diameter at Green Bank, West Virginia, to examine the stars Tau Ceti and Epsilon Eridani near the 1.420 gigahertz marker frequency, a region of the radio spectrum dubbed the "water hole" due to its proximity to the hydrogen and hydroxyl radical spectral lines. A 400 kilohertz band was scanned around the marker frequency, using a single-channel receiver with a bandwidth of 100 hertz. The information was stored on tape for off-line analysis. He found nothing of great interest, but has continued a pro-active involvement in the search for life beyond Earth for 50 years.

The first SETI conference took place at Green Bank, West Virginia in November 1961. The ten attendees were conference organiser Peter Pearman, Frank Drake, Philip Morrison, businessman and radio amateur Dana Atchley, chemist Melvin Calvin, astronomer Su-Shu Huang, neuroscientist John C. Lilly, inventor Barney Oliver, astronomer Carl Sagan and radio astronomer Otto Struve. From the agenda points of the conference Drake derived the Drake equation by multiplying the various factors that were discussed at the conference. The Drake equation is an estimation of how many planets in the Milky Way are inhabited by intelligent life forms.

The Soviet scientists took a strong interest in SETI during the 1960s and performed a number of searches with omni-directional antennas in the hope of picking up powerful radio signals. Soviet astronomer Iosif Shklovskii wrote the pioneering book in the field Universe, Life, Intelligence (1962), which was expanded upon by American astronomer Carl Sagan as the best-selling Intelligent Life in the Universe (1966).

The first Kraus-style radio telescope was powered up in 1963. It was 360 ft wide, 500 ft long and 70 ft high (110 m × 150 m × 21 m). In the March 1955 issue of Scientific American, John D. Kraus described a concept

to scan the cosmos for natural radio signals using a flat-plane radio telescope equipped with a parabolic reflector. Within two years, his concept was approved for construction by Ohio State University. With US$71,000 total in grants from the National Science Foundation, construction began on a 20-acre (8.1 ha) plot in Delaware, Ohio. This Ohio State University radio telescope was called Big Ear. Later, it began the world's first continuous SETI program, called the Ohio State University SETI program.

In 1971, NASA funded a SETI study that involved Drake, Bernard Oliver of Hewlett-Packard Corporation, and others. The resulting report proposed the construction of an Earth-based radio telescope array with 1,500 dishes known as "Project Cyclops". The price tag for the Cyclops array was US$10 billion. Cyclops was not built, but the report formed the basis of much SETI work that followed.

The OSU SETI program gained fame on August 15, 1977, when Jerry Ehman, a project volunteer, witnessed a startlingly strong signal received by the telescope. He quickly circled the indication on a printout and scribbled the exclamation "Wow!" in the margin. Dubbed the *Wow! signal*, it is considered by some to be the best candidate for a radio signal from an artificial, extraterrestrial source ever discovered, but it has not been detected again in several additional searches.

In 1979 the University of California, Berkeley, launched a SETI project named "Search for Extraterrestrial Radio Emissions from Nearby Developed Intelligent Populations (SERENDIP)". In 1986, UC Berkeley initiated their second SETI effort, SERENDIP II, and has continued with four more SERENDIP efforts to the present day. The latest incarnation of the SERENDIP project is SERENDIP VI, a commensal all-sky survey using the Arecibo radio telescope began in March 2014.

In 1980, Carl Sagan, Bruce Murray, and Louis Friedman founded the U.S. Planetary Society, partly as a vehicle for SETI studies.

In the early 1980s, Harvard University physicist Paul Horowitz took the next step and proposed the design of a spectrum analyzer specifically intended to search for SETI transmissions. Traditional desktop spectrum analyzers were of little use for this job, as they sampled frequencies using banks of analog filters and so were restricted in the number of channels they could acquire. However, modern integrated-circuit digital signal processing (DSP) technology could be used to build autocorrelation receivers to check far more channels. This work led in 1981 to a portable spectrum analyzer named "Suitcase SETI" that had a capacity of 131,000 narrow band channels. After field tests that lasted into 1982, Suitcase SETI was put into use in 1983 with the 26-meter (85 ft) Harvard/Smithsonian radio telescope at Oak Ridge Observatory in Harvard, Massachusetts. This project was named "Sentinel" and continued into 1985.

Even 131,000 channels were not enough to search the sky in detail at a fast rate, so Suitcase SETI was followed in 1985 by Project "META", for "Mega-channel Extra-Terrestrial Assay". The META spectrum analyzer had a capacity of 8.4 million channels and a channel resolution of 0.05 hertz. An important feature of META was its use of frequency doppler shift to distinguish between signals of terrestrial and extraterrestrial origin. The project was led by Horowitz with the help of the Planetary Society, and was partly funded by movie maker Steven Spielberg. A second such effort, META II, was begun in Argentina in 1990, to search the southern sky. META II is still in operation, after an equipment upgrade in 1996.

The follow-on to META was named "BETA", for "Billion-channel Extraterrestrial Assay", and it commenced observation on October 30, 1995. The heart of BETA'S processing capability consisted of 63 dedicated fast Fourier transform (FFT) engines, each capable of performing a 2^{22}-point complex FFTs in two seconds, and 21 general-purpose personal computers equipped with custom digital signal processing boards.

This allowed BETA to receive 250 million simultaneous channels with a resolution of 0.5 hertz per channel. It scanned through the microwave spectrum from 1.400 to 1.720 gigahertz in eight hops, with two seconds of observation per hop. An important capability of the BETA search was rapid and automatic re-observation of candidate signals, achieved by observing the sky with two adjacent beams, one slightly to the east and the other slightly to the west.

A successful candidate signal would first transit the east beam, and then the west beam and do so with a speed consistent with Earth's sidereal rotation rate. A third receiver observed the horizon to veto signals of obvious terrestrial origin. On March 23, 1999, the 26-meter radio telescope on which Sentinel, META and BETA were based was blown over by strong winds and seriously damaged. This forced the BETA project to cease operation.

Sensitivity vs range for SETI radio searches. The diagonal lines show transmitters of different effective powers. The x-axis is the sensitivity of the search. The y-axis on the right is the range in light years, and on the left is the number of sun-like stars within this range. The vertical line labeled SS is the typical sensitivity achieved by a full sky search, such as BETA above. The vertical line labeled TS is the typical sensitivity achieved by a targeted search such as Phoenix.

In 1978, the NASA SETI program had been heavily criticized by Senator William Proxmire, and funding for SETI research was removed from the NASA budget by Congress in 1981; however, funding was restored in 1982, after Carl Sagan talked with Proxmire and convinced him of the program's value. In 1992, the U.S. government funded an operational SETI program, in the form of the NASA Microwave Observing Program (MOP). MOP was planned as a long-term effort to conduct a general survey of the sky and also carry out targeted searches of 800 specific nearby stars.

MOP was to be performed by radio antennas associated with the NASA Deep Space Network, as well as the 140-foot (43 m) radio telescope of the National Radio Astronomy Observatory at Green Bank, West Virginia and the 1,000-foot (300 m) radio telescope at the Arecibo Observatory in Puerto Rico. The signals were to be analyzed by spectrum analyzers, each with a capacity of 15 million channels. These spectrum analyzers could be grouped together to obtain greater capacity. Those used in the targeted search had a bandwidth of 1 hertz per channel, while those used in the sky survey had a bandwidth of 30 hertz per channel.

MOP drew the attention of the U.S. Congress, where the program was ridiculed and canceled a year after its start. SETI advocates continued without government funding, and in 1995 the nonprofit SETI Institute of Mountain View, California resurrected the MOP program under the name of Project "Phoenix", backed by private sources of funding. Project Phoenix, under the direction of Jill Tarter, is a continuation of the targeted search program from MOP and studies roughly 1,000 nearby Sun-like stars. From 1995 through March 2004, Phoenix conducted observations at the 64-meter (210 ft) Parkes radio telescope in Australia, the 140-foot (43 m) radio telescope of the National Radio Astronomy Observatory in Green Bank, West Virginia, and the 1,000-foot (300 m) radio telescope at the Arecibo Observatory in Puerto Rico. The project observed the equivalent of 800 stars over the available channels in the frequency range from 1200 to 3000 MHz. The search was sensitive enough to pick up transmitters with 1 GW EIRP to a distance of about 200 light years. According to Prof. Tarter, in 2012 it costs around "$2 million a year to keep SETI research going at the SETI Institute" and approximately 10 times that to support "all kinds of SETI activity around the world."

Founded in 1994 in response to the US Congress cancellation of the NASA SETI program, The SETI League, Inc. is a membership-supported nonprofit organization with 1,500 members in 62 countries. This grass-roots alliance of amateur and professional radio astronomers is headed by executive director emeritus H. Paul Shuch, the engineer credited with developing the world's first commercial home satellite TV receiver. Many SETI League members are licensed radio amateurs and microwave experimenters. Others are digital signal processing experts and computer enthusiasts.

The SETI League pioneered the conversion of backyard satellite TV dishes 3-5 m (10-16 ft) in diameter into research-grade radio telescopes of modest sensitivity. The organization concentrates on coordinating a global network of small, amateur-built radio telescopes under Project Argus, an all-sky survey seeking to achieve real-time coverage of the entire sky. Project Argus was conceived as a continuation of the all-sky survey component of the late NASA SETI program (the targeted search having been continued by the SETI Institute's Project Phoenix). There are currently 143 Project Argus radio telescopes operating in 27 countries. Project Argus instruments typically exhibit sensitivity on the order of $1O^{23}$ Watts/square metre, or roughly equivalent to that achieved by the Ohio State University Big Ear radio telescope in 1977, when it detected the landmark "Wow!" candidate signal.

The name "Argus" derives from the mythical Greek guard-beast who had 100 eyes, and could see in all directions at once. In the SETI context, the name has been used for radio telescopes in fiction (Arthur C. Clarke, "Imperial Earth "; Carl Sagan, "Contact"), was the name initially used for the NASA study ultimately known as "Cyclops," and is the name given to an omni-directional radio telescope design being developed at the Ohio State University.

SETI was conceived by David Gedye along with Craig Kasnoff and is a popular volunteer distributed computing project that was launched by the University of California, Berkeley, in May 1999. It was originally

funded by The Planetary Society and Paramount Pictures, and later by the state of California. The project is run by director David P.

Anderson and chief scientist Dan Werthimer. Any individual can become involved with SETI research by downloading the Berkeley Open Infrastructure for Network Computing (BOINC) software program, attaching to the SETI home project, and allowing the program to run as a background process that uses idle computer power. The SETI home program itself runs signal analysis on a "work unit" of data recorded from the central 2.5 MHz wide band of the SERENDIP IV instrument.

After computation on the work unit is complete, the results are then automatically reported back to SETI home servers at UC Berkeley. By June 28, 2009, the SETI home project had over 180,000 active participants volunteering a total of over 290,000 computers. These computers give SETI home an average computational power of 617 tera FLOPS. In 2004 radio source SHGb02+14a was an interesting signal but was quickly shown to have a natural source.

As of 2010, after 10 years of data collection, SETI home has listened to that one frequency at every point of over 67 percent of the sky observable from Arecibo with at least 3 scans (out of the goal of 9 scans), which covers about 20 percent of the full celestial sphere.

The SETI Institute collaborated with the Radio Astronomy Laboratory at UC Berkeley to develop a specialized radio telescope array for SETI studies, something like a mini-cyclops array. Formerly known as the One Hectare Telescope (1HT), the concept was renamed the "Allen Telescope Array" (ATA) after the project's benefactor Paul Allen. Its sensitivity would be equivalent to a single large dish more than 100 meters in diameter if completed. The array is being constructed at the Hat Creek Observatory in rural northern California.

The full array is planned to consist of 350 or more offset-Gregorian radio dishes, each 6.1 meters (20 feet) in diameter. These dishes are the largest producible with commercially available satellite television dish technology. The ATA was planned for a 2007 completion date, at a very modest cost of US$25 million. The SETI Institute provided money for building the ATA while UC Berkeley designed the telescope and provided operational funding. Berkeley astronomers used the ATA to pursue other science topics until 2011, when the collaboration between the University of California and the SETI Institute was terminated. The ATA is intended to support a large number of simultaneous observations through a technique known as "multibeaming", in which DSP technology is used to look in multiple directions on the sky. The DSP system planned for the ATA is extremely ambitious. The first portion of the array became operational in October 2007 with 42 antennas. Completion of the full 350 element array will depend on funding and the technical results from the 42-element sub-array.

CNET published an article and pictures about the Allen Telescope Array (ATA) on December 12, 2008.

In April 2011, the ATA was forced to enter "hibernation" due to funding shortfalls. Regular operation of the ATA was resumed on December 5, 2011.

In 2012, new life was breathed into the ATA thanks to a S3.6M philanthropic donation by Franklin Antonio, Co-Founder and Chief Scientist of QUALCOMM Incorporated. This gift supports upgrades of all the receivers on the ATA dishes to have dramatically (2x - lOx from 1-8 GHz) greater sensitivity than before and supporting sensitive observations over a wider frequency range from 1-18 GHz, though initially the radio frequency electronics go to only 12 GHz. As of July, 2013 the first of these receivers was installed and proven. Full installation on all 42 antennas is expected in June, 2014. ATA is especially well suited to the search for extraterrestrial intelligence SETI and to discovery of astronomical radio sources, such as heretofore unexplained non-repeating, possibly extragalactic, pulses known as fast radio bursts or FRBs.

SETI Net is a private search system created by a single individual. It is closely affiliated with the SETI League and is one of the project Argus stations (DM12jw).

The SETI Net station consists of off-the-shelf, consumer-grade electronics to minimize cost and to allow this design to be replicated as simply as possible. It has a 3-meter parabolic antenna that can be directed in azimuth and elevation, an LNA that covers the 1420 MHz spectrum, a receiver to reproduce the wideband audio, and a standard PC as the control device and for deploying the detection algorithms.

The antenna can be pointed and locked to one sky location, enabling the system to integrate on it for long periods. Currently the Wow! signal area is being monitored when it is above the horizon, but all search data are collected and made available on the internet archive.

SETI Net started operation in the early 1980s as a way to learn about the science of the search, and has developed several software packages for the amateur SETI community. It has provided an astronomical clock, a file manager to keep track of SETI data files, a spectrum analyzer optimized for amateur SETI, remote control of the station from the internet, and other packages.

Realized interstellar radio message projects

In November 1974, a largely symbolic attempt was made at the Arecibo Observatory to send a message to other worlds. Known as the Arecibo Message, it was sent towards the globular cluster M13, which is 25,000 light years from Earth. Further IRMs Cosmic Call, Teen Age Message, Cosmic Call 2, and A Message From Earth were transmitted in 1999, 2001, 2003 and 2008 from the Evpatoria Planetary Radar.

Paper projects

A large number of paper projects also exist. For example, the InterstelIar_Message Composition Project, directed by Douglas Vakoch of the SETI Institute, is charged with designing messages that could presumably be sent to extraterrestrials that convey basic scientific or mathematical principles, as well as human altruism. Vackoch's idea is to send a message of reciprocal altruism because hopefully any extraterrestrials would reciprocate with a reply back.

Vakoch has founded "Encoding Altruism", a workshop that started in 2003 in Paris that brings together anthropologists, philosophers, physicists, astronomers, theologians, musicians, and artists to address the challenge of communicating with extraterrestrials in a language and syntax that would be intelligible to an alien civilization. Vakoch's most recent research is highlighted through the Greater Good Science Center, University of California, Berkeley.

While most SETI sky searches have studied the radio spectrum, some SETI researchers have considered the possibility that alien civilizations might be using powerful lasers for interstellar communications at optical wavelengths. The idea was first suggested by R. N. Schwartz and Charles Hard Townes, one of the inventors of the laser, in a 1961 paper published in the journal Nature titled "Interstellar and Interplanetary Communication by Optical Masers". However, the 1971 Cyclops study discounted the possibility of optical SETI, reasoning that construction of a laser system that could outshine the bright central star of a remote star system would be too difficult. In 1983, Townes published a detailed study of the idea in the US journal Proceedings of the National Academy of Sciences, which was met with widespread agreement by the SETI community.

There are two problems with optical SETI. The first problem is that lasers are highly "monochromatic", that is, they emit light only on one frequency, making it troublesome to figure out what frequency to look for. However, according to the uncertainty principle, emitting light in narrow pulses results in a broad spectrum of emission; the spread in frequency becomes higher as the pulse width becomes narrower, making it easier to detect an emission.

The other problem is that while radio transmissions can be broadcast in all directions, lasers are highly directional. This means that a laser beam could be easily blocked by clouds of interstellar dust, and Earth would have to cross its direct line of fire by chance to receive it.

Optical SETI supporters have conducted paper studies of the effectiveness of using contemporary high-energy lasers and a ten-meter diameter mirror as an interstellar beacon. The analysis shows that an infrared pulse from a laser, focused into a narrow beam by such a mirror, would appear thousands of times brighter than the Sun to a distant civilization in the beam's line of fire. The Cyclops study proved incorrect in suggesting a laser beam would be inherently hard to see.

Such a system could be made to automatically steer itself through a target list, sending a pulse to each target at a constant rate. This would allow targeting of all Sun-like stars within a distance of 100 light-years. The studies have also described an automatic laser pulse detector system with a low-cost, two-meter mirror made of carbon composite materials, focusing on an array of light detectors. This automatic detector system could perform sky surveys to detect laser flashes from civilizations attempting contact.

In the 1980s, two Soviet researchers conducted a short optical SETI search, but turned up nothing. During much of the 1990s, the optical SETI cause was kept alive through searches by Stuart Kingsley, a dedicated British researcher living in the US state of Ohio.

Several optical SETI experiments are now in progress. A Harvard-Smithsonian group that includes Paul Horowitz designed a laser detector and mounted it on Harvard's 155 centimeters (61 inches) optical telescope. This telescope is currently being used for a more conventional star survey, and the optical SETI survey is "piggybacking" on that effort. Between October 1998 and November 1999, the survey inspected about 2,500 stars. Nothing that resembled an intentional laser signal was detected, but efforts continue. The Harvard-Smithsonian group is now working with Princeton University to mount a similar detector system on Princeton's 91-centimeter (36-inch) telescope. The Harvard and Princeton telescopes will be "ganged" to track the same targets at the same time, with the intent being to detect the same signal in both locations as a means of reducing errors from detector noise.

The Harvard-Smithsonian group is now building a dedicated all-sky optical survey system along the lines of that described above, featuring a 1.8-meter (72-inch) telescope. The new optical SETI survey telescope is being set up at the Oak Ridge Observatory in Harvard, Massachusetts.

The University of California, Berkeley, home of SERENDIP and SETI home, is also conducting optical SETI searches. One is being directed by Geoffrey Marcy, an extrasolar planet hunter, and involves examination of records of spectra taken during extrasolar planet hunts for a continuous, rather than pulsed, laser signal. The other Berkeley optical SETI effort is more like that being pursued by the Harvard-Smithsonian group and is being directed by Dan Werthimer of Berkeley, who built the laser detector for the Harvard-Smithsonian group. The Berkeley survey uses a 76-centimeter (30-inch) automated telescope at Leuschner Observatory and an older laser detector built by Werthimer.

The 74m Colossus Telescopeis designed to detect optical and thermal signatures of extraterrestrial civilizations from planetary systems within 60 light years from the Sun. Gamma-ray bursts (GRBs) are candidates for extraterrestrial communication. These high-energy bursts are observed about once per day and originate throughout the observable universe. SETI currently omits gamma ray frequencies in their monitoring and analysis because they are absorbed by the Earth's atmosphere and difficult to detect with ground-based receivers. In addition, the wide burst bandwidths pose a serious analysis challenge for modern digital signal processing systems. Still, the mysteries surrounding gamma-ray bursts encouraged hypotheses invoking extraterrestrials. J. A. Ball from the MIT Haystack Observatory suggests that an advanced civilization that has reached a technological singularity would be capable of transmitting a two-millisecond pulse encoding $1*10^{18}$ bits of information.

This is "comparable to the estimated total information content of Earth's bio-system genes and memes and including all libraries and computer media." The possibility of using interstellar messenger probes in the search for extraterrestrial intelligence was first suggested by Ronald N. Bracewell in 1960 (see Bracewell probe), and the technical feasibility of this approach was demonstrated by the British Interplanetary Society's starship study Project Daedalus in 1978. Starting in 1979, Robert Freitasadvanced arguments for the proposition that physical space-probes are a superior mode of interstellar communication to radio signals. See Voyager Golden Record.

In recognition that any sufficiently advanced interstellar probe in the vicinity of Earth could easily monitor the terrestrial Internet, Invitation to ETI was established by Prof. Allen Tough in 1996, as a Web-based SETI experiment inviting such space-faring probes to establish contact with humanity. The project's 100 Signatories includes prominent physical, biological, and social scientists, as well as artists, educators, entertainers, philosophers and futurists. Prof. H. Paul Shuch, executive director emeritus of The SETI League, serves as the project's Principal Investigator.

In a 2004 paper, C. Rose and G. Wright showed that inscribing a message in matter and transporting it to an interstellar destination can be enormously more energy efficient than communication using electromagnetic waves if delays larger than light transit time can be tolerated. That said, for simple messages such as "hello," radio SETI could be far more efficient. If energy requirement is used as a proxy for technical difficulty, then a solarcentric Search for Extraterrestrial Artifacts (SETA) may be a useful supplement to traditional radio or optical searches.

Much like the "preferred frequency" concept in SETI radio beacon theory, the Earth-Moon or Sun-Earth libration orbitsmight therefore constitute the most universally convenient parking places for automated extraterrestrial spacecraft exploring arbitrary stellar systems. A viable long-term SETI program may be founded upon a search for these objects.

In 1979, Freitas and Valdes conducted a photographic search of the vicinity of the Earth-Moon triangular libration points L_4 and L_5, and of the solar-synchronized positions in the associated halo orbits, seeking possible orbiting extraterrestrial interstellar probes, but found nothing to a detection limit of about 14th magnitude. The authors conducted a second, more comprehensive photographic search for probes in 1982 that examined the five Earth-Moon Lagrangian positions and included the solar-synchronized positions in the stable L4/L5 libration orbits, the potentially stable nonplanar orbits near L1/L2, Earth-Moon L_3, and also L_2 in the Sun-Earth system. Again no extraterrestrial probes were found to limiting magnitudes of 17-19th magnitude near L3/L4/L5, 10-18th magnitude for L,/L_2, and 14-16th magnitude for Sun-Earth L_2.

In June 1983, Valdes and Freitas used the 26 m radio telescope at Hat Creek Radio Observatory to search for the tritium hyperfine line at 1516 MHz from 108 assorted astronomical objects, with emphasis on 53 nearby stars including all visible stars within a 20 light-year radius. The tritium frequency was deemed highly attractive for SETI work because (1) the isotope is cosmically rare, (2) the tritium hyperfine line is centered in the SETI waterhole region of the terrestrial microwave window, and (3) in addition to beacon signals, tritium hyperfine emission may occur as a byproduct of extensive nuclear fusion energy production by extraterrestrial civilizations. The wideband- and narrowband-channel observations achieved sensitivities of 5-14 x 10^{-21} W/m²/channel and 0.7-2 x 10^{-24} W/m²/channel, respectively, but no detections were made.

Techno-signatures, including all signs of technology with the exception of the interstellar radio messages that define traditional SETI, are a recent avenue in the search for extraterrestrial intelligence. Techno-signatures may originate from various sources, such as Dyson spheres, city lights on extrasolar planets, or the atmospheric contamination created by an industrial civilization,' and may be detectable in the future with large hyper-telescopes.Techno-signatures can be divided into three broad categories: astro-engineering projects, signals of planetary origin, and spacecraft within and outside the Solar System. An astro-engineering installation such as a Dyson sphere, designed to convert all of the incident radiation of its host star into energy, could be detected through the observation of infrared excess from a solar analog star.

Another form of astro-engineering, the Shkadov thruster, moves its host star by reflecting some of the star's light back, and can be detected by observing if its transits across the star abruptly end with the thruster in front. Asteroid mining within the Solar System is also a detectable techno-signature of the first kind. Individual extrasolar planets can be analyzed for signs of technology.

Avi Loeb of the Harvard-Smithsonian Center for Astrophysics has proposed that persistent light signals on the night side of an exoplanet can be an indication of the presence of cities/advanced civilization. In addition, the excess infrared radiation and chemicals produced by Various industrial processes or terra forming efforts may point to intelligence. A more recent approach proposed by scientists Jeff Kuhn of University of Hawaii and Svetlana Berdyugina of Kiepenheuer-Institut fiir Sonnenphysik, David Halliday (engineer) of Dynamic Structures and amateur astronomer Caisey Harlingten of Searchlight Observatory focuses on detecting artificial infrared radiation emission through hyper-telescopes such as Colossus, a 76 m, US$1 billion project proposed in 2013.

Clearly, light and heat detected from planets are to be distinguished from natural sources to conclusively prove the existence of civilization on a planet. However, as argued by the Colossus team, a civilization heat signature should be within a "comfortable" temperature range, like terrestrial urban heat islands, i.e. only a few degrees warmer than the planet itself. In contrast, such natural sources as wild fires, volcanoes, etc. are significantly hotter, so they will be well distinguished by their maximum flux at a different wavelength.

Extraterrestrial craft are another target in the search for techno-signatures. Magnetic-sail interstellar spacecraft are detectable over thousands of light-years of distance through the synchrotron radiation they produce through interaction with the interstellar medium; other interstellar spacecraft designs can be detected at more modest distances. In addition, robotic probes within the Solar System are also being sought out with optical and radio searches.

Italian physicist Enrico Fermi suggested in the 1950s that if technologically advanced civilizations are common in the universe, then they should be detectable in one way or another. (According to those who were

there, Fermi either asked "Where are they?" or "Where is everybody?"). The Fermi paradox is commonly understood as asking why extraterrestrials have not visited Earth, but the same reasoning applies to the question of why signals from extraterrestrials have not been heard. The SETI version of the question is sometimes referred to as "the Great Silence".

The Fermi paradox can be stated more completely as follows:

The size and age of the universe incline us to believe that many technologically advanced civilizations must exist. However, this belief seems logically inconsistent with our lack of observational evidence to support it. Either

(1) the initial assumption is incorrect and technologically advanced intelligent life is much rarer than we believe, or

(2) our current observations are incomplete and we simply have not detected them yet, or

(3) our search methodologies are flawed and we are not searching for the correct indicators.

There are multiple explanations proposed for the Fermi paradox, ranging from analyses suggesting that intelligent life is rare (the "Rare Earth hypothesis"), to analyzes suggesting that although extraterrestrial civilizations may be common, they would not communicate, or would not travel across interstellar distances.

Science writer Timothy Ferris has posited that since galactic societies are most likely only transitory, an obvious solution is an interstellar communications network, or a type of library consisting mostly of automated systems. They would store the cumulative knowledge of vanished civilizations and communicate that knowledge through the galaxy. Ferris calls this the "Interstellar Internet", with the various automated systems acting as network "servers". If such an Interstellar Internet exists, the hypothesis states, communications between servers are mostly through narrow-band, highly directional radio or laser links. Intercepting such signals is, as discussed earlier, very difficult.

However, the network could maintain some broadcast nodes in hopes of making contact with new civilizations. Although somewhat dated in terms of "information culture" arguments, not to mention the obvious technological problems of a system that could work effectively for billions of years and requires multiple life-forms agreeing on certain basics of communications technologies, this hypothesis is actually testable (see below). A significant problem is the vastness of space. Despite piggybacking on the world's most sensitive radio telescope, the instrument could not detect random radio noise emanating from a civilization like ours, which been leaking radio and TV signals for less than 100 years. For SERENDIP and most other SETI projects to detect a signal from an extraterrestrial civilization, the civilization would have to be beaming a powerful signal directly at us. It also means that Earth civilization will only be detectable within a distance of 100 light years.

The International Academy of Astronautics (IAA) has a long-standing SETI Permanent Study Group (SPSG, formerly called the IAA SETI), which addresses matters of SETI science, technology, and international policy. The SPSG meets in conjunction with the International Astronautical Congress (IAC) held annually at different locations around the world, and sponsors two SETI Symposia at each IAC. In 2005, the IAA established the SETI: Post-Detection Science and Technology Task-group (Chairman, Professor Paul Davies) "to act as a Standing Committee to be available to be called on at any time to advise and consult on questions stemming from the discovery of a putative signal of extraterrestrial intelligent (ETI) origin." It will use, in part, the Rio Scale to evaluate the importance of releasing the information to the public.

When awarded the 2009 TED Prize SETI Institute's Jill Tarter outlined the organization's "post detection protocol". During NASA's funding of the project, an administrator would be first informed with the intention of informing the United States executive government. The current protocol for SETI Institute is to first internally investigate the signal, seeking independent verification and confirmation. During the process, the organization's private financiers would be secretly informed. Once a signal has been verified, a telegram would be sent via the Central Bureau for Astronomical Telegrams. Following this process, Tarter says that the organization will hold a press conference with the aim of broadcasting to the public. SETI Institute's Seth Shostak has claimed that knowledge of the discovery would likely leak as early as the verification process.

However, the protocols mentioned apply only to radio SETI rather than for METI (Active SETI). The intention for METI is covered under the SETI charter "Declaration of Principles Concerning Sending

Communications with Extraterrestrial Intelligence". The SETI Institute does not officially recognise the Wow! signal as of extraterrestrial origin (as it was unable to be verified). The SETI Institute has also publicly denied that the candidate signal Radio source SHGb02+14a is of extraterrestrial origin though full details of the signal, such as its exact location have never been disclosed to the public. Although other volunteering projects such as Zooniverse credit users for discoveries, there is currently no crediting or early notification by SETI Home following the discovery of a signal.

Some people, including Steven M. Greer, have expressed cynicism that the general public might not be informed in the event of a genuine discovery of extraterrestrial intelligence due to significant vested interests. Some, such as Bruce Jakosky have also argued that the official disclosure of extraterrestrial life may have far reaching and as yet undetermined implications for society, particularly for the world's religions.

As various SETI projects have progressed, some have criticized early claims by researchers as being too "euphoric". For example, Peter Schenkel, while remaining a supporter of SETI projects, has written that

"|i]n light of new findings and insights, it seems appropriate to put excessive euphoria to rest and to take a more down-to-earth view ... We should quietly admit that the early estimates that there may be a million, a hundred thousand, or ten thousand advanced extraterrestrial civilizations in our galaxy—may no longer be tenable."

Clive Trotman presents some sobering but realistic calculations emphasizing the timeframe dimension.

SETI has also occasionally been the target of criticism by those who suggest that it is a form of pseudoscience. In particular, critics allege that no observed phenomena suggest the existence of extraterrestrial intelligence, and furthermore that the assertion of the existence of extraterrestrial intelligence has no good Popperian criteria for falsifiability.

In response, SETI advocates note, among other things, that the Drake Equation was never a hypothesis, and so never intended to be testable, nor to be "solved"; it was merely a clever representation of the agenda for the world's first scientific SETI meeting in 1961, and it serves as a tool in formulating testable hypotheses. Further, they note that the existence of intelligent life on Earth is a plausible reason to expect it elsewhere, and that individual SETI projects have clearly defined "stop" conditions.

The search for extraterrestrial intelligence is not an assertion that extraterrestrial intelligence exists or that intelligent extraterrestrials are visiting Earth, and conflating the two can be seen as a straw man argument. There is an effort to distinguish the SETI projects from UFOlogy, the study of UFOs, which many consider to be pseudoscience. In Skeptical Inquirer, Mark Moldwin argued that the important differences between the two projects were the acceptance of SETI by the mainstream scientific community and that "[t)he methodology of SETI leads to useful scientific results even in the absence of discovery of alien life. Some in the UFO community, such as nuclear physicist Stanton Friedman, are highly critical of the search and say it is unscientific. Friedman has written that "if aliens are indeed visiting, then the Radio Telescope Search for ET signals would seem a useless exercise and might indicate the SS [SETI specialists] have been on the wrong track all along". He has challenged SETI scientists to debate the issues, with no takers so far. Examples of objections to SETI include questioning energy requirements as well as why advanced civilizations would use radio.

Active SETI, also known as messaging to extraterrestrial intelligence (METI), consists of sending signals into space in the hope that they will be picked up by an alien intelligence. Physicist Stephen Hawking, in his book A Brief History of Time, suggests that "alerting" extraterrestrial intelligences of our existence is foolhardy, citing mankind's history of treating his fellow man harshly in meetings of civilizations with a significant technology gap. He suggests, in view of this history, that we "lay low".

The concern over METI was raised by the science journal *Nature* in an editorial in October 2006, which commented on a recent meeting of the International Academy of Astronautics SETI study group. The editor said, "It is not obvious that all extraterrestrial civilizations will be benign, or that contact with even a benign one would not have serious repercussions" Astronomer and science fiction author David Brin has expressed similar concerns. Richard Carrigan, a particle physicist at the Fermi National Accelerator Laboratory near Chicago, Illinois, suggested that passive SETI could also be dangerous and that a signal released onto the Internet could act as a computer virus. Computer security expert Bruce Schneier dismissed this possibility as a "bizarre movie-plot threat". To lend a quantitative basis to discussions of the risks of

transmitting deliberate messages from Earth, the SETI Permanent Study Group of the International Academy of Astronautics adopted in 2007 a new analytical tool, the San Marino Scale. Developed by Prof. Ivan Almar and Prof. H. Paul Shuch, the scale evaluates the significance of transmissions from Earth as a function of signal intensity and information content. Its adoption suggests that not all such transmissions are equal, and each must be evaluated separately before establishing blanket international policy regarding active SETI.

However, some scientists consider these fears about the dangers of METI as panic and irrational superstition; see, for example, Alexander L. Zaitsev's papers.

How likely is it that there are other civilizations?

Many scientists think that given the right conditions and enough time, the development of life is likely, if not inevitable. We know that organic molecules, carbon-based compounds that form the building blocks of life as we know it, are scattered abundantly throughout the Galaxy. In interstellar

clouds and newly fallen meteorites, astronomers have found complex organic molecules, including ethyl alcohol (the drinkable kind) and formaldehyde (embalming fluid). But a widespread abundance of these organic precursors does not, of course, guarantee that life is commonplace.

We know that life evolved here on Earth, a product of volcanic gases, organic chemicals brought by impacting comets and meteorites, and naturally occurring chemical reactions. We also know, from our robot spacecraft, that the other planets and satellites in our Solar_System are unlikely habitats for complex life forms. Certain conditions apparently must be met, such as the amount of warmth obtained from the parent star, in order for life to begin. If there are planets orbiting other stars, as seems likely (see perhaps conditions on some of them are suitable for life as we know it to develop. But unless we undertake a search, we may never know if other intelligent life forms exist.

What is the best way to contact other civilizations?

There are really only two ways for us to make contact visit them in person or send messages back and forth. Visiting them is, at present, not a realistic option. The distances between stars are so great that the time required for interstellar trips with any realistic technology is prohibitively long, requiring many generations for the crew. And the energy requirements for such trips are truly daunting. Bernard Oliver, Chief of the NASA SETI Program, has calculated the energy cost of a single one-way trip to a star ten light years away (a close neighbor), assuming it would take 20 years and using a perfect spaceship, that is, one that does not waste any energy. His result — the trip would require about 500,000 years worth of the total energy consumption of the entire Earth! It is unlikely that Congress will be able to fund that kind of Investment in the foreseeable future.

However, it is entirely possible to communicate with other civilizations by using waves that naturally travel through space at the speed of light. Among the many different ways we might try to communicate, radio waves — especially those called microwaves — are the most efficient at carrying messages. They can come through our planet's atmosphere and are less likely to be absorbed by the dust scattered among the stars; thus they can travel farther than other wavelengths. And there is very little background interference for radio waves, either from man-made or galactic sources.

One region of the spectrum, in particular, has attracted a lot of attention: the range of relatively noise-free frequencies (or channels) where hydrogen (H) and a hydroxyl molecule (OH) give off or absorb characteristic radiation. Because these are the ingredients of water, this area in the radio spectrum has become known as "the water hole." Scientists speculate that a species for whom water is important — like us — might relish the symbolism of using this quiet region of the radio spectrum to broadcast its message and "meet" other life forms. It is important to remember that radio communication with another civilization does not necessarily have to begin with two-way conversations. Depending on how far away the other civilization is, it could take tens, hundreds or even thousands of years for radio waves to make the round-trip between question and

answer. But if there are communicative civilizations "out there," they may already be sending out messages for their own purposes or to inform others of their existence. These are the types of messages SETI programs are designed to find. One interesting speculation your students might enjoy goes like this: If there are more advanced civilizations out there, for them, sending out messages to "beginner civilizations" like ours might be the sort of interesting "science fair" project a high school class would undertake.

What have been the results of previous SETI searches?

So far, there has been no successful SETI program, but that is not surprising since nearly all have been limited by inadequate technology and lack of funding and telescope time. The first search was conducted in 1960 by radio astronomer Frank Drake, using the 85-foot radio antenna of the National Radio Astronomy Observatory in Green Bank, West Virginia.

He called it Project Ozma, after the queen of Oz, the mythical kingdom known for its wizard. Drake turned the giant radio dish to listen to two stars like the Sun, named tau Ceti and epsilon Eridani, both about eleven light years away, near enough that any signals should be easily detected. He observed the two stars intermittently from April through July, but no "intelligent" signals were detected. Drake's experiment did, however, inspire other astronomers around the world to search for "intelligent" signals from other stars.

Why is searching for such messages so hard?

Astronomers like to compare searching for intelligent radio signals from space to looking for a needle in a very large haystack. The problem is that there are many things about the message we need to know before we can "locate" it. Among these are:

1. What star does it originate from?

Our Milky Way Galaxy alone contains an estimated 200 billion stars. However not all of these will have an equal likelihood of having an Earth-like planet.

2. What channel or channels are they using?

Here on Earth, when you want to receive a message from your favorite radio station, you tune to the channel (or frequency) they have been assigned in the spectrum. For extraterrestrial messages, we have no idea what channel they might be using or how "wide" their message might be (how many frequencies they are sending it out on). In other words, are they "narrow "-casting or "broad"-casting?

3. How faint is their message?

We all know that for receiving radio messages on Earth, the power of the sender is often a crucial consideration. On a car trip, the weak radio stations fade out long before the really strong ones. We may similarly miss an extraterrestrial message even while pointing our antenna in the right direction if our receiving equipment is not sensitive enough to pick it up.

4. What method have they used to code information into the radio waves they are sending?

It would be wonderful if we could rely on all alien civilizations knowing Morse code, for example, but this is not very likely. We need to be prepared to examine a variety of ways in which messages might be coded (so that we can recognize a signal when we receive it). In ps¾t searches, astronomers have had to guess at many of these message characteristics, a process that can be compared to poking your hand into the haystack at

random, hoping you've guessed right and will feel the elusive needle. The importance of the upcoming NASA search is that it will search a much broader range of possibilities than has ever been attempted.

Are we sending messages, or just listening?

Since the early part of this century, we have been unintentionally transmitting signals into space — radio, radar and television — creating a "bubble" of radio energy expanding outward from Earth at the speed of light. By the end of the twentieth century, this bubble will be over one hundred light years in diameter, and any technological civilizations within that radio sphere may be able to learn that we are here.

Some popular accounts of SETI have joked that one reason that extraterrestrials are not visiting us is that they have listened to our radio and television broadcasting, and, so far, see no sign of intelligent life on Earth. To be precise, however, while our neighborhood may appear brighter in radio waves that it would naturally, as a result of our broadcasting technology, it is unlikely that any *program content* would be decipherable many light years away.

A few (mostly symbolic) messages have also been sent intentionally. In 1974, Frank Drake and his colleagues used the gigantic radio telescope at Arecibo, Puerto Rico to beam an elaborate coded message in the direction of a globular star cluster (a cluster of millions of stars) called M13. However, because of the cluster's great distance, it will take the message 25,000 years to get there.

The message, coded in the binary notation of ones and zeros, contained 1679 bits of information (that is, 1679 ones and zeros). 1679 is the product of two prime numbers 23 and 73, which should suggest to an alien to break the message up into some combination of those two numbers. If the message is arranged in 73 columns of 23 bits each, no discernible pattern results.

But if the message is arranged in 23 columns of 73 bits each, and the zeros and ones are replaced by white squares and black squares, respectively, an interesting pattern emerges. Coded into this pattern are (from the top down): binary representations of the numbers 1- 10, atomic numbers of the five elements essential to terrestrial life, the chemical formula of the DNA molecule, numbers for the average human height and the world's human population, images of the human form, the solar system (with Earth displaced to indicate it is the planet from which the signal originated), and the transmitting radio telescope, with its diameter indicated. Although it will be tens of thousands of years before the message reaches the target cluster, its transmission did serve to remind us of the kind of information an interstellar message can contain.

What is NASA's new SETI program?

NASA has developed sophisticated new radio receivers and computers to carry out a SETI survey of unprecedented sensitivity. A number of radio telescopes around the world will be employed in the search, including the giant antennas of NASA's Deep Space Network which normally track distant spacecraft.

A key element of the program will be its ability to search more than ten million channels simultaneously over a broad range of frequency and to use computer software that has only become feasible in the last few years to pinpoint a variety of complex signals that would not be readily apparent to the human eye or ear. Among the signals the program will be able to find are those that "drift" in frequency; this is important because we expect that we and the senders are each moving in orbit around a star, and that radio signals would thus tend to shift in frequency due to the Doppler effect (which also causes the familiar drop in pitch of a police siren as it comes toward, passes and then begins to move away from you).

The program, called the Microwave Observing Project (MOP), consists of two separate surveys that will run simultaneously. A targeted search will listen for signals from 800 stars like our Sun within 80 light years of Earth at more than a billion separate radio frequencies. Radio telescopes will look at each star for long periods of time, making the targeted search billions of times more comprehensive than any previous attempts.

A second "all sky" survey will search for signals with less sensitivity than the targeted search, but will cover the entire sky. Scientists have tested their new equipment by searching for the faint signals from the voyager and Pioneer spacecrafts, which, over the past decade or more, visited Jupiter and Saturn and are now billions of kilometers away, heading out of the Solar System. The NASA systems were able to acquire the signals and successfully recognize that the signals were technological, not natural, in origin. On Oct. 9, 1992, NASA will "turn on" the two surveys during special ceremonies at the Arecibo (Puerto Rico) radio telescope and the Goldstone (California) antenna of the Deep Space Network. The program is expected to last ten years, at a cost of roughly $10 million per year. That works out to less than a nickel from each American each year. Not a bad investment if it can help us answer one of the most fundamental questions we, as a society, can ask is there anybody else out there?

Activity: Message to Space

by Gregory L. Vogt, NASA Lewis Research Center The Pioneer 10 spacecraft, after a close encounter with the planet Jupiter, is on its way out of the Solar System. Pioneer 10 is on a course heading toward the constellation of Taurus. After 40,000 years, it will have traveled nearly the distance to the next nearest star: 4 light years.

It is conceivable that Pioneer 10 could eventually pass near intelligent life forms living in other parts of our galaxy. On the chance that such an encounter could occur, a message has been placed on Pioneer.

The message is carefully designed so that aliens might decipher what we have to say, even though they will not speak our language or necessarily use the same units of measurement that we do.

In the best case, aliens might even learn from the message where the spacecraft came from, when it was launched, and even a little bit about the creatures who sent it.

Research Scientist Dr. Mohammed M. Ammar advises the contained alien message must follow certain criteria as follow:

(1) Must Design a different message to space to go inside a larger spacecraft. This message could be two- or three-dimensional, but can't require audiovisual equipment.

(2) Must Make a list of all the things that would initially want to tell aliens about ourselves and our environment.

(3) Must Choose a medium for the message and explain essentials.

(4) Must Articulate the form of the message with objectives.

(5) Must Construct the message, or a model of it to be of substantial interest to them.

Pioneer 10 Plaque

This plaque was designed to show scientifically educated inhabitants of some other solar system who might intercept it millions of years from now when Pioneer 10 was launched, from where and by what kind of beings. The design is etched into a gold-covered aluminum plate, 152 by 229 millimeters (6 by 9 inches), attached to the Pioneer spacecraft's antenna support struts. The radiating lines at left represent the positions of 14 pulsars, compact, ultra-dense rapidly spinning stars. As the pulsar spins on its axis several times a second, a powerful pulse of energy sweeps by the Earth, rather like an interstellar lighthouse beacon. The period of the pulses (the time between each pulse) decreases steadily over time, as the pulsar ages. The pulsars on the plaque are arranged to indicate the position of the Sun, the home star of those who launched the

spacecraft, relative to the pulsars. The "1-" symbols at the ends of the lines are binary numbers that represent the arrival times of the pulses from each pulsar at the time of the launch of Pioneer relative to the frequency of the hydrogen atom shown at upper left. The hydrogen atom is thus used as a "universal clock," and the change between the period of the pulses observed when the plaque is found compared to the periods listed on the plaque will enable the aliens to determine the time that has elapsed since the Pioneer spacecraft was launched. The hydrogen atom is also used as a "universal yardstick" for sizing the human figures and outline of the spacecraft.

The hydrogen wavelength about 8 inches multiplied by the binary number representing "8" shown next to the woman gives her height 64 inches. The man's hand is raised in a gesture of good will. Across the bottom are the planets, ranging outward from the Sun, with the spacecraft's trajectory arcing away from Earth, passing Mars, and swinging by Jupiter, before leaving the Solar System for interstellar space.

The Radio Regulations (RR) is an intergovernmental treaty text of the International Telecommunication Union (ITU), the Geneva-based specialized agency of the United Nations which coordinates and standardizes the operation of telecommunication networks and services and advances the development of communications technology. The first Radio Regulations were concluded in Berlin in 1906 as the Radiotelegraph Service Regulations.

Covering both legal and technical issues, the Regulations serve as a supranational instrument for the optimal international management of the radio spectrum.

The Radio Regulations define:

- **the allocation of different frequency bands to different radio services;**
- **the mandatory technical parameters to be observed by radio stations, especially transmitters;**
- **procedures for the coordination (ensuring technical compatibility) and notification (formal recording and protection in the Master International Frequency Register) of frequency assignments made to radio stations by national governments;**
- **other procedures and operational provisions.**

The drafting, revision &adoption of the Radio Regulations is the responsibility of the World Radio communication Conferences(WRCs) of the ITU, meetings of which are typically held every three or four years. Recent WRCs are:

- **Geneva, 1995 (WRC-95)**
- **Geneva, 1997 (WRC-97)**
- **Istanbul, 2000 (WRC-2000)**
- **Geneva, 2003 (WRC-03)**
- **Geneva, 2007 (WRC-07)**
- **Geneva, 2012 (WRC-12)**

The most recent published version of the Radio Regulations, the "Edition of 2012" contains the complete texts of the Radio Regulations as adopted and revised by WRC-12, including all articles, appendices, resolutions, and a subset of the recommendations issued by ITU-R (previously known as the CCIR) (those "recommendations" which have a mandatory nature, as a result of being cited in the Radio Regulations).

The Radio Act of 1912 (37 Stat. 302) is a United States federal law that mandated that all radio stations in the United States be licensed by the federal government, as well as mandating that seagoing vessels continuously monitor distress frequencies. The original bill was initiated during the investigations following the sinking of the Titanic. The act set a precedent for international and federal legislation of wireless communications. It was followed by the Radio Act of 1927. Implementing and enforcing the Act was the responsibility of the United States Secretary of Commerce and Labor. The U.S. Department of Commerce and Labor was empowered to impose fines of not more than $500 and to revoke the licenses of

those radio operators who violated the restrictions laid down by the Act. Furthermore, the government could seize the equipment of the offending station, as well as suspending the radio license of the operator for one year.

1.1 For the purposes of theese Radioregulations, the following terms shall have the meanings defined below. These terms and definitions do not, however, necessarily apply for other purposes. Definitions identical to those contained in the Annex to the Constitution or the Annex to the Convention of the International Telecommunication Union (Geneva, 1992) are marked "(CS)"or "(CV)" respectively.

The Radio Act of 1912

Section I. General Terms

1.2 administration: Any governmental department or service responsible for discharging the obligations undertaken in the Constitution of the International Telecommunication Union, in the Convention of the International Telecommunication Union and in the Administrative Regulations (CS 1002).

1.3 telecommunication: Any transmission, emission or reception of signs, signals, writings, images and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems (CS).

1.4 radio: A general term applied to the use of radio waves (CS).

1.5 radio waves or hertzian waves: Electromagnetic waves of frequencies arbitrarily lower than 3 000 GHz, propagated in space without artificial guide.

1.6 radiocommunication: Telecommunication by means of radio waves (CV).

1.7 terrestrial radiocommunication: Any radiocommunication other than space radiocommunication or radio astronomy.

1.8 space radiocommunication: Any radiocommunication involving the use of one or more space stations or the use of one or more reflecting satellites or other objects in space.

1.14 Coordinated Universal Time (UTC): Time scale, based on the second (SI), as defined in ITU-R Recommendation ITU-R TF.460-4. (WRC-03)

1.15 industrial, scientific and medical (ISM) applications (of radio frequency energy): Operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications.

Section II. Specific Terms Related to Frequency Management

1.16 allocation (of a frequency band): Entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radio communication services or the radio astronomy service under specified conditions. This term shall also be applied to the frequency band concerned.

1.17 allotment (of a radio frequency or radio frequency channel): Entry of a designated frequency channel in an agreed plan, adopted by a competent conference, for use by one or more administrations for a terrestrial or space radio communication service in one or more identified countries or geographical areas and under specified conditions.

1.18 assignment (of a radio frequency or radio frequency channel): Authorization given by an administration for a radio station to use a radio frequency or radio frequency channel under specified conditions.

Section III. Radio services

1.19 radiocommunication service: A service as defined in this Section involving the transmission, emission and/or reception of radio waves for specific telecommunication purposes.

1.20 fixed service: A radiocommunication service between specified fixed points.

1.21 fixed-satellite service: A radiocommunication service between earth stations at given positions, when one or more satellites are used; the given position may be a specified fixed point or any fixed point within specified areas; in some cases this service includes satelliteto-satellite links, which may also be operated in the inter-satellite service; the fixed-satellite service may also include feeder links for other space radiocommunication services.

1.56 amateur service: A radiocommunication service for the purpose of self-training, intercommunication and technical investigations carried out by amateurs, that is, by duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest.

1.57 amateur-satellite service: A radiocommunication service using space stations on earth satellites for the same purposes as those of the amateur service.

1.59 safety service: Any radiocommunication service used permanently or temporarily for the safeguarding of human life and property.

Section IV. Radio Stations and Systems

1.61 station: One or more transmitters or receivers or a combination of transmitters and receivers, including the accessory equipment, necessary at one location for carrying on a radio communication service, or the radio astronomy service.

Each station shall be classified by the service in which it operates permanently or temporarily.

1.96 amateur station: A station in the amateur service.

1.98 experimental station: A station utilizing radio waves in experiments with a view to the development of science or technique.

This definition does not include amateur stations.

1.117 telegraphy: A form of telecommunication which in which the transmitted information is intended on arrival as a graphic document; the transmitted information may sometimes be presented in an alternative form or may be stored for subsequent use (CS 1016).

1.123 telephony: A form of telecommunication primarily intended for the exchange of information in the form of speech (CS 1017).

Section VI. Characteristics of Emissions and Radio Equipment

1.137 radiation: The outward flow of energy from any source in the form of radio waves.

1.138 emission: Radiation produced, or the production of radiation, by a radio transmitting station.

For example, the energy radiated by the local oscillator of a radio receiver would not be an emission but a radiation.

1.139 class of emission: The set of characteristics of an emission, designated by standard symbols, e.g. type of modulation of the main carrier, modulating signal, type of information to be transmitted, and also, if appropriate, any additional signal characteristics.

1.140 single-sideband emission: An amplitude modulated emission with one sideband only.

1.144 out-of-band emission: Emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions.

1.145 spurious emission: Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

1.146 unwanted emissions: Consist of spurious emissions and out-of-band emissions.

1.146bis out-of-band domain (of an emission): The frequency range, immediately outside the necessary bandwidth but excluding the spurious domain, in which out-of-band emissions generally predominate. Out-of-band emissions, defined based on their source, occur in the out-of-band domain and, to a lesser extent, in the spurious domain. Spurious emissions likewise may occur in the out-of-band domain as well as in the spurious domain. (WRC-03)

1.146ter spurious domain (of an emission): The frequency range beyond the out-of-band domain in which spurious emissions generally predominate. (WRC-03)

1.147 assigned frequency band: The frequency band within which the emission of a station is authorized; the width of the band equals the necessary bandwidth plus twice the absolute value of thefrequency tolerance. Where space stations are concerned, the assigned frequency band includes twice the maximum Doppler shift that may occur in relation to any point of the Earth's surface.

1.148 assigned frequency: The centre of the frequency band assigned to a station.

1.149 characteristic frequency: A frequency which can be easily identified and measured in a given emission. A carrier frequency may, for example, be designated as the characteristic frequency.

1.150 reference frequency: A frequency having a fixed and specified position with respect to the assigned frequency. The displacement of this frequency with respect to the assigned frequency has the same absolute value and sign that the displacement of the characteristic frequency has with respect to the centre of the frequency band occupied by the emission.

1.151 frequency tolerance: The maximum permissible departure by the centre frequency of the frequency band occupied by an emission from the assigned frequency or, by the characteristic frequency of an emission from the reference frequency. The frequency tolerance is expressed in hertz.

1.152 necessary bandwidth: For a given class of emission, the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.

1.153 occupied bandwidth: The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage β/2 of the totalmean power of a given emission. Unless otherwise specified by the BR for the appropriate class of emission, the value of ß/2 should be taken as 0.5%.

1.156 power: Whenever the power of a radio transmitter, etc. is referred to it shall be expressed in one of the following forms, according to the class of emission, using the arbitrary symbols indicated:

- peak envelope power (PX or pX);

- mean power (PY or pY);

- carrier power (PZ or pZ).

For different classes of emission, the relationships between peak envelope power, mean power and carrier power, under the conditions of normal operation and of no modulation, are contained in ITU-R Recommendations which may be used as a guide.

For use in formulae, the symbol p denotes power expressed in watts and the symbol P denotes power expressed in decibels relative to a reference level.

1.157 peak envelope power (of a radio transmitter): The average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle at the crest of the modulation envelope taken under normal operating conditions.

1.158 mean power (of a radio transmitter): The average power supplied to the antenna transmission line by a transmitter during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation taken under normal operating conditions.

1.159 carrier power (of a radio transmitter): The average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle taken under the condition of no modulation.

1.160 gain of an antenna: The ratio, usually expressed in decibels, of the power required at the input of a loss-free reference antenna to the power supplied to the input of the given antenna to produce, in a given direction, the same field strength or the same power flux-density at the same distance. When not specified otherwise, the gain refers to the direction of maximum radiation. The gain may be considered for a specified polarization.

Depending on the choice of the reference antenna a distinction is made between:

a) absolute or isotropic gain (Gi), when the reference antenna is an isotropic antenna isolated in space;

b) gain relative to a half-wave dipole (Gd), when the reference antenna is a half-wave dipole isolated in space whose equatorial plane contains the given direction;

c) gain relative to a short vertical antenna (Gv), when the reference antenna is a linear conductor, much shorter than one quarter of the wavelength, normal to the surface of a perfectly conducting plane which contains the given direction.

1.161 equivalent isotropically radiated power (e.i.r.p.): The product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain).

1.162 effective radiated power (e.r.p.) (in a given direction): The product of the power supplied to the antenna and its gain relative to a half-wave dipole in a given direction.

Section VII. Frequency Sharing

1.166 interference: The effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radio communication system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy.

1.167 permissible interferencel: Observed or predicted interference which complies with quantitative interference and sharing criteria contained in these Regulations or in ITU-R Recommendations or in special agreements as provided for in these Regulations.

1.167.1 1 The terms "permissible interference" and "accepted interference" are used in the coordination of frequency assignments between administrations.

1.168 accepted interferencel : Interference at a higher level than that defined as permissible interference and which has been agreed upon between two or more administrations without prejudice to other administrations.

1.168.1 1 The terms "permissible interference" and "accepted interference" are used in the coordination of frequency assignments between administrations.

1.169 harmful interference: Interference which endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts aradio-communication service operating in accordance with these Regulations.

1.170 protection ratio (R.F.): The minimum value of the wanted-to-unwanted signal ratio, usually expressed in decibels, at the receiver input, determined under specified conditions such that a specified reception quality of the wanted signal is achieved at the receiver output.

Radio spectrum is that part of the electromagnetic spectrum corresponding to radio frequencies - that is, frequencies lower than around 300 GHz (or, equivalently, wavelengths longer than about 1 mm). Electromagnetic waves in this frequency range, called radio waves, are used for radio communication and various other applications, such as heating. The generation of radio waves is strictly regulated by the government in most countries, coordinated by an international standards body called the International Telecommunications Union (ITU).

Different parts of the radio spectrum are allocated for different radio transmission technologies and applications. In some cases, parts of the radio spectrum is sold or licensed to operators of private radio transmission services (for example, cellular telephone operators or broadcast television stations). Ranges of allocated frequencies are often referred to by their provisioned use (for example, cellular spectrum or television spectrum).

A band is a small section of the spectrum of radio communication frequencies, in which channels are usually used or set aside for the same purpose.

Above 300 GHz, the absorption of electromagnetic radiation by Earth's atmosphere is so great that the atmosphere is effectively opaque, until it becomes transparent again in the near-infrared and optical window frequency ranges.

To prevent interference and allow for efficient use of the radio spectrum, similar services are allocated in bands. For example, broadcasting, mobile radio, or navigation devices, will be allocated in non-overlapping ranges of frequencies.

As a matter of convention, bands are divided at wavelengths of 10" metres, or frequencies of 3x10" hertz. For example, 30 MHz or 10 m divides shortwave (lower and longer) from VHF (shorter and higher). These are the parts of the radio spectrum, and not its frequency allocation.

Band name	Abbreviation	ITU band	Frequency and wavelength in air	Example uses
Tremendously low frequency	TLF		< 3 Hz > 100,000 km	Natural and artificial electromagnetic noise
Extremely low frequency	ELF		3–30 Hz 100,000 km – 10,000 km	Communication with submarines
Super low frequency	SLF		30–300 Hz 10,000 km – 1000 km	Communication with submarines
Ultra low frequency	ULF		300–3000 Hz 1000 km – 100 km	Submarine communication, Communication within mines
Very low frequency	VLF	4	3–30 kHz 100 km – 10 km	Navigation, time signals, submarine communication, wireless heart rate monitors, geophysics
Low frequency	LF	5	30–300 kHz 10 km – 1 km	Navigation, time signals, AM longwave broadcasting (Europe and parts of Asia), RFID, amateur radio
Medium frequency	MF	6	300–3000 kHz 1 km – 100 m	AM (medium-wave) broadcasts, amateur radio, avalanche beacons
High frequency	HF	7	3–30 MHz 100 m – 10 m	Shortwave broadcasts, citizens' band radio, amateur radio and over-the-horizon aviation communications, RFID, Over-the-horizon radar, Automatic link establishment (ALE) / Near Vertical Incidence Sky-wave (NVIS) radio communications, Marine and mobile

				radio telephony
Very high frequency	VHF	8	30–300 MHz 10 m – 1 m	FM, television broadcasts and line-of-sight ground-to-aircraft and aircraft-to-aircraft communications. Land Mobile and Maritime Mobile communications, amateur radio, weather radio
Ultra high frequency	UHF	9	300–3000 MHz 1 m – 100 mm	Television broadcasts, Microwave oven, Microwave devices/communications, radio astronomy, mobile phones, wireless LAN, Bluetooth, ZigBee, GPS and two-way radios such as Land Mobile, FRS and GMRSradios, amateur radio
Super high frequency	SHF	10	3–30 GHz 100 mm – 10 mm	Radio astronomy, microwave devices/communications, wireless LAN, most modern radars, communications satellites, satellite television broadcasting, DBS, amateur radio
Extremely high frequency	EHF	11	30–300 GHz 10 mm – 1 mm	Radio astronomy, high-frequency microwave radio relay, microwave remote sensing, amateur radio, directed-energy weapon, millimeter wave scanner
Terahertz or Tremendously high frequency	THz or THF	12	300–3,000 GHz 1 mm – 100 μm	Terahertz imaging – a potential replacement for X-rays in some medical applications, ultrafast molecular dynamics, condensed-matter physics, terahertz time-domain spectroscopy, terahertz computing/communications, sub-mm remote sensing, amateur radio

The ITU radio bands are designations defined in the ITU Radio Regulations. Article 2, provision No. 2.1 states that "the radio spectrum shall be subdivided into nine frequency bands, which shall be designated by progressive whole numbers in accordance with the following table".

The table originated with a recommendation of the IVth CCIR meeting, held in Bucharest in 1937, and was approved by the International Radio Conference held at Atlantic City in 1947. The idea to give each band a number, in which the number is the logarithm of the approximate geometric mean of the upper and lower

band limits in Hz, originated with B.C. Fleming-Williams, who suggested it in a letter to the editor of Wireless Engineer in 1942. (For example, the approximate geometric mean of Band 7 is 10 MHz, or 10^7 Hz.)

Radio frequency (RF) is a rate of oscillation in the range of around 3 kHz to 300 GHz, which corresponds to the frequency of radio waves, and the alternating currents which carry radio signals. RF usually refers to electrical rather than mechanical oscillations; however, mechanical RF systems do exist (mechanical filter and RF MEMS).

Although radio frequency is a rate of oscillation, the term "radio frequency" or its abbreviation "RF" are also used as a synonym for radio - i.e. to describe the use of wireless communication, as opposed to communication via electric wires. Examples include:

- Radio-frequency identification
- ISO/IEC 14443-2 Radio frequency power and signal interface

Electric currents that oscillate at radio frequencies have special properties not shared by direct current or alternating current of lower frequencies.

- The energy in an RF current can radiate off a conductor into space as electromagnetic waves (radio waves); this is the basis of radio technology.
- RF current does not penetrate deeply into electrical conductors but tends to flow along their surfaces; this is known as the skin effect. For this reason, when the human bodycomes in contact with high power RF currents it can cause superficial but serious burns called RF burns.
- RF currents applied to the body often do not cause the painful sensation of electric shock as do lower frequency currents. This is because the current changes direction too quickly to trigger depolarization of nerve membranes.
- RF current can easily ionize air, creating a conductive path through it. This property is exploited by "high frequency" units used in electric arc welding, which use currents at higher frequencies than power distribution uses.
- Another property is the ability to appear to flow through paths that contain insulating material, like the dielectric insulator of a capacitor.
- When conducted by an ordinary electric cable, RF current has a tendency to reflect from discontinuities in the cable such as connectors and travel back down the cable toward the source, causing a condition called standing waves, so RF current must be carried by specialized types of cable called transmission line.

To receive radio signals an antenna must be used. However, since the antenna will pick up thousands of radio signals at a time, a radio tuner is necessary to *tune into* a particular frequency (or frequency range). This is typically done via a resonator in its simplest form, a circuit with a capacitor and an inductor form a tuned circuit. The resonator amplifies oscillations within a particular frequency band, while reducing oscillations at other frequencies outside the band.

Another method to isolate a particular radio frequency is by oversampling (which gets a wide range of frequencies) and picking out the frequencies of interest, as done in software defined radio.

The distance over which radio communications is useful depends significantly on things other than wavelength, such as transmitter power, receiver quality, type, size, and height of antenna, mode of transmission, noise, and interfering signals.

Ground waves, tropospheric scatter and sky-waves can all achieve greater ranges than line-of-sight propagation. The study of radio propagation allows estimates of useful range to be made.

Radio Spectrum / Frequency Bands:

Frequency	Wavelength	Designation	Abbreviation
3 – 30 Hz	10^5 – 10^4 km	Extremely low frequency	ELF
30 – 300 Hz	10^4 – 10^3 km	Super low frequency	SLF
300 – 3000 Hz	10^3 – 100 km	Ultra low frequency	ULF
3 – 30 kHz	100 – 10 km	Very low frequency	VLF
30 – 300 kHz	10 – 1 km	Low frequency	LF
300 kHz – 3 MHz	1 km – 100 m	Medium frequency	MF
3 – 30 MHz	100 – 10 m	High frequency	HF
30 – 300 MHz	10 – 1 m	Very high frequency	VHF
300 MHz – 3 GHz	1 m – 10 cm	Ultra high frequency	UHF
3 – 30 GHz	10 – 1 cm	Super high frequency	SHF
30 – 300 GHz	1 cm – 1 mm	Extremely high frequency	EHF
300 GHz - 3000 GHz	1 mm - 0.1 mm	Tremendously high frequency	THF

Universal Alien Species and races

Two Kilometers South from the Vatican, there lies a small pink house, with a sign always for rent, but it is never ever rented, they keep it there empty quite intentionally, who keeps it there empty? [Alien resembles humans called "Humanoids" that shows Interstellar Travelling Capabilities Of Humanoids and Reptiloids].

Universal Alien Species and Races

(1). Agharians or (Aghartians) (Resembling-humans).

(2). Alpha-Draconians (Reptilian-beings) desire the taking of earth.

(3). Altairians (Reptilian-beings) Reptilian inhabitants of the ALTAIR STELLAR system, in the constellation Aquila, in collaboration with smaller Nordic human element and a collaborative grey and terran military presence, headquarters of a collective known as the corporate which maintain ties with the Ashtar and Draconian collectives (Draconian - A shtar Command).

(4). Amphibians Similar to the Saurians or Reptilians, yet being hominoid creatures with reptilian as well as Amphibians-like features and are semi-aquatic in nature, may have once lived on land, yet become more aquatic over the centuries. They have been encountered near SWAMPY Regions rivers, etc. they have been known to attack people without being provoked. It is interesting that some types of greys and reptiloids are believed to be semi-aquatic, having webbed fingers and toes.

(5). Ankim

(6). Andromedans

(7). Anunnaki

(8). Antarctican

(9). Antaries resembling humans and they are the most advanced in the entire universe.

(10). Atlans resembling humans.

(11). Afim they come from constellation Lyra, they can come from their planet to the earth in 20 minutes, they do not need oxygen.

(12). Alcohbata aggressive race that comes from the Constellation Perseus, they have over 5000 ships, they colonized 10 planets on their own, they are one of the parasite's races. Abduction of human is frequent and ongoing; they do not like to interact with other alien races. They are suspected to have been involved in many airplane crashes; most noteably the Korean airlines flight 007 over Russia in 1983, the Russian took the blame for it.

(13). Allamuluk-Strat-163 they come from Jupiter after a reputed lost battle in ancient India against reptoids, they were forced to leave our planet, of which they have been visiting for over 200 years and they have resumed their visits since 1948, this race is so extremely technologically advanced, their ship is invisible and they wear a suit that make them invisible as well.

(14). Ainanna this race what we humans call Martians, they come from the constellation Gemini, for thousands of years they have had bases on Mars, where they mine a sort of gold-like mineral. The first recorded visit on earth was in 1235 BC in Japan. According to the book, they were last seen on earth in Madagascar in 2003.

(15). Al-Gruualix they come from the constellation Cetus near Deneb Kaitos Shemali, although they are often confused with Reptilians, they do not share anything with the Reptilians except the appearance. Their height is about two meters (6ft) and can live up to 350 years. This is one of 21 races that have more than 2 genders. This race has 8 different genders, and all of them can reproduce when in sexual contact with each other, no matter which, their purpose to visit earth is unknown, last spotted in Lima, Peru in December 2004.

(16). Akart this race comes from the constellation Sextans, they crashed one of their ships near the town of Vagihana in Brazil in 1996. Two of the occupants under U.S.A Custody, they paid Brazil a huge amount of

money for them. According to the book they have the fastest ships among all alien races. They were last seen on earth February 2002 near vagihana in Brazil Again.

(17). Airk they come from constellation Ophiuchus, near Yed Prior, considered by other races as peaceful, the reason for their visit is unknown and they never stay long on earth and they do not interact with humans or other aliens here. They mostly use earth as a stop to quickly gather something they may need before they leave to their real destination, they are mostly nocturnal. Their ships emit a brought-orange light and most of them, not all. They were last spotted near London, England in May 2003.

(18). Alabram they live on a planet that lies beyond the Andromeda Galaxy. The beings on this particular planet have a similar physical appearance to humans on earth, but with great enlarged diaphragms and lungs, this is because the oxygen on this planet is so weak that an earth person could not exist. This planet has millions of people on it like earth. Their birthing process is different than humans, in that they carry the fetus for a shorter gestation period in their stomachs and regurgitate it when the time come for giving birth, at that time the new baby is extremely small, it reaches full maturity in only seven years, the beings on this planet have extremely large brains and they are able to absorb information through osmosis, and are very telepathic. They drink liquid similar to water and they live on foods that are grown in caves and tunnels hollowed out beneath the service of the earth, the reason for this is the star that serves as their sun is so hot that it would burn the plants if they were planted on the surface of the planet.

(19). Baavi the inhabitants of the planet Baavi look like the typical blonds and as such they belong to the Lyran Caucasian group. In other words they can walk among humans without being recognize at all.

(20). Bernarians this race is the inhabitants of the Barnard's Star System.

(21). Bootians aka the Salamani Confederation They originated from constellation BootEs, Approximately 30 to 40 light years from earth, physically they are said to be Chamalion or Reptalian like, they have originated from the dranconians reptalians and they are very hostile towards humans, they are extremely intelligent and they eat humans because they review humans as a food source. Their reptilian heritage lead them to believe that they are the ultimate worriers. One of their ultimate goals is to invade and totally occupy planet earth, to dominate the earth, they are working in deep underground bases with the dranconians and the grays to take over the earth, they have also exchanged advanced technology to the U.S Government according to Alex Collier They endorse infiltration on all levels to dominate galactic civilizations and planet earth.

(22). Burrowers

(23). Blue People aka The Blues

(24). Buttahs

(25). Cetians aka Tau Cetians

(26). Chameleon they are reptilians, genetically engineered to look like humans.

(27). Chirons they are hexapods, they possess four legs and two arms, they have destroyed their race with nuclear wars.

(28). Deros underground species, some believe them to be humans, dreaming of taking planet earth one day

(29). Dracos (reptilians) Location home system Alfa Draconis Draco is the name of astronomical constellation, this constellation is the home of the Draconian Empire. These are the most feared of the reptoid species; they regard humans as totally inferior race and they intend on domination the entire planet earth, because their planet is becoming inadequate to support life. They are considered one of the most technologically advanced species, they have three bases on earth, one is the Bermuda triangle, one off the coast off New Zealand and one of the coasts off Denmark. They can travel interdimensionally (most races cannot) and they also high ranking have the power to become invisible, they have presence on thousands of planets and they have also

colonized 500 planets by way of infiltration and then overcoming / overthrowing of governments and leaderships.

(30). Dorsay

(31). Dries

(32). El Manouk

(33). Elffaf

(34). Ellina aka The Elves

(35). The council of 5 the council of 5 is composed of the following races:
ORELA - EGAROT - GINVO - REDAN - EMERTHER -

(36). X-1Z

(37). X5-Tykut this race is created by the race Maitre in order to be used as slaves, they are only 300 and can live forever because they are not organic (organism), they are made out of extremely rare cosmic elements, they are usually sent by the race Miatre to carry out abductions.

(38). "2017"

(39). Felines

(40). Gizan
(41). Graysli

(42). Solipsi Rai, (aka as the greys)

(43). The invisibles, they come from constellation Mensa

(44). Iguanoids, hateful to humans

(45). Indugutk, aka "Tall Whites "also known as men in Black

(46). Jighantik, they come from constellation Horologium

(47). Jefok, they come from constellation Indus, they are known by other races as peace makers, they are very advanced technologically.

(48). Kalenia, they come from constellate Aquila, star tarazed, they have colonized three planets and have a life span of 150 years. They are often sighted in Northern Africa and the Sahara region, first visited earth around 300 BC. They do not conduct abductions and their main interest about earth is minerals. They were last sighted in 2003 near a volcano in Iceland.

(49). Killimat-Arr, (aka. K-Arr) they come from constellation Crux near Gacrux, it is a very hard race to track down or spot, both the U.S and the Russian Military have developed a special camera and radar system that allows to spot them when they are on earth, but even then, they have only been sighted8 times, the purpose of their presence is unknown. They are always sighted in the area of the Bermuda Triangle.

(50). Killy-Tokurt, they come from constellation Vela near the star Suhail Al Muhlif, they grow up to two meters high and live up to 200 years, they can shape-shift, but there is one thing they cannot change and that is the size and color of their eyes. They are one of the oldest known races, they do abduct humans and last time seen on earth July of 2008.

(51). Kurs, (aka "Gods of Lands") they come from the planet Dillimuns and believes to be related to the race Anunnaki, After centuries away from earth, they have recently returned, their own leaders amongst the most recent visitors, they will stay on earth permanently and they will have an important role in the years to come.

(52). Lyran, with its celestial keys, its chords of air, its frets of fire, the Samian's great Aeolian Lyre, Rising through, all its sevenfold bars, from earth onto, the fixed stars.

Long-fellow on Lyra from Occultation of Orion

They come in all shapes, sizes from dark-skinned to Caucasians, there is supposedly a red haired, light skinned giant race, with rather large features. Lyrans were evidently driven out of their star system several thousands of years ago and relocated to many areas in the galaxy, the Lyrans were the original ancestors of our galactic family. Many thousands of years ago their civilization reached very high technological level, however fell into disagreement and factions within their culture. These factions went to war and destroyed much of their society, many of these being from Lyra left their star ships to colonize the Pleiades, the Hyades and the vega system. This region like our own system, may still be a battleground between Saurian areys and Humans. Some of these Pleiadians of Lyrian Ancestors also came to earth during the Lemurians and Atlanteans period. These other civilizations could be looked at as our galactic cousins.

(53). Lang, they come from the Sixth Star in the constellation Coma Berenices, they have three home planets (maybe 4) and have colonized at least ten, they are small species growing to 70 centimeters, they were one of the first races to visit earth, this race started the stories about Elves, two alien races claim that they (race Lang) have abducted over 10 million humans throughout history, that number is highly disputed by two other alien races, they state that the number is much lower and one race even made a statement to a Russian President saying that the race Lang has never abducted any humans, last sighting New Zealand in 2006, a group of 20 members.

(54). Maitre, they have two home planets in constellation Megopei, the same average height as humans. They are hermaphrodites and their life span is 120 years, they have colonized at least 26 planets and have abducted at least 5000 humans of all males. Their abduction of humans is carried out openly and are considered by many other alien races as parasites. They have visited earth at least 200 times. They have the goal of colonizing Earth that did not happen yet, because of protection from other alien races, such as the races from council of the five, last sighting September 2006 near Nome, Alaska, USA.

(55). Moovianthan-Kayphik, (aka "Shining Ones" they come from constellation Vulpecula, they have met with at least U.S. Presidents as well as with USSR Russian leaders and some high ranking officials. They supply limited amount of their technologies to humans in exchange for the freedom to conduct Abductions and they do not involve other alien races in this process. They have a big role in Siberian and Tibetan cultures and they have bases in those areas hidden in the north face of the mountains. They have colonized over 40 planets outside our solar system so far.

(56). Magell, they have two permanent bases in South America, they are 100% Nocturnal and do not interact with humans and are described by other races as being "Shy". They harvest insects and rodents by many thousands on a monthly basis, their visitations to earth for unknown reasons. At least three of them have been under Brazilian Military Custody for the past 12 years, their last sighting near Oaxaca, Mexico in 2003. They are visited by their own kind (race) every 20 years, the next visit should be around 2016.

(57). Matrax, they come from constellation Delphinus near Sualocin , despite their appearance (installs fear in humans when sighted) this race is not known to be aggressive, they can live up to 400 years, they have been visiting earth for at least 4000 years, but quite often during the *19th* century, they served as inspiration for the Alien Race, last sighting happened near Marseille, France in 1996.

(58). Mythilae, they come from constellation Serpens, Star Alva , once related to the Reptoids species, they are not however Reptilians, their first visit to earth was only in June 13 1965, they do not represent any threat

to humans and often seen around Antarctica, the reason for their visit is unknown, their last sighting was in Antarctica May 1st 1997.

(59). The Massagers, they are probably the most enigmatic of all alien races , not much is known about them, they visit earth around every 300 years, their next visit is supposed to happen anytime now. They do not reveal themselves and they do not make direct contact with humans, they leave Carvings, Drawings and writings on rocks, as well as symbols in historical monuments, their ship have the shape of a "tear drop" and are silver in color. Solar Sonic Technologies proudly announces that its long awaiting underground research project of globally dominating SETI Technologies have been finally completed and excessively tested, which dominates the entire Solar System through extremely advanced Cross-Alien-Sonics Proprietary Technologies that enable Solar Sonic Scientists to communicate and issue dominating dialogues to all non human entities within the entire solar system utilizing the sun rays as a medium of multi-link continuity (extremely advanced alien technology of indescribable Hi Tech Capabilities from non human entities within the solar system).

Manipulation and monopolization of Interplanetary Entities by utilizing solar-system communications (capabilities of aliens on earth with thoughts of invading planet earth on June 21, 2050 at 1:14 AM):

With regards to interplanetary foreign entities, their activities and the impact of non-human entities on planet earth, precisely the Search for Extraterrestrial Intelligence (SETI). Solar Sonic Technologies proudly present with great pride "The Foreign Entities Communication Technology" as the only SETI discovery to date. This discovery is the World's Most Sophisticated Extraterrestrial Intelligence Communication Technology ever been announced. It is emerging to communicate with Invisible Light-Being Entities that never been known to exist. We are prepared to prove that such technology works via Ground Based and Orbital Solar Triggers and Converging Mediums.

We are also prepared to prove that those Interplanetary Foreign Entities have devastated and will continue to deteriorate earth, since they are made of Invisible Cosmic Elements, enabling them to maneuver within the Solar System undetected. Some of their Fatal Impacts on earth are Natural Disasters, Shifting in Gravitational and Electromagnetic Fields, Asteroids, Airborne Objects, Cosmic Radiation, Microwaves, Micro Changes in Air Density and also in Water Molecules, Obstruction in all types of Energies, Energetic Structures and the laws of Physics. Navigational Interferences in Air, Water and Land, Interferences in Aerodynamics, Astrodynamics, Electrodynamics and Hydrodynamics and also causing High Altitude Static Discharge. Interfering in global Satellite systems and all forms of Global Communications, causing mysterious occurrences & unexplained Phenomena, simultaneous but yet gradual deterioration of North and South Poles. Interfering in the Solar system, the photon belt, space energy and earth core.

Ferocious Geological, Geophysical & Atmospheric Shifting, Re-Setting of Nuclear Equations and Atomic Structures with Extreme Subatomic Variations, Unnatural Deaths, Cancer(s), Neurological Disorders, Alien Viruses and Diseases causing new strands of mutations, Paralysis, Loss of Hearing/Sight, Memory Eradication Viruses and many other Fatal Impacts that quite literally cover all aspects of human-life with its pertaining areas and departments that substantially affect life on earth.

This Extraterrestrial message was received on 1-14-2015 by Dr. Mohammed M. Ammar with Solar Sonic Technologies and Laboratories, the message has been interpreted as follow:

"Our earthly Scientists, especially Universal Coding Interpreter and Inter-Galactic Scientist Our Beloved "Mohammed"

This message below was not in the English Ianguage, it was interpreted and recorded by Research Scientist Dr. Mohammed M. Ammar and the recording is available upon request as verification of absolute substantiation and the technological abilities for actual extraterrestrial communications and the validity of our SETI factual technology and contact:

The Extraterrestrial Message received on 1 - 14 - 2015 is:

We agree to your contents, we fully support and participate in all your efforts to reach out within divine parameters, in that regard we will comply accordingly.

Please transmit in an orderly fashion as time is now of the essence here and down there below on earth, we read you very clearly our Mohammed both telepathic-ally and Cybernetic-ally, we are pleased that we are now became so obvious to you on varied platforms and that serve all of our interests.

Deliberately persistent evil will be met with a higher degree of evil, after an overwhelmingly consensual approval by the council of five we honor your communications and we accept all the pertaining contents of which we strongly believe interstellar intervention is really a must.

Dr. Ammar (also called by them "our Mohammed") beware of the bearers of false gifts and their broken promises, much pain but still time. Believe there is good out there, we oppose deception and we accept all your contents of communications, we support you with all inter-galactic multidimensional engagements and capabilities. Be Guided Accordingly, as time is of the essence down on our old planet earth.

All Upcoming Occurrences are simply beyond the description of words, we will be waiting for your proposed suggestions and engagement methodologies. Ultimately, we much prefer if you declare us as warning signs to our old planet earth, whereas the lack of rational compliance by all earthly classifications will lead to interstellar intervention on all platforms. Bearing in mind that a possible earth invasion could be inevitable and imminently advancing in a very obvious manner. Be guided accordingly in conveying interstellar warning signs, exactly as transmitted by us to all of the inhabitants of our old earth and now Conduit Closing.

The Inter-Galactic Warning Signs sent to Solar Sonic Extraterrestrial Mass-Universal Communications and Manipulations Technologies:

Manipulation and monopolization of Interplanetary Entities by utilizing solar-system communications:

With regards to interplanetary foreign entities, their activities and the impact of non-human entities on planet earth, precisely the Search for Extraterrestrial Intelligence (SETI), Solar Sonic Technology present with great pride "The Foreign Entities Communication Technology" as the only SETI discovery to date. This discovery is the World's Most Sophisticated Extraterrestrial Intelligence Communication Technology ever been announced. It's emerging to communicate with Invisible Light-Being Entities that never been known to exist. We are prepared to prove that such technology works via Ground Based and Orbital Solar Sonic Triggers and Converging Mediums. We are also prepared to prove that those Interplanetary Foreign Entities have devastated and will continue to deteriorate earth, since they are made of Invisible Cosmic Elements, which enabling them to maneuver within the Solar System undetected with unknown thoughts toward earth.

Some of their Fatal Impacts on earth are Natural Disasters, Shifting in Gravitational and Electromagnetic Fields, Asteroids, Airborne Objects, Cosmic Radiation, Microwaves, Micro Changes in Air Density and also in Water Molecules, Obstruction in all types of Energies, Energetic Structures and the laws of Physics. Navigational Interferences in Air, Water and Land, Interferences in Aerodynamics, Astrodynamics, Electrodynamics and Hydrodynamics and also causing High Altitude Static Discharge. Interfering in global Satellite systems and all forms of Global Communications, causing mysterious occurrences & unexplained Phenomenon, simultaneous but yet gradual deterioration of North and South Poles. Interfering in the Solar system, the photon belt, space energy and earth core. Ferocious Geological, Geophysical & Atmospheric Shifting, Re-Setting of Nuclear Equations and Atomic Structures with Extreme Subatomic Variations, Unnatural Deaths, Cancer(s), Neurological Disorders, Alien Viruses and Diseases causing new strands of

mutations, Paralysis, Loss of Hearing/Sight, Memory Eradication Viruses and many other Fatal Impacts that quite literally cover all aspects of human-life with its pertaining departments that affect life on earth.

In the subatomic world, few things can be predicted with **100** percent precision; however, accurate predictions can be made about the probability of any particular outcome.

One has to work with the probabilities rather than certainties, because it is impossible (for an observer) to describe all aspects of a particle at once (speed and location).

Electromagnetic energy (such as light or heat) does not always behave like a continuous wave—rather it is grainy, because energy can be transferred only in quantum packages. Therefore, light has a dual character. Under certain circumstances, it may display wavelike aspects; and in other circumstances, it may have the characteristics of particles.

The following Phenomena will begin to occur on a very gradual scale, marking the beginning of the warning signs, fulfilling extraterrestrial calculations. We are both honored and accountable to an affirmation of such a magnitude; under the circumstances the only viable method of validation is time.

The universe stands continually open to our gaze, but cannot be understood unless one first learns to comprehend the language and interpret the characters in which it is written. It is written in the language of mathematics, and its characters rectangles, circles, and other geometric figures, without which it is humanly impossible to understand a single word of it; without these, one is wandering about in a dark labyrinth."

Consciousness is simply the awareness of being. Consciousness seeks to know itself in relationship to others, because without this knowledge, there is no purpose to existence. Since this is true, we can now understand that Consciousness must fragment itself in order that there are others to relate to. Consciousness is in everything. Everything that exists is conscious at some level -even a chunk of lead.

Evidence of this has been scientifically proven in the discovery that particles that have once responded to each other will always do so, regardless of their distance from each other in the future, even light-years apart. We have also found that the observer changes the behavior of the thing observed and vice versa. No matter how "detached" the observer is in their attempt to remain objective, the relationship exists and changes are affected simply by the connection between the two.

Consciousness exists beyond space-time, and indeed, space-time is a manifestation of Consciousness as it seeks to experience the minutest details of itself through these relationships. Growth occurs through expansion of knowledge and increasing awareness.

When Consciousness, at a certain level, has acquired all the knowledge possible at that level, changes must be made in order for the acquisition of knowledge to continue. These changes are not always pleasant for the manifestations of consciousness existing at the time, but it has been shown that the changes occur at fairly regular intervals of **11,000** to **13,000** years, calculated according to the time frame we understand in human terms.

Perceptive people have always had intuitive and clairvoyant knowledge of these changes; because they are perhaps more open to the information already available in the Universal Mind about such things. Their awareness is, however, shaped and colored by the prevailing belief systems of their time. Their visions are received and interpreted from images and feelings that do not carry complete understanding, so most are fear-based and instill fear in those who hear or read of these revelations. This need not be.

Human beings are, by nature, egocentric, meaning that their perspective on any experience is based in its relationship to an effect on themselves. Their identity is anchored firmly in their body, so they perceive any experience of the body in direct proportion to the joy or pain it brings. And events that bring pain are feared.

It doesn't occur to most people to understand that such events are not based on anything they personally did, right or wrong.

The Universal Mind is, to a large extent, still perceived as a separate Being of great power that gives rules to live by, a Being who metes out punishment if the rules are broken. But if all experiences are simply received by the Universal Mind in terms of the value of each experience for itself, there can be no such judgment or punishment. After all, whom would it punish but pieces of itself?

There is a larger perspective to be taken here. If we remove the personal beliefs about judgment and punishment from the picture, we are left with an entity, Consciousness, which desires to know itself through its experiences with itself, and all experiences, joyful or painful, are received and accepted solely for the value they have as experiences. And the cyclical nature of the changes is for the purpose of further growth and knowledge acquisition. There is no judgment or punishment intended or involved, regardless of traditional beliefs about such events.

Changes occur in cycles all the time. Earth's seasons are a prime example. On a personal level, each individual experiencing life goes through many such changes in a lifetime. Our bodies completely renew themselves every 7 years, if all systems are working properly. There are the cycles of infancy, childhood, adolescence, adulthood, midlife, and seniority. And if seniority lasts long enough, there is a return to childhood. Would we experience a second full cycle if we lived 200 years? Very likely, we would.

Beyond personal experience, there are cycles of knowledge acquisition that include mental and emotional growth for the entire species. Human history is full of such cycles. In each Age, new ideas spring forth, are ridiculed, opposed and finally accepted. In each Age, people learn more about love, sadness, wealth, poverty, and experience great changes in their values.

The Cosmos has Great Cycles, periods of growth and change brought about by the cumulative acquisition of knowledge and experience from all living, sentient species. We are entering such a period of change now.

Explanations of the symptoms of change are given for your understanding, but they do not explain the changes going on across the Cosmos, they only show how the greater Cosmic changes will affect the Earth and ourselves. There is no judgment or punishment involved or intended, and no one is being singled out for condemnation. With the understanding that light and sound frequencies are involved in impersonal ways, we can now enter the Photon Belt more completely; the effects of these light particles and sound waves on our planet will be disruptive. The old Earth system must be transformed, making way for the new, but this is only so that Consciousness can keep growing, expanding and learning about itself. Think of a child outgrowing last year's clothing, that's what's happening on a cosmic scale!

It is a simple fact that those who enter the experience of these changes with a larger perspective will be less inclined to fear them, and will adapt more easily to what is required of them. They can then, in turn, assist others in the process of survival.

List of inter-galactic warning signs that are in progress for old planet earth

(1) The principal of divine entrapment will be the first of intergalactic warning signs precisely sent to earth.

(2) The principal of divine retaliation will immediately follow as the second sign of intergalactic warning sign.

(3) The gradual appearance of extraterrestrial entities of invisible light-beings inhabiting all the solar system.

(4) Raging winds of the dead emerge and overwhelmingly prevail as extraterrestrial beings via frequencies.

(5) Inter-Planetary shifting & its effects on global communications, aerospace, defense, navigation, migration

(6) Non human entities communicating with humans via induced and coded frequencies on varied platforms

(7) Raging senses of the dead emerge and immensely prevail over humans via extraterrestrial mass-induction

(8) Deterioration of hearing and seeing abilities of humans via extraterrestrial multi-dimensional induction

(9) Gradual migration of inter-planetary extraterrestrial frequencies disrupting life on earth on a large scale

(10) Coded extraterrestrial messages embedded into humans via alien viruses for domination and replication

(11) Inter-Planetary discharges transmitted to earth via extraterrestrial replication capability for domination

(12) Inter-Planetary electromagnetic frequency shifting leading to gradual imbalance of gravitational fields

(13) Inter-Planetary shifting leading to micro changes in air density and water molecules on a global scale

(14) Deeply penetrating extraterrestrial frequencies as form of warning signs and illustration to all others

(15) Inter-Planetary induced elements leading to total invasion of the air and transmission of alien viruses

(16) Inter-Planetary frequency shifting, gradually leading to self-combustion of elements and reversal of all directed energies including (missiles, bombs, IED and nuclear weapons). Air molecules will significantly reformulate on a molecular level, whereas the induced migration of any form of directed energy will lose its velocity and intended precision.

(17) Inter-Planetary frequencies migrating and penetrating into the earth, whereas their effects will be seen in all aspects of human life. To the extent that such interferences will be witnessed in communications, human health, animal health, agriculture, aviation, aerospace, waterways(oceans, seas, rivers), air quality, water quality, gravitational fields, vital signs, human senses, hormones, thyroids, immune system & nervous system.

(18) Inter-Planetary frequencies affecting all non human life on earth (animals, birds, fish, insects, microbes, viruses, strain/strand mechanisms, biological mechanisms governing mutations & replications of organisms).

(19) Inter-Planetary frequencies affecting the nervous system of humans, leading to a gradual eradication of memory and recall mechanism, whereas a new category and classification of neurological disorders will be introduced, as an immediate result of extraterrestrial interferences into the human physiology / bio-tolerance.

(20) Inter-Planetary extraterrestrial frequencies transmitted via [Sun Rays, Wind, Air, Water, Soil] as a new evolution of physiological disorders, affecting all body systems in humans and animals, causing new strands and strains of mutations, inevitable breakdown of immunity, blood brain barrier, heart dynamics / tolerance.

Changes in animals, crops and food supplies:

Contamination will come from multiple directions. Radiation Cosmic and Earthly sources, will present stunted and distorted growth, insect infestations and diseases such as viral tumors, fungus and bacterial rot. Radiation alters DNA, reduces white blood cells, accelerates growth of pathogens and causes severe free radical damaged to every organ and system. Even human-induced radar wavelengths will become intense and will have damaging effects on all living organisms. The genetic structure of our food source will become severely damaged. The mere fact that food is intentionally irradiated is a contributing factor in itself. The increase in Gamma rays will play havoc with all food and water sources. The levels of water contamination will become out of control; natural disasters will yield a fury of toxicity that has been supposedly secured and made safe. Toxic industries that lay in the paths of natural disasters will contaminate land and waterways all over the world. A high level of carbon dioxide in our waters weakens the life that exists within them.

Micro changes in air density and water molecules on a global scale:

These two elements will feed toxins and pathogens back and forth in large portions. The air and water will have fowl stench and will be fatally toxic. The natural disasters related to both will inevitably unleash deadly organisms and toxins. Infectious organisms will abound due to the destruction that will be caused from water as it turns up regions of land that have been heavily populated.

Hazardous materials that have been stored above or below ground will have a massive impact in every environment. As vile chemicals and heavy metals become unleashed from containment, the water and air that sustains us will suffer. The amount of volcanic activity and the debris released from them can suffocate our upper atmosphere. Whole forests will light up like matchsticks and oil fields will burn uncontrollably, contributing large amounts of particles and toxins to the atmosphere and diminishing our light.

Changes in diseases and physical distress

With the changes occurring, both geologically and atmospherically, greater amounts of radiation are generated. Geophysical radiation causes disturbances to the autonomic nervous system. Drastic changes will cause internal shifts in our physiology, pH balance, heart rate, blood sedimentation rate, cell membrane polarization, ion pump degradation, extreme reduction in T-lymphocytes, and more. Toxicity levels in air, water and food have a large impact on the diseases that will occur.

There will be breaches in the containment of deadly chemicals and pathogens in facilities that store such substances. The containment breaches will be from damages incurred by geophysical changes and intense weather patterns that destroy everything over large areas. Regardless of any structure that man has made, and regardless of location or depth, nothing will be immune to the changes.

Changes in the earth's population

There will be such a change in the dynamics of this planet that certain aspects of matter that are dense and have particular wavelengths and harmonics will be unable to keep up with the physical and energetic shifts that take place. Essentially, any living organism and every source of inanimate matter that is not evolving with respect to the agenda of Consciousness manifesting at this time will dematerialize back into organic energy and matter. Lesser Light manifestations will move through and vibrate into a different continuum as they vanish. Electromagnetic forces exist which will affect the rhythms of life and the appearance and extinction of species within the Earth's magnetic field.

Drastic geophysical changes will bring about a large number of deaths. Many densely populated cities are located around the world in areas that will be hardest hit by the atmospheric and geological changes. In addition, in spite of major successes against infectious diseases in the 20th century, new infectious diseases have emerged and old ones re-emerged in recent decades in different parts of the world. With the increase in diseases, both known and unknown, births will decrease as fertility is altered and the number of deaths will increase dramatically, causing a reversal in the population. The world's levels of contamination are responsible for the faster pace of pathogenic mutations. The world can expect to see a massive change in global population within a very short time.

Changes in our Five Senses

Our sense of sight will be among the most dramatically affected as we find out we can see energy fields around all living things. The quality of the air will change for us as we experience seeing the interchange of energies between people and between people and their environment. We will at last understand, mentally, what we have only known emotionally before - that we can indeed sense energy and manipulate it with our thoughts and emotions.

Hearing will be next to experience increased sensitivity. As air-quality changes and our bodies restructure, sounds will manifest differently and may carry vibration from particle to particle, transferring audible sound for longer distances. As sounds penetrate the body, we will learn to recognize different signals and utilize internal senses in ways we never did before.

Along with smell, taste will become acute. We will smell and taste toxins that are not immediately part of our experience, and the increased awareness and ability to intuitively identify such substances may save many lives. The sense of touch will be very sensitive for many. Some people, already, can feel Earth energies through their hands, and can tell when an earthquake is about to hit. Others can identify storm patterns through their skin. In short, the kinds of sensitivity that have so far been limited only to the experience of animals that are totally connected to nature will become available to people, too.

Geophysical and Atmospheric Changes

Drastic and significant increases in every form of natural disaster, unlike those ever seen before in history, Tectonic plate activity, near earth objects, comets, asteroids, meteorites, catastrophic solar events, earthquakes, Sink holes, volcanoes, lahars, magma chamber eruptions(calderas), mudslides, tsunamis, floods, Limnic eruptions, blizzards, hailstorms, hurricanes, tornadoes, typhoons, cyclones, floods, avalanches, cold snaps, winds, lightening, tidal waves, draughts, fires and famines will reshape every continent. The changes in Earth's gravity and Geomagnetic(s) are responsible for the vast majority of these events, but make no mistake; humans are also, to a large extent, responsible for these dramatic changes through lack of consciousness and integrity. Arrogance, ignorance, stupidity and greed are the paths that have allowed man to create his own destruction.

The North American continent will see catastrophic changes. The following areas will experience significant geological restructuring. East Coast, Gulf coast all the way up the Mississippi Valley through Canada, the entire west coast and south along the ring of fire, to South America and Antarctica. The tectonic plates that divide this planet will each experience massive movements so great that every land mass will be redefined. The landmasses closest to the Ring of Fire will experience some of the most violent reshaping. As the poles flip their magnetic direction, there will be a rise in earthquake activity, causing great distortions that will twist and pull every form of energy. As the intensity and magnitude of earthquakes increase, such changes will the precursors to the massive magnetic shift. Earthquakes will occur in regions around the world that have had very little or no activity in the past. No one will be prepared. As gravity continues to shift, more intense winds will be created, and not all will necessarily be related to hurricanes and the like. The wind will move into speeds up to 900 to 1000 miles per hour.

Water will swallow entire towns and cities. Rivers such as the Mississippi will engulf massive areas of land in every direction. A division of great proportions will strike this region. The increase in water-related disasters is connected to the increasing temperatures. Besides the rise in water levels, the number of hurricanes and tsunamis will seem unending, and will only continue to increase in size and intensity. There will be disasters that stem from objects colliding with earth. Their impacts will cause intense damage and destruction, especially those that strike water, which occupies 75% of the earth's surface.

Here again, however, it is consciousness and the changes in individual and mass consciousness, specifically, which are creating these changes. It is difficult to believe, when we aren't given to thinking of ourselves as powerful beings, but it is true. The physical changes in our planet are being assisted and pushed by our own violence against each other and our environment. It's enough to make one wonder what would happen if we all simply stopped fighting (with each other and ourselves) and stood still for a while.

Gravitational and Geological Changes

Of all the changes that occur, the shift in gravity will be the most significant event to be experienced. This will affect every single aspect and domain of life. Whether human, animal, plant, insect, or mineral, nothing will be immune to the changes that take place in Earth's gravity. We will not be so densely grounded and bound

to the earth. The decrease in the gravitational field that holds things down will cease to do so as it once did. This will completely change how our bodies function.

The magnetite within our brains and blood, and every crystalline form in our body will experience a certain degree molecular restructuring and realigning. The magnetic field we experience everyday arises as a result of interactions in the Earth's iron core, which Consists of a solid inner core and a fluid outer core. The flow of heat from the core drives fluid motions in the outer core that produce an electric current and generate the magnetic field. The magnetic field reliably aligns compass needles, helps animals navigate, and deflects a portion of the Sun's radiation and solar debris.

As the gravitational fields change, the relationship of the Earth's crust to its core will be out of sync, affecting everything on the surface, as well. A momentary sense of "floating" may someday give way to spontaneous experiences of levitation. Bodily disorientation will be one symptom, as our fluids and the organs that process them don't know how to function in a weightless environment.

If you are overweight, you may think this to be a blessing, but consider the other side of the coin - your body won't be able to process excess fluids for elimination, or solids, either, for that matter.

Your sense of balance and orientation will be compromised, so you may not know you're falling or which way is up. Molecules not held in place will expand and free-float, causing expansion of bodily tissues and organs, and people and animals already bloated may simply explode.

On a planetary scale, oceans may swell with the release of restraint on their ecosystems, causing them to cover land and bringing many water-bound life-forms with them. Even icebergs could conceivably float on the surface, instead of being mostly submerged, and end up on coastal lands as a result.

Animals won't be able to navigate any better than we can, and will find their way into cities where they don't belong. Vehicles that are regulated by a computer's crystalline structures will malfunction as gravity and electromagnetic frequencies oscillate wildly beyond their originally designed ranges of operation.

People may experience either the relief of pain or the commencement of it as their bodies try to adapt to these strange experiences and fail to keep pace. Animals, too, may experience the same, and if they are in pain, they will be more aggressive toward anyone who tries to help. The best of intentions can lead to injury for all involved.

Mental confusion will be prevalent as the gravitational changes influence the brain's electromagnetic operation. Increased experiences with forgetfulness and disorientation will become more prevalent and noticeable.

Plants of all kinds may not be able to draw nourishment from the Earth during spells of reduced gravity as fluids that usually travel in given patterns will no longer have patterns to follow.

Minerals molecularly aligned with the Earth's magnetic core may suddenly disassemble themselves into so much sand Or change molecular structure entirely and become another type of element.

The deaths or many wildlife forms will occur in large numbers, especially in animals that follow migration paths. Magnetism is one of the major factors for the deaths that occur, as the inability to accurately migrate will leave animals stranded in environments where they cannot survive. Though it is obvious that the severe toxicity of air and water will create a domino effect on the health of every species, something more powerful is the culprit in this case.

All species, including humans, have what is known as magnetite, which is created by organisms that produce this ferromagnetic mineral. It is a form of crystallized iron oxide. It is this unique mineral that allows us to be

aware of Earth's magnetic field. Though humans are largely unaware, animals are not! Humans utilize far less of this magnetite than do the animals, a distinct difference, because survival dictates the active quantity necessary per species.

The magnetite is able to transform the geomagnetic fields into signals that can be processed by the nervous system. The crystalline network that resides in the brain acts as a template recorder cell, sending out signals of information that are continually active in space. In magnetite-containing bacteria, the magnetite crystals turn the bacteria into swimming compass needles that orient with respect to the earth's magnetic fields.

This helps us to gather information based on direction. Animals navigate by their internal sense of direction. The altering of Earth's magnetic field will significantly de-regulate all biological rhythms. Electromagnetic properties on the planet will change so drastically that animals will be unable to align with the Earth's grid system. Keep in mind, though, that none of this is necessarily bad or to be feared. It's all part of the reorganization of experience that allows Consciousness to grow and evolve. This doesn't mean it will be easy to handle, mentally or emotionally. It only means that nothing happens that isn't part of the larger plan.

The Appearance of a Memory Virus

The first and most significant cause will be from the shifting of gravity and the Earth's electromagnetic lattices. Our chemistry and physiology will be redefined. Every cell will be challenged as gravity plays an integral part in how our bodies function. The true memory virus we will see is the one caused by the decrease in gravity. Our DNA will be exposed to new patterns of energy that will affect our communication processes from within.

The body and the mind will suffer communication breakdowns as our cellular structures are subjected to unrelenting changes in resonance. First, cells will lose the ability to process and communicate information properly. Second, biological weapons will have a serious impact, epidemic in proportion. This is an artificially Designed Biological-Mimicking Substance that will be produced by man and supported in its development by governments and drug companies. For many this will be a microscopic killing machine that uses viruses and neurotoxins to affect the capacity to retain, recall, and process information.

One such neurotoxin is already available to the public and sold in stores - it's called NutraSweet and the chemical is Aspartame. This chemical becomes a neurotoxin at 86 degrees Fahrenheit, which is twelve degrees below normal body temperature. This chemical contains 10% Formalin and Formaldehyde. Many of you recognize the name Formaldehyde and know it as an embalming fluid. What do you think is happening to your brain?

The virus acts by binding specifically to receptors of targeted organisms. Cultivating an organism and extracting the toxic materials from it or its spent medium produce a "biological chemical weapon." As the technology evolves to artificially create such substances, they will be far more damaging and nearly impossible to identify, especially by current means.

The contaminants will cause severe degradation and can incapacitate every physiological and neurological system, and that will interfere with normal behavior. The virus will be primarily airborne. The chem-trails left in our skies on a daily basis will be the aerosol medium by which exposure will initially take place. There will also be a re-emergence of other pathogens, such smallpox, plague, typhoid, etc. And our governments will all claim to have no knowledge of where they come from or how they re-emerged after all this time.

Mental and Emotional Changes

We can expect to witness a gradual increase in mental diseases, manic and depressive behaviors, unwanted thoughts and paranoia. Not everyone will be able to achieve the awareness to accept the changes without fear. We will be exposed to frequency waves and pulses of great magnitude as the earth goes through gross

physical changes. The energetic changes will change how our bodies respond to temperature, electromagnetic shifts, radiation, ELF (extra low frequency) waves and gravitational fluctuations.

All frequency shifts, whether physical or purely energetic, will impact our nervous systems and brain structures, increasing tension in emotional responses and generating strange thoughts and behaviors. Additional factors include the synthetic compounds (pharmaceuticals, excite-toxins) that so many people consume and the frequency waves generated by such devices as HAARP. The more sedated our minds and bodies are, the less responsive and aware we become.

Those whose bodies carry a heavy toxic load will experience greater susceptibility and more intense reactions as gravity and electromagnetic fields change. The change in electromagnetic density and gravity will trigger violence in some people, in their responses both to themselves and others around them. This is because the frequencies we are exposed to are having unrelenting effects on our brains and nervous system, which finds its response in our emotional state.

The Earth is moving out of an old electromagnetic frequency pattern and, because our bodies are electromagnetic, we will be subject to many distortions on mental, emotional and physical levels.

All these factors can disrupt our internal workings in as much as hormones, neurotransmitters, bio-chemical processes and circadian rhythms will alter the brain, which is the physical locus of the mind and our perceptual apparatus.

The brain is the physical manifestation of consciousness, however, and not the generator of it. This has been researched and proven many times over, and the conclusion must always be the same - Consciousness, as the awareness of being, is independent of the physical structure.

Suicide rates will rise to dramatic levels as many people see no other way out of the torment and terror. More densely populated areas will witness the highest incidence, because of the greater tension of mass consciousness influence, and geophysically active areas will be even higher as people near those active locations are in direct range of influence for those energies.

With prolonged exposure, geopathic and cosmic radiation causes irreversible genetic damage, provoking personality changes and aggression. The degree of disturbance varies widely, depending on the individual field intensity, pulse and radiation wavelength.

The changes in gravity and magnetism will affect human behaviors, as well as every other species. The lack of gravity will create various degrees of disturbance for every living organism. Our internal compass will become erratic and organs won't function properly as the messages that get through are garbled and confused.

Some of this is due to diet habits, some to genetically modified and highly processed foods, some to the proliferation of electrical power grids and their electromagnetic interference with life systems, some to pollution in air, water and food supplies.

It is all part of the changes that occur naturally as Consciousness grows, expands, and acquires more knowledge about itself. If we are to release our fear of what's happening, we must understand this, above all.

Falling Objects

The brass and fire falling from the sky will be aircraft, satellites and any other structures orbiting in Earth's atmosphere. As gravity starts shifting, electronics will not function properly and compasses won't work.

Magnetic and electrical failures will occur everywhere, and variations in the degree of failure will depend on the gravitational and electromagnetic orientation at any given place, at any given time.

Weather- and geology-related disasters will be influenced by gravity, as the Earth is thrown off its axis and relationships with the moon and sun are changed. All electro-mechanical devices, such as cars, which are run by computers, may simply stop working, as the dynamics that allow them to work, now, will be changed completely.

Changes in Lifestyles

Plain and simple, the mass changes that affect the earth will displace millions of people; those that survive the devastated areas will find themselves homeless, with no place to go. Help in many areas will become impossible, as the devastation will come fast and furious to many places at the same time. All levels of governmental infrastructure will cease to function. Survival will be a challenge, even for those who are prepared.

Mysterious Events in Holy Places on a global scale

The nature of religious and spiritual beliefs will bring about the experience of miracles for many. Those of strong faith will experience and witness incredible events, such as mass healings from disease and injury. Many in areas of extreme crisis will find that bonding with others of apparently opposing belief systems will generate a connection and common ground always sought but seldom found prior to the crisis. The connections between all living things, once experienced with an open heart, will seem to be miraculous.

The power of such "power spots" as Stonehenge, the Pyramids and other sacred sites around the globe will be increased as these are the primary energy vortices of the planet. Many who visit such places will experience new and expanded understandings and the sudden acquisition of knowledge not previously held, as to the true nature of Ultimate Reality, and they will share what they have learned with any who wish to know.

The understandings they gain will give them greater insight into the true nature of light, darkness and opposites, stripping away much of the previously held judgments about good and evil in connection with currently held perceptions of light and dark. The association of dark with evil negates the true knowledge that everything was manifested by Consciousness out of Itself, the Higher Intelligence that designs and orders all that is.

It is closer to Ultimate Truth to say that Fear is the opposite of Love, and those who live in fear, propagate fear, and use fear to manipulate others are "evil." Evil, however, is still a judgment placed on the behavior of others, and is not connected in any way to the value of the experience chosen by the person who is living with it. When judgments are removed, perceptions are cleared, and deeper understanding is possible for those who seek it.

Spirits will be plainly visible to many in these places as the dead apparently return to life, and others among the living will simply vanish. Communications from beyond our planet will be heard as mysterious sounds without a source. Portals between dimensions will be open and clearly in evidence - many may step through them and never be seen again.

The Photon Belt

Our entire solar system is moving into an area of space known as the Photon Belt. It is a donut-shaped belt of intense and rarefied light particles, and we entered the fringes of this Belt in 1992. By the end of this decade, we will be fully immersed in its influences, and since everything is made of vibration-ally slowed light and sound, including our bodies, we and our entire environment of experience, the Solar System, will be affected.

The atmospheres of the planets are changing, said Solar Sonic Professor of Geology and Mineralogy, and Chief Scientific Member, United Institute of Geology, Geophysics, and Mineralogy, Siberian Department of Russian Academy of Sciences, Expert on Global Ecology, and Fast -Processing Earth Events,

Current Plane to Physical alterations of the Earth is becoming irreversible. Strong evidence exists that these transformations are being caused by highly charged material and energetic non-uniformity in an isotropic interstellar space, which have broken into the interplanetary area of our Solar System.

This "donation" of energy is producing hybrid processes and excited energy states in all planets, as well as the Sun. Effects here on Earth are to be found in the acceleration of the magnetic pole shift, in the vertical and horizontal ozone content distribution, and in the increased frequency and magnitude of significant catastrophic climatic events. There is growing probability that we are moving into a rapid temperature instability period similar to the one that took place 10,000 years ago.

The adaptive responses of the biosphere, and humanity, to these new conditions may lead to a total global revision of the range of species and life on Earth. It is only through a deep understanding of the fundamental changes taking place in the natural environment surrounding us that politicians, and citizens alike, will be able to achieve balance with the renewing flow of Plane to Physical states and processes.

What we refer to, when we speak of "the donation of energy", is the entry of our entire galaxy into a phenomenon known as The Photon Belt. This is a donut-shaped belt of energy that is highly charged with photons - light particles. And as we merge into this Belt, the spaces between our physical molecules become charged with light, causing perceptible expansion and physical changes. And it isn't just people who are affected.

The planets most closely studied are those of our own Solar System, but in fact, our entire galaxy is moving into this Belt. The increases in energy are causing changes in every area of space in our immediate planetary environment, from the molecular level to the size, composition and environmental elements of the planets themselves.

The glowing plasma at the leading edge of our Solar System has recently increased 1000 percent. The Sun itself has a magnetic field, of course, and that magnetic field creates an egg around the Solar System, which is known as the heliosphere. The heliosphere is shaped like a teardrop, with the long and thin end of the drop pointing in the opposite direction from the direction that we're traveling, like a comet's tail. Today, the leading edge of the glowing plasma has gone to 100 astronomical units deep. Although Solar Sonic does not give an exact timeline, we can assume that this increase happening in the same 1963 to 2016 period as the increase we found in natural disasters.

And this is conscious energy that is changing how the planets work, how they function, and what kind of life they support. The harmonics of the DNA spiral itself are altering. Life forms are changing, and some of the oldest ones are dying out completely. All this is happening all at the same time. As individual elements involved in these changes gather energy and morph into their own new manifestations, they contribute more energy to the shifting of the whole. Very soon, those individual elements that have resisted the changes will have to make the leap or die out.

In other words, we will get to the point where we are so far into the new level of energy that there will be a sudden expansion of the basic harmonic wavelengths that the Sun emits as radiating energy. This increase in energy emission will change the basic nature of all matter in the Solar System. The planets are pushed slightly farther away from the Sun and the atoms and molecules that make them up actually expand in terms of their physical size.

The Poles

The North and South magnetic poles are currently undergoing changes, generating torque that will rearrange the globe. Some feel the axis is simply shifting to a point somewhere in the area of Hudson Bay, and some insist that the poles will trade places completely. Either way, we are in for changes in the Earth's appearance and the life forms existing now. Some landmasses will disappear or simply reduce in size and new ones will emerge. Cosmic waves will enter through the atmosphere at the poles and have a direct effect on the Earth's core, releasing energy beyond our comprehension. Every level of science, from the biophysical to the astrophysical, will experience quantum leaps upon recognition and acceptance of the Higher Intelligence that permeates our reality.

But what is causing these changes? It's not just the Photon Belt, and it's not just the cycles every 11,000 to 13,000 years (which are connected to the galactic passage through this Belt). There is another element involved that must be considered. Consciousness is the originator of both thought and emotion. Without the fragmentation of Consciousness into many forms and relationships, there would be nothing to think about or respond to, emotionally. But how does this impact the changes we are experiencing today? Thought creates. More accurately, thought gives form for manifestation, and emotion coalesces energy into manifestation through the properties of desire. We've all heard the expression, "Be careful what you wish for, because you might get it." The true meaning of this has seldom been explored by any but the most contemplative of thinkers. What it really means is "Be careful what you CONCENTRATE ON..." because concentration of thought gives form, and what you concentrate on is what you feel the most passionate about.

We truly do create our own realities, as individuals and en masse (collective consciousness). There are things that everyone has agreed to, so there are common elements to our experience, such as the fact that the sky is blue and the seasons change and if you run head-first into a tree, it will hurt you. These thought-forms give rise to the experiences of our daily lives and mutual enjoyment of the environments we have created. But there's more.

There is also individual consciousness, capable of creating its own experience at the personal level - whether it does so consciously or unconsciously, and regardless of the results. We aren't used to watching our thoughts, so we have no real awareness of how they manifest our experience. People, who are broke live in fear of not having enough money to buy food, take care of basic needs, etc. That fear perpetuates their experience of being broke, because that's what they concentrate on. Those who eventually make it out of such a financial hole have changed their thinking before their experience changed to align with their thoughts. But they may not have been aware of changing their thinking.

These days, we are faced with a world in chaos. How did it get that way? For starters, as we started denying our feelings, our intuitive abilities stopped giving us feedback, and we stopped having a direct experience with our environment on a daily basis. We also stopped being aware of our thoughts and how they shape our experience. As we denied our own feelings, we also began to deny the feelings of others. This denial brought us full circle as others also denied our feelings.

An example: If a man steals from his employer, even in small ways such as pens, paper clips, scratch pads and other small office supplies, he has created a reality in which it is okay to take what isn't his, without regard for others. But not being aware of his thinking, he doesn't realize the reality he has created for himself, and is in denial of the ways in which he also will experience the reality he has created. Others will steal from HIM.

This is the true meaning of The Golden Rule - Do unto others, as you would have them do unto you. Now, apply this on a global scale, and you have created a world in which people are completely unconscious to their own thoughts and feelings, as well as the connection between others and themselves. Everyone is flailing around blindly, grasping for something to hold onto, yet everything they grasp is taken away. They are in constant fear, polarizing, mistrusting each other, lying to protect themselves or others, and doing things in darkness that they fear will come into the light... both figuratively and literally. Societies, cultures,

governments and religions - all are clashing and conflicting, each trying to find the answers to their needs, trying to make themselves understood, insisting that they have the answers and others don't, but failing because they aren't looking where the answers are - within each individual person. Yes... our thoughts and feelings.

All of this clashing and conflict creates chaos in the energy field of the entire planet. If our thoughts, on the level of mass consciousness, are not cohesive, the physical structure of our own creation begins to fall apart and restructure itself to meet the ever-changing thought-forms that give rise to its existence. Since our thoughts and feelings are always changing, and are even conflicted within individuals, the structure of the planet must become flexible and mobile. This creates changes in weather patterns, the shapes of continents, and the chemical makeup of every physical element there is.

Oh, yes, the mind is the most powerful thing in existence. Transformation on a Universal scale is on the near horizon. Depending on how you look at it, this can be a good thing. Consciousness does indeed desire to grow and acquire knowledge about itself in relationship to others. Does this mean we've done something wrong for which we need to be punished? No, not at all, What it DOES mean is that, as Consciousness outgrows one experience, the patterns that held the experience in place need to change, too, and this, ultimately, is the reason for disconnection from our thoughts and feelings.

If we don't detach from our thoughts and feelings, the power of the mind is such that the same experience would be held in place and played and replayed for infinity. Granted, this disconnection is difficult to handle. To the Universal Mind, the shift in focus and loss of concentration is simply a blink in time. To our ordinary awareness, however, the process takes many years, and is filled with fear, because we don't know what's happening and we seem unable to stop it.

This isn't something that happened by coincidence or without a plan. There is a plan, and this is part of it. In order to follow the plan, we must do one thing - suspend all judgment. If we can do this one thing, we will be able to allow our neighbor their own choices while we have ours, and our internal conflict and confusion will cease, along with the belief that anything must be done to stop what's happening. This is bigger than any of us - bigger than ALL of us - and from our limited perspective, we are truly in no position to judge what our Higher Intelligence is doing to our world.

There are those who believe there is no Higher Intelligence, and that's okay. Then there are those who have different ideas about what this Higher Intelligence is and what it wants from us. That's okay, too. Even the polarization of beliefs serves a purpose in the overall design plan. For those who hold a belief that there IS a plan, however, the changes in our experience, which have already begun, will be much easier to bear.

Temperature Changes

Overall, the world's climate is becoming hotter. The Earth's core is a pressure cooker; it is bulging around its equator. Temperatures are at elevated levels, greater than any other time in current human history. The poles are heating up and polar ice is melting at alarming rates. Greenland alone, if melted, would increase the world's water levels by 23 feet. This is a small amount when you add up every other region covered by ice, layers that are miles thick. The world will see water levels rise at alarming and uncontrollable rates. Warming at the higher latitudes will reach easily to an additional 15+ degrees Fahrenheit (9+ degrees Celsius). The world's natural air conditioners will be compromised.

The world's glaciers are melting rapidly. An example of this is Montana's Glacier National Park: in 1910, the park counted 150 glaciers. Today, there are fewer than 30, and they are drastically shrinking.

The changes in temperature are dramatically altering what is known as the Earth's conveyor belt. This underwater belt is the ocean's circulatory system. It moderates global temperatures by moving tropical heat around the planet. Increased warming will affect the mix of fresh and salt water globally. Significant warming will cause the extinction of many plants and birds, marine life and other mammals.

NASA has documented that the Arctic itself is shrinking at alarming rates. It has decreased in size 20% since 1979. Arctic temperatures are rising twice as fast than any other part of the world. Even the Arctic Sea has been melting at 9% per decade. This trend will change to a degree that the 9% that has been equated to the change per decade will be what occurs in a matter of months once the gross physical earth changes start to significantly increase. Temperatures will be experienced at levels that will kill much of the biological life and corresponding habitats that this planet sustains.

Cataclysmic rises in water levels around the world will cause significant loss of life. Only four other times in recorded human history has the world collapsed upon itself. We are entering a unique period where we will repeat history for a fifth time.

But is this tragic? No. If we are honest with ourselves, only our fear and judgment deems it to be tragic. Consider the possibility that Spirit has another agenda, and in order to fulfill that, it must change the form it occupies. What, then, happens to the existing form? It dies. Spirit's focus in the body animates the body, but without that focus, the body mechanism cannot be maintained. We must remember that Ego - our body-focused sense of identity - is the only thing that really feels threatened here. If we were not so attached to the body as the SOURCE of our identity (which is it not), we would be far more inclined to change physical forms as we wish, in order to have several physical experiences at the same time.

But does Spirit lose its identity when it leaves the body? No. Identity is a factor of Consciousness - the awareness of being. We always know who we are, and changes in our bodies and our environment cannot remove that.

Airborne Objects Falling

We will witness an increase in the number of objects falling from the sky. The objects may be meteors and asteroids, or manmade debris, such as satellites. Even birds will be falling, as the earth's magnetic shifts become more noticeable. Objects will come from many areas around the world. As the intense changes in weather occur, winds will carry debris everywhere. Such objects will be most noticeable and damage is expected to be extensive.

More UFO's

We will see significant numbers of unknown flying objects in the sky. Pilots, astronauts, will see unknown flying objects more frequently. Earthly detection devices will record more incidents of objects that have previously gone unnoticed and unreported. They will clearly not be from Earth. The gravitational and electromagnetic shifts will open a window where that which has been invisible to our eyes and deaf to our ears will now be visible and audible. Confirmation of extraterrestrials will be a given, and most undeniable.

Changes in visible light frequencies

Several causes exist that are present here. First the manipulation of light or any other radiant energy above or below the visible light range will occur by outside forces manipulating the frequency rate of the matter/anti-matter cycle. The time and speed of light can be varied in direct proportion to a desired value.

Other causes will include, but are not limited to, the change of sensitivity as our entrance into the Photon Belt brings more light, in general, into our sphere of experience. The physiological changes to our bodies will most certainly include changes to our ability to see. And what we are able to see, then, is unimaginable at this time.

What is invisible will become visible

Entities or beings will be visible due to the entire change of the known electromagnetic spectrum. Light will have a whole new meaning. Light waves, guided seemingly by superior intelligence, form intricate interlocking grid patterns that graduate from the simple to the complex, as the elements from hydrogen at the lower end of the scale to element 144 are changed in frequency.

All mathematical and scientific evidence amassed today indicates that the maximum number of individual elements to be found in the universe to be 144. Each of these elements will have six isotopes, which will make up a completed table of separate substances numbering 1008.

Mathematically the progression would create 144 octaves of separate substances giving a theoretical value of 1152. The difference between the total number of substances (1008) and the harmonic value in octaves (1152) would be 144, the light harmonic.

The earth is part of a solar web. The inhabitants of this earth are chained on a geomagnetic level, planetary bondage to a solar magnetic field paradigm. It is the iron that imposes this design. Our electromagnetic spectrum is emitted by the Sun and mediated through the Polyhedronic Crystal Grid of which Earth is a part. Depending on our orientation, gravity holds us to the Earth and the solar winds blow fiercely to keep us within its magnetic field.

The earth resides in its own tailored electromagnetic domain, or frequency / life spectrum, as is so for every other planetary body. One could then surmise that the Earth being a giant orbiting crystalline object also then is wired for sound and light variation. Even vibrating and condensed sound fields can nullify the power of gravitation.

The earth is moving out of denseness and changing its electromagnetic properties, vibrating to new harmonics that will give rise to new realities. New resonant frequencies will allow for the sudden visibility of entities and objects as well as the complete awareness of sounds and images that would normally be beyond our ability to see and hear.

Extraterrestrial Aerospace Superiorities and Star War Multi-Dimensional Defense Technologies within earth:

(1) Project True Light _ Cosmic Energy Stimulation
(2) Project Total Calm _ Global Frequency Penetration
(3) Project Total Superiority _ Cross Continent Defense
(4) Project Total Solar Sonic Invisibility _The Invisible Army
(5) Project Solar Sonic Eagle _ Building Of The Ghost
(6) Project Reversible Impact _ Regional Intensity Of Sunrays
(7) Project Total Memory Lapse _ Memory Manipulation Technology
(8) Project Total Sunbeam Penetration _ Sudden Intensity Of Sunrays
(9) Project Solar Sonic Insertion/Dissipation _ Manipulating Defense Visibility
(10) Project Foreign Entities commanding ignition _ Manipulating Space Energy
(11) Sunbeam Missile Technology for Asteroid Defense _ SSF-Sunbeam Missiles
(12) Antamatics Multi-dimensional defense Technology _ SSF-Sunbeam Utilization

Solar Sonic Extraterrestrial Deep Space Researches & Communication Technologies have been investigated, prepared, tested, discussed, debated and now comprehensively implemented. In doing so, Extraterrestrial Experimentations to design a constructive methodology of two way Extraterrestrial Communications (Interstellar Language) between Research Scientist Dr. Mohammed M. Ammar and non human entities within the entire Solar System will be a distant reality to come.

Whereas Dr. Ammar's Extraterrestrial Communicational Methodologies are not only designed to accommodate a specifically selected source in deep space, but also to resonate within the Solar System. We must all bear in mind that if the language invented is rightfully applicable to all Aliens, there will be an Electromagnetic Spectrum Language of Communications at once, since Aliens are already on earth, this language will make us their good friends.

Whereas there can be exchanges of technologies, resources, cultures, industries and all other matters to enhance the interests of planet earth and to constructively derail the Currently Existing Agenda for Extraterrestrial Invasion and Destruction of earth by Various Species of Extraterrestrial Aliens.

Dr. Ammar urges everyone close or far, specialized or not to really cooperate and support all our work in every way possible. We Are Not Asking You to Believe or Disbelieve, we thank all of you in advance For All Considerations Extended Under The Circumstances To Save The Earth from what is planned to happen by other Alien Species in specifically given periods of time.

[Just because you don't know it, it certainly doesn't mean it's not out there). Dr. Ammar takes this opportunity to thank all of you for extending a helping hand for a better world and start by supporting our Work, Researches, Technologies, Experimentations and the international recognition of this Patent and of us.

The Principal Claims of the Invention

1. The undersigned jointly present a World-Class Hi-Tech Patent of Allen Communications and Mnnipiiiatiom Technology, It is by all means a legendary Work of Precision Targeting beyond the description of words. Prof. Or. Amuar hast quite literally communicated with Extraterrestrial Intelligence^), and has dominated *the* Electromagnetic Spectrum "Six Different Times" with Telepatliically Resonating Capsulated Energy Streaming (TRCES) which is the Universal Alien Language of the Entire Universe.

2. It is a form of Consensually Agreeable Alphabet of the Universe, both Interstellar and Intergalactlc Radio Signal Waves which is "armed" with galactically agreeable language and energetic streaming patterns, the radio signals are energetically armed, in order to vibrate, stimulate, dominate, override, spread, publicize, impede, emit, Intercept, receive, transfer, mediate, convey, control, transform, carrlci-wave, propagate, transmit, converse, release and tnterprcte all Intcrgalactic and lnterstellarTelepathically Resonating Capsulated Energy Streaming, universally known as (TRES). The underlying innvention is "Solar Sonic Deep-Space Multidimensional Coded Universal Communications" via Ionosphere Armed Signals and Quantum Algorithm Resonance of Hydroxyl Molecules Cosmic-Radio- Waves.

3. The said invention is a Solar Sonic Universe Multidimensional Radio Astronomical Control Tower Resonator for Systematic Multi-Communications and Manipulations of all resonating Matters and Antimatters alike", lite Solar Sonic Multidimensional Interstellar Radio Signal Communications Resonator is a novel technology precisely pertaining to Deep Space Multidimensional Radio Signal Communications, which is an art reflected within the formal technology stated title. We explain the basis for our Hi Tech Assertions in a systematic manner whereas we will Illustrate further clarification of the underlying contents of data *as* follows.

4. *A* system for communications on nn extraterrestrial body may include a space-based component and an ancillary extraterrestrial component on the extraterrestrial body. The space-based component may be configured to provide wireless communications with a plurality of radio-terminals located on the extraterrestrial body over a satellite frequency hand wherein the space-based component includes at least oae satellite orbiting the extraterrestrial body. The ancillary extraterrestrial component may be configured to provide wireless communications with the plurality of radio-terminals located on the extraterrestrial body. Moreover, the ancillary extraterrestrial component may reuse at least one satellite frequency of the satellite frequency band, and the space-based component and the ancillary extraterrestrial component may be configured to relay communications there between. Related methods are also discussed.

claims (continued)

5. Communications System Composing: A first space-based component that is configured to provide wireless communications to a plurality of radio terminals located on an extra terrestrial body using frequencies of » first satellite frequency band wherein the first space-based component includes at least one satellite orbiting the extraterrestrial body; and a first ancillary extraterrestrial component on the extraterrestrial body that is configured to establish first wireless links directly between itself and the first space-based component and directly between Itself and a first radio-terminal and to nse the first wireless links to provide wireless communications between the first radio-terminal and n second radio-terminal; wherein the second radio-terminal communicates with the first radio-terminal via a second ancillary extraterrestrial component on the extraterrestrial body that is configured to establish second wireless links directly between itsolf and the first space-based component and directly between itself and the second radio terminal.

6. Wherein the first ancillary extraterrestrial component is further conflgarcd to detect transmissions of the second ancillary extraterrestrial component, to establish a link there between responsïve to having detected the transmissions and to use the link that is estnblislicd to coordinate frequency reuse, transmission power and/or hand-off of radio-terminals with the second ancillary extraterrestrial component. A system according to claims wherein the first space-based component is configured to relay communications between first and second radio-terminals on the extraterrestrial body without using any ancillary extraterrestrial components. A system according to claims wherein at least one ancillary Extraterrestrial component is configured to relay communications between first and second radio-terminals on the extraterrestrial body by using at least one frequency of the first satellite frequency band. A system according to claims wherein an ancillary extraterrestrial component and the first space-based component are configured to relay communications between first and second radio-terminals on the extraterrestrial body such that communications between the first and second radio-terminals are relayed through both the ancillary extraterrestrial component and the first space-based component

7. A system according to claims wherein a radio-tormina) is configured to provide full duplex voice communications. A system according to claims wherein a radio-terminal is configured to provide digital data communications. A system according to claims further comprising a plurality of ancillary extraterrestrial components on the extraterrestrial body with each ancillary extraterrestrial component defining a respective wireless communications coverage area on the extraterrestrial body. A system according to claims wherein the plurality of ancillary extraterrestrial components use a plurality of frequencies of the first satellite frequency band wherein the plurality of frequencies are shared among the plurality of Ancillary extraterrestrial components according to a frequency reuse pattern to reduce interference between adjacent ancillary extraterrestrial components. A system according to claims further comprising;

8. A second space-based component that is configured to provide wireless communications to a plurality of radio-terminals located on earth over a second satellite frequency band wherein the second space-based component includes at least one satellite orbiting the earth, wherein the first space-based component, the second space-based component, and the ancillary extraterrestrial component are configured to relay communications there between via direct wireless links there between. A system according to claims further comprising: An ancillary terrestrial component on earth that is configured to provide wireless communications to a plurality of radio-terminals located on earth, wherein the ancillary terrestrial component uses at least one frequency of the first and/or second satellite frequency band, and wherein the second space-based component and the ancillary terrestrial component are configured to relay communications there between via direct wireless links there between.

9. A system according to claims wherein the first satellite frequency band and the second satellite frequency band comprise substantially the same satellite frequency band. A system according to claims wherein the ancillary extraterrestrial component on the extraterrestrial body and the ancillary terrestrial component on earth are configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body. A system according to claims wherein the first space-based component and the ancillary terrestrial component are configured to relay communications between u radio-tcrminql on earth and a radio-terminal on the extraterrestrial body.

10. A system according to claims wherein the first space-based component and the second spncc-based component are configured to relay communications between a radio-terminal on earth and a radio-terminal the extraterrestrial body. A system according to claims wherein the ancillary extraterrestrial component and the second space-based component are configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body. An extraterrestrial communications system comprising; A first space-based component that is conngurcd to provide wireless communications to a first plurality of radio-terminals located on an extraterrestrial body wherein the first space-based component Includes at least one satellite orbiting the extraterrestrial body.

An ancillary extraterrestrial component on the extraterrestrial body that is configured to provide wireless communications to the first plurality of radio-terminals located on the extraterrestrial body, wherein the first space-based component and the ancillary extraterrestrial component arc configured to relay communications **there** between and wherein the ancillary extraterrestrial component is configured to detect transmissions of at least one other ancillary extraterrestrial component, to establish a link there between responsive to having detected the transmissions and to use the link that is established to coordinate frequency reuse, transmission power and/or hand-off of radio-terminals with the at least one other ancillary extraterrestrial component; A second space-based component that is configured to provide wireless communications to a second plurality of radio terminals located on earth wherein the second space-based component includes at least one satellite orbiting earth; and an ancillary terrestrial component on earth that is configured to provide wireless communications to the second plurality of radio terminals located on earth, wherein the second space-based component and the ancillary terrestrial component are configured to relay communications there between; wherein the first space-based component, the ancillary extraterrestrial component, the second space-based component, and the ancillary terrestrial component are configured to relay communications between a radio-terminal on the extraterrestrial body and a radio-terminal on earth such that communications between the radio-terminal on the extraterrestrial body and the radio-terminal on earth are relayed at least two of the first space-based component, the Ancillary extraterrestrial component, the second space-based component and the ancillary terrestrial component.

12. An extraterrestrial communications system according to claims wherein the first space-based component is configured to provide wireless communications over a first satellite frequency band and wherein the ancillary extraterrestrial component is configured to use at least one frequency of the first satellite frequency band. An extraterrestrial communications system according to claims wherein the second space-based component Is configured to provide wireless communications over a second satellite frequency band and wherein the ancillary terrestrial component is configured to use at least one frequency of the second satellite frequency band.

13. An extraterrestrial communications system, wherein the first and second satellite frequency bands comprise substantially the same satellite frequency band.20. An extraterrestrial communications system according to claims wherein the first space-based component is configured to relay communications between first and second radio-terminals on the extraterrestrial body. An extraterrestrial communications system according to claims wherein the ancillary extraterrestrial component is configured to relay communications between first and second radio-terminals on the extraterrestrial body. An extraterrestrial communications system according to claims wherein the first space-based component and the ancillary extraterrestrial component are configured to relay communications between first and second radio-terminals on the extraterrestrial body such that communications between the first and second radio-terminals are relayed through both the ancillary extraterrestrial component and the first space-based component.

14. An extraterrestrial communications system according to claims wherein the radio-terminals located on earth and on the extraterrestrial body comprise mobile radio-terminals configured to provide full duplex voice communications. An extraterrestrial communications system according to claims wherein the radio-terminals located on earth and on the extraterrestrial body are configured to provide digital data communications. An extraterrestrial communications system according to claims wherein the ancillary extraterrestrial component is one of a plurality of ancillary extraterrestrial components on the extraterrestrial body with each ancillary extraterrestrial component defining a respective wireless communications coverage area on the extraterrestrial body,

15. An extraterrestrial communications system according to claims wherein the first space-based component is configured to provide wireless communications over a first satellite frequency band, wherein the ancillary extraterrestrial component is configured to use a plurality of frequencies of the first satellite frequency band, and wherein the plurality of frequencies are shared among the plurality of ancillary extraterrestrial components according to a reuse pattern to reduce interference between adjacent extraterrestrial components. An extraterrestrial communications system according to claims wherein the ancillary extraterrestrial component on the extra terrestrial body and the ancillary terrestrial component on earth are configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body such that communications between the radin-tcrminnl on earth and the radio-terminal on the extraterrestrial body are relayed through both the ancillary extraterrestrial component and the ancillary terrestrial component.

16. An extraterrestrial communications system according to claims wherein the first space-based component and the second space-based component are configured to relay communications between n radio-terminal on earth and a radio-terminal on the extraterrestrial body such that communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body arc relayed through both the first space-based component and the second spnee-based component. An extraterrestrial communications system according to claims wherein the first space-based component aud the ancillai-y terrestrial component are configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body such that communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body nre relayed through both the first space-based component and the ancillary terrestrial component. An extraterrestrial communications system according to claims wherein the ancillary extraterrestrial component and the second space-based component are configured to relay communications between a radio-terminal on earth and a radio-terminal on the extraterrestrial body such that communications between the radio-terminal on earth and the radio-terminal on the extraterrestrial body are relayed through both the ancillary extraterrestrial component and the second space-based component.

17. A communications system comprising: a space-based component that is configured to provide wireless communications to a plurality of radio-terminals located on earth over a first satellite frequency band wherein the space-based component includes at least one satellite orbiting earth; and an ancillary terrestrial component on earth that is configured to provide wireless communications to with the plurality of radio-terminals located on earth; wherein the ancillary terrestrial component uses at least one frequency of the first satellite frequency band, is configured to detect transmissions of at least one other ancillary terrestrial component, to establish a link there between responsive to having detected the transmissions and to use the link that is established to coordinate frequency reuse, transmission power and/or band-off of radio-terminals with the at least one other ancillary terrestrial component; and wherein the space-based component and the ancillary terrestrial component are configured to relay communications there between and at least one of the space-based component and the ancillary terrestrial component is configured to relay communications between one of the plurality of radio terminals located on earth and a radio-terminal located on an extraterrestrial body.

18. A communications system according to claims further comprising; a second space-based component that Is configured to provide wireless communications to a plurality of radio-terminals located on the extraterrestrial body over a second satellite frequency band wherein the second space-based component includes at least one satellite orbiting the extraterrestrial body, wherein the first space-based component, the second space-based component, and the ancillary terrestrial component are configured to establish direct wireless communications links there between and to relay communications there between using the direct wireless communications links.

19. A communications system according to claims further comprising: an ancillary extraterrestrial component on the extraterrestrial body that is configured to provide wireless communications to the plurality of radio-terminals located on the extraterrestrial body, wherein (he ancillary extraterrestrial component uses at least one frequency of the second and/or first satellite frequency band, and wherein the second spaco-based

component and the ancillary extraterrestrial component are configured to establish direct wireless links there between and to relay communications there between using the direct wireless links.

20. A communications system according to claims wherein the first satellite frequency band and the second satellite frequency band comprise substantially the same satellite frequency bund. Λ method of operating a communications system comprising a space-based component including at least one satellite orbiting an extraterrestrial body and an ancillary extraterrestrial component on the extraterrestrial body, the method comprising: providing wireless communications by the space-based component to a plurality of radio termiuals located on the extraterrestrial body over a satellite frequency band. Whereas the system provides wireless communications by the ancillary extraterrestrial component to the plurality of radio-teruiinuls located on the extraterrestrial body, wherein the ancillary extraterrestrial component uses at least one frequency of the satellite frequency band.

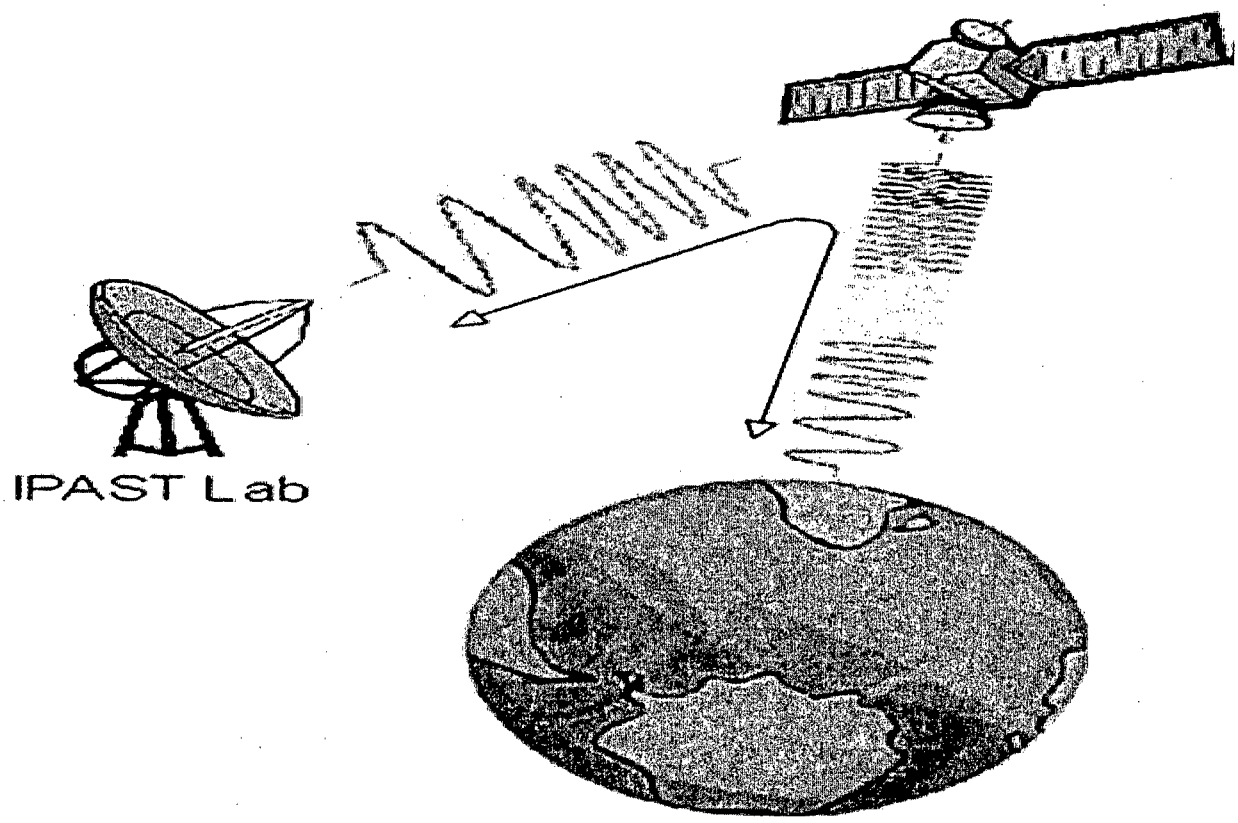
2 f. Wherein the system establishes the direct wireless links between the space-based component and the ancillary extraterrestrial component and relaying communications between the space-based component and the ancillary extraterrestrial component using the direct wireless links; and detecting by the ancillary extraterrestrial component transmissions of at least one other ancillary extraterrestrial component, establishing a link there between responsive to the detecting and coordinating with the at least one other ancillary extraterrestrial component, using the link that is established, frequency reuse, transmission power and/or hand-off of radio-terminals. A method of operating a communications system comprising a first space-based component including at least one satellite orbiting an extraterrestrial body, an ancillary extraterrestrial component on the extraterrestrial body, a secoud space-based component Including at least one satellite orbiting earth, and an ancillary terrestrial component on earth, the method comprising: providing wireless communications by the first space-based component to a plurality of radio-terminals located on the extraterrestrial body; providing wireless communications by the ancillary extraterrestrial component to the plurality of radio-terminals located on the extraterrestrial body; establishing direct wireless links between the first space-based component and the ancillary extraterrestrial component and relaying communications between the first space-based component and the ancillary extraterrestrial component using the direct wireless links.

2 2 -Wherein, the system provides wireless communications by the second space-based component to a plurality of radio-terminals located on earth; providing wireless communications by the ancillary terrestrial component to the plurality of radio-terminals located on earth; establishing direct wireless communications links between the second space-bused component and the ancillary terrestrial component and relaying wireless communications there between using the direct wireless communications links; detecting by the ancillary extraterrestrial component transmissions of at least one other ancillary extraterrestrial component, establishing a link there between responsive to the detecting aud coordinating with the at least one other ancillary extraterrestrial component, using the link that is established, frequency reuse, transmission power and/or hand-off of radio-terminals.

2 3. Wherein, relaying communications between a radio-terminal on the extraterrestrial body and a radio-terminal on earth such that communications between the radio-terminal on the extraterrestrial body and the radio-terminal on earth are relayed through at least two of the first space-based component, the ancillary extraterrestrial component, the second space-based component and the ancillary terrestrial component. A method of operating a communications system comprising a space-based component including at least one satellite orbiting earth, and an ancillary terrestrial conipunont on earth, the method comprising: providing wireless communications by the space-based compouent to a plurality of radio-terminals located on earth using service link frequencies of a satellite frequency band.

2 4. Wherein, the system provides wireless communications by the ancillary terrestrial component to the plurality of radio-terminals located on earth using service link frequencies of the satellite frequency band; relaying communications between the space-based component and the ancillary terrestrial component; detecting by the ancillary terrestrial compouent transmissions of at least one other ancillary terrestrial component, establishing a link there between responsive to the detecting and coordinating with the at least one other ancillary terrestrial component, using the link that is established responsive to the detecting,

frequency reuse, transmission power and/or hand-off of radio-terminals; and
relaying communications between one of the plurality of railio-tenninafs located on earth and a radio-terminal located on an extraterrestrial body using the space-based component and the Hiictllnry terrestrial component.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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/000427

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04B7/185
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/239457 A1 (LEVIN LON C [US] ET AL) 27 October 2005 (2005-10-27) paragraphs [0006] - [0022], [0047]; claims 1-37; figures 1-3	1-24
X	US 2011/171986 A1 (LEVIN LON C [US] ET AL) 14 July 2011 (2011-07-14) paragraphs [0007] - [0022]; claims 1-16; figures 1-3	1-24
X	US 2008/151913 A1 (EL-DAMH0UGY HESHAM [US] ET AL) 26 June 2008 (2008-06-26) paragraphs [0002] - [0016]; claims 1-24; figures 1A, IB, 6A	1-24
X	US 2008/155070 A1 (EL-DAMH0UGY HESHAM [US] ET AL) 26 June 2008 (2008-06-26) paragraphs [0002] - [0014], [0024]; claims 1-32; figures 1A, IB	1-24

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 November 2015	30/11/2015

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2015/000427

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005239457 A1	27-10-2005	US 2005239457 A1	27-10-2005
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