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SETI, Just Beyond The Cutting Edge

by Richard Hall, KF8ST (email DickKF8ST@aol.com)
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I have been a SETI league member for several years, because I find the general philosophy of SETI fascinating. Now that I have retired, I plan on devoting more time and resources to establishing a Project Argus receiving station. While gathering my thoughts on how to approach this project, I began to think about other possibilities of intelligent communication within the electromagnetic spectrum.

The rationale behind the "water hole" region for electromagnetic communication is convincing and has a sound basis that has been developed around our present understanding of physics and the universe. The water hole is defined as a band of frequencies between 1420 MHz and 1670 MHz. 1420 MHz is one of several "magic frequencies" much favored for SETI work. The reason for this is, that it is the natural frequency emitted by neutral hydrogen. Hydrogen line radiation is found throughout the known universe. It is kind of a cosmic beacon. But perhaps not the only one.

In 1967, I was working on a laser project at the Bendix Research Laboratories, a process that would produce coherent, vacuum ultraviolet light. The physics involved is basically the same as that employed in today's modern gas lasers. But this process generated light in the UV spectrum at a wavelength of 90 nanometers, far above the visible spectrum, which peaks in the blue green at 520 nanometers. This was "cutting edge" technology at the time, and required a process known as "single photon counting" to detect the ultraviolet light.

The term vacuum ultraviolet refers to wavelengths of light that can only exist under ultra-high vacuum conditions in the laboratory or in the vacuum of space. The detector itself, by today's standards, was crude. An experimental package containing an array of these detectors was placed on the lunar surface during the second moon walk. The package was designed to detect particles such as cosmic and gamma rays, as well as high-energy neutrons emitted from the Sun's surface and other cosmic sources.

Transmission of information using short bursts of modulated ultra-violet light would be very efficient, assuming very efficient detectors and light sources were available. The data rate and bandwidth would be almost infinite at these wavelengths. As an example, currently data is transferred over the Internet through fiber-optic cable and microwaves. The information is contained in short packets of digital data used to modulate light, as well as microwaves. We are fast moving in the direction of optical communications and SETI should follow the same trend.

During a videocast from the Shuttle a few years back, some unexplained streaks of light appeared in the background. The streaks were moving at extremely high speeds and abruptly changed direction as they went. Intensely bright flashes could be seen in and around the fast moving objects. NASA speculated we were seeing ice crystals streaming back from the orbiter.

Perhaps we were. Perhaps not. Might the fast moving objects have been some sort of space probes, and these intense, short flashes of light have actually been some form of communication between these fast moving objects? Regardless of the evolutionary process involved in producing an extraterrestrial intelligence, communication between entities would most likely take place somewhere within the electromagnetic spectrum. Otherwise, why are we going to all this trouble to listen?

If (as has been widely suggested) interstellar space probes do exist, then it stands to reason that they must carry some means of communication. Many ideas have been published on what form this communication may take. This suggests that many others are giving serious thought to SETI. We should now be considering technologies just beyond the cutting edge. They may represent the future of interstellar communications.

New satellites are presently under development. They will be able to view x-ray, as well as ultraviolet emission sources beyond the attenuation and absorption effects of Earth's atmosphere. ETI may already be trying to communicate; we just may not be listening at the right spot on the electromagnetic dial. ❖

Optical SETI Pioneer Receives 2000 Bruno Award

LITTLE FERRY, NJ.., 26 March, 2000 -- The SETI League, Inc., leaders in the privatized Search for Extra-Terrestrial Intelligence, has awarded its highest honor to a leading proponent of Optical SETI (OSETI). Photonics engineer Dr. Stuart Kingsley, 51, director of the Columbus Optical SETI Observatory, today received the coveted Giordano Bruno Memorial Award for his pioneering efforts in the search for laser signals from space.

For forty years, the world's SETI programs have been dominated by microwave technology, while OSETI proponents have argued that laser communication is at least as likely a mechanism as radio for establishing interstellar contact. Dr. Kingsley's has been a voice in the wilderness for at least the past ten years, his optical observatory among the first to search for laser communications from space. The scientific establishment is only now beginning to embrace OSETI, due in large part to Kingsely's research, publications and conference presentations.

Since 1990, Stuart Kingsley has been conducting what has become the world's longest-running optical SETI program from an observatory dome behind his home in Columbus, OH. His modest 25 cm diameter reflector telescope searches the 550 nm spectrum for pulsed lasers emanating from nearby stars. While most SETI scientists concentrated on the more conventional microwave spectrum, Dr. Kingsley's optical search has received support from such visionaries as Nobel laureate Dr. Charles Townes and novelist Sir Arthur C. Clarke.

As vindication of Kingsley's vision, the past five years have seen the launch of half a dozen ambitious OSETI projects at the Harvard-Smithsonian Astronomical Observatory; the University of California, Berkeley; the Lick Observatory in California; on the Keck telescope in Hawaii; at Perth and Sydney, Australia; and in the Czech Republic. Dr. Kingsley now chairs the SETI League's Optical SETI Committee, through which he encourages other experimenters to embrace OSETI.

Dr. Kingsley's curriculum vita may be found on the web, at www.setileague.org/admin/kingsley.htm. ❖

OSETI Bruno Shows Vision

by Dr. Stuart Kingsley (kingsley@coseti.org)

Since I couldn't be present to make my "SETI Oscar" acceptance speech on Oscar day in March, I will do so here. I wish to thank the members of The SETI League for the honor of this year's Bruno Award. It is greatly appreciated. It comes at a time when the optical search for extraterrestrial intelligence is receiving increased attention. Little did I think when embarking upon this venture in the summer of 1990, that a decade later I would still be actively involved in Optical SETI. Prior to 1990, I did not know that a limited amount of OSETI research had been done since 1961. Next year, I chair the third SPIE conference on the subject.

This will mark the 40th anniversary of OSETI, though up to now very few people have appreciated the fact that the optical approach to SETI has considerable merit. Interestingly, despite the fact that opposition to Optical SETI in the SETI establishment has substantially abated since the summer of 1998, there are still articles, books and documentaries on SETI-related subjects being produced that fail to mention the approach. All it needs is the two extra words "and optical" when referring to radio or microwave SETI. It is not necessary to describe what Optical SETI is, but it does need a mention.

Let us hope that by 2010, we will have discovered extraterrestrial laser beacon signals and then know for sure that "we are not alone." Of course, this may take space-based observatories, so it is important that future space-based optical observatories, whether they operate in the infrared, visible or ultraviolet spectrums, should be equipped to undertake Optical SETI observations. I can confidently predict that by 2005, most SETI activities on this planet will be of the optical kind and that by 2010, most funding for SETI will be for the optical variety.

As far as The SETI League is concerned, the next decade will see its membership grow substantially, but driven by vast numbers of amateur optical astronomers who will have decided to take up the optical search. Amateurs make significant contributions to conventional astronomy, so there is no reason why they should not do the same in the Optical SETI arena.

We have seen how successful SETI@Home has been in generating interest in Microwave SETI, from data collected by the Arecibo radio telescope. How much more interest will be generated by the ability to collect one's own optical data or process data obtained over the Internet from other research groups! For this reason, The Columbus Optical SETI Observatory intends to make its data available over the Internet when the present upgrade is completed next year. ❖

SETI League Director Receives Dayton Technical Award

LITTLE FERRY, NJ.., May, 2000 -- The Dayton Amateur Radio Association, which hosts the world's largest ham radio gathering, has honored Dr. H. Paul Shuch with its annual Technical Excellence Award, in recognition of his many years of teaching and leadership in microwave and space communications. Shuch, who holds amateur radio callsign N6TX, has served since its inception as executive director of the membership-supported SETI League, Inc., grassroots leaders in a privatized Search for Extra-Terrestrial Intelligence. The award will be presented on Saturday night, May 20, 2000, as part of the Dayton Hamvention Banquet at the Nuter Center, Dayton OH. Details are available on the Dayton Hamvention website, <http://www.hamvention.org>.

Dr. Shuch is credited with designing the world's first commercial home satellite TV receiver, developed early weather satellite receivers, and holds patents for aircraft radar systems. An Extra-class radio amateur first licensed in 1961, N6TX has been operational in all 20 ham bands between 1.8 MHz and 24 GHz, and is now operating radio telescopes at 1.42 and 14 GHz. Paul has chaired the VHF/UHF Advisory Committee of the American Radio Relay League, and served as Technical Director and Board Chairman of Project OSCAR, Inc., designers of the world's first nongovernment communications satellites. He has served as a Director of the Central States VHF Society, and was Banquet Speaker at the 1996 Dayton Hamvention.

Paul was a college professor for 24 years, and is the author of more than 250 publications. His past honors include the National Space Club's Dr. Robert H. Goddard Scholarship, a Hertz Foundation Fellowship in the Applied Physical Sciences, the Hertz Doctoral Thesis Prize, the Central States VHF Society's John T. Chambers Memorial Award, and a Technical Achievement Award from the American Radio Relay League. Dr. Shuch is a Fellow of the British Interplanetary Society, serves as a fellowship interviewer for the Hertz Foundation, is a manuscript reviewer for several peer reviewed journals, has been an advisor to the National Science Foundation, and is a military program evaluator for the American Council on Education.

SETI scientists seek to determine through microwave and optical measurements whether humankind is alone in the universe. Since Congress terminated NASA's SETI funding in 1993, The SETI League and other scientific groups have been attempting to privatize the research. Experimenters interested in participating in the search for intelligent alien life, or citizens wishing to help support it, should visit us on the Web at <http://www.setileague.org/>, email to join@setileague.org, send a fax to 1 (201) 641-1771, or contact The SETI League, Inc. membership hotline at 1 (800) TAU-SETI. Be sure to provide us with a postal address to which we will mail further information. The SETI League, Inc. is a membership-supported, nonprofit [501(c)(3)], educational and scientific corporation dedicated to the electromagnetic Search for Extra-Terrestrial Intelligence. ❖

Guest Editorial: SETI and a New World Order

by Peter Schenkel (email schenkel@ECNET.ec)
SETI League Regional Coordinator for Ecuador

In her speech at the opening of the 50th IAF Congress in Amsterdam last October, the Dutch Minister of Economic Affairs, Mrs. Jorritsma-Lebbink, said that the task of this congress was not only to consider the question how to take man into space, but "How can we take space to man? Or better still: how can space research contribute towards enhancing the welfare and well-being of mankind - perhaps even more important - how can we use these data and technologies to make planet Earth a healthy and safe place, also for the generations to come."

This was a most appropriate and timely reminder. Science - especially in times of financial bottlenecks - should not be performed only "for science sake," but must bring solid and foreseeable results and benefits for humanity. Costly research, especially in space, needs this for its justification. This is also true for SETI, hampered in the US by Senate obstructionism, but also by its sometimes ill-oriented promotion efforts.

However thrilling the technological wizardry of such SETI projects as Phoenix, BETA, SERENDIP and Argus may be, it is not radio antennas and sophisticated spectrum analyzers that appeal to the public and on whose merit the legitimacy of SETI should be gauged. What will Contact with an advanced extraterrestrial civilization mean to mankind? This is the central question. In what way will Contact, either via radio astronomy, detection of alien probes or habitats in our solar system, near comets and asteroids, or a visit of an alien craft, benefit and spur on our civilization? I posit that Contact with a scientifically and organizationally superior ETI would be a blessing for us in many ways, especially for the following reason:

Due to the presence of only one superpower, the US, the threat of a ghastly global war now seems diminished. But by the middle of the new century there will be five or six superpowers vying for world supremacy, and by then population growth, resource scarcities, development gaps, ecological degradation and political and economic competition will have built up colossal strains and pressures. Already, today, these forces press for the establishment of a unified global order with a strong supranational authority, the only one capable of dealing effectively and justly with our mounting global problems. The only questions is, will this new world order be introduced via peaceful consent, or only after a devastating clash among the future superpowers?

The ETI we are likely to contact will necessarily be endowed with a peaceful global organizational order. It will have done away with war and destabilizing forces eons ago and be benign and friendly toward other intelligences, for ethical considerations and self interest. Contact with such an ETI would therefore be most opportune during the coming critical decades. It would deal a severe blow to all reactionary and aggressive forces, show us that eternal peace, of which Kant dreamt, is not an illusion, and that the creation of a rational and just global order may be within our grasp. Contact would strengthen the cause of a peaceful transition toward a global order and the faith of all people who believe that mankind awaits a great future. It might help stave off a disaster that may face our next generations. What a benefit for mankind! Not a small reason why all SETI efforts are so important, and need your urgent support. ❖

Book Reviews:

Passport to the Cosmos

by John E. Mack; New York: Crown Publishers, 1999
reviewed by Albert A. Harrison, Ph.D.
University of California, Davis (aaharrison@ucdavis.edu)

Psychiatrist John Mack's *Passport to the Cosmos* takes a fresh look at the alien abduction experience. This relatively brief, organized and readable work departs in significant ways from Mack's earlier *Abductions: Human Encounters with Aliens* (Crown, 1994) which was organized around case histories. Although Passport to the Cosmos introduces new case material, most of this built into topical chapters and presented to illustrate and support the author's thesis. The topical organization, the impressive use of cross-cultural material and citations of very recent references are among the features that set this apart from Mack's earlier work.

If we take alien abduction reports at face value, then countless humans have been transported through walls or ceilings to destinations where they are examined and sexually abused (if not impregnated) by humanoids, and shown visions of a calamitous future Earth. Some report repeated abductions and establishing continuing relationships with their abductors. Over time these experiencers gain a new perspective on the cosmos, become more aware and socially concerned, and undergo self-actualization or personal growth.

Many elements in abduction reports hint that abductees have come into contact with advanced beings from other worlds. Yet, as Mack points out, neither the level of physical evidence nor corroborative testimony satisfies scientific criteria. Even if we ignore the efforts of the media to publicize the phenomena and make the assumption that individual abduction reports are independent and convergent, we cannot take them as evidence of life on other worlds, at least not the physical worlds familiar to the astronomers, physicists, and biologists. Yet, to ignore these reports because they are absurd and not supported by material evidence would be a mistake. Such reports may tell us little about life on other worlds, but they do tell us much about our culture and psychology, and about the emerging relationship between humans and the cosmos.

Rather than attempt to establish the "reality" of alien abductions, Mack centers on the powerful nature of the abduction experience. He urges readers to suspend preconception and disbelief, consider the reports in their entirety, and accompany him on a journey to explore common themes. In this book Mack adopts a remarkable cross-cultural perspective which shed much light on diverse and long-standing beliefs in star people. This breaks important new ground and helps him develop a comprehensive framework for organizing and interpreting abduction reports.

Part I offers an introductory overview of the abduction experience, discusses methodological issues, and grapples with the "reality" of such reports. It also includes a chapter on the abduction experience, which suggests to this reader a tremendous gulf between people who undergo this powerful experience (and those who view the experiencers' powerful emotions) and people who only read about it. Part I also includes a brief synopsis of the major cases that appear repeatedly throughout the text. These synopses are a useful orientation to the diversity of people who report experiences and a welcome reference section for readers who are interested in tracking who-said-what.

Part II discusses the increased environmental awareness that often accompanies the experience, and the recurrent and seemingly absurd notion of human-alien breeding. Such topics have been discussed before, but placing these reports within a cross-cultural framework and attempting to evaluate them even-handedly are welcome twists.

Although cross-cultural material is spread throughout the entire book, Part III begins with a focused introduction to the anthropological dimensions of belief in life on other worlds and the relationship between human and nonhuman entities. In this chapter, and in three subsequent chapters that develop case histories, Mack identifies the threads that bind the world views and experiences of "mainstream" and indigenous societies. These chapters remind us of the infinite diversity and complexity of the human personality and the immense amounts that we can learn from different cultures.

Part IV emphasizes the psychological and cultural impact of the abduction experience. Of particular interest is how such stressful, indeed traumatic, experiences are transformed into an increased awareness of the cosmos and personal growth. This reader came away doubting that a mish-mash of simple psychological principles (the distortion of memory, especially under hypnosis; therapist or interviewer expectations; transference; and social support) provide a satisfactory explanation of the overall pattern or Gestalt of abduction reports. Still, mundane and well-known psychological principles probably contribute, and a failure to address this head-on is a weakness in a book by a psychiatrist.

Several authors, including Mack, have noted similarities between near death experiences and alien abduction reports, and an exploration of still other types of experiences may provide further insights. Of particular interest to this reviewer are experiences that cause people to look beyond themselves, develop a heightened appreciation for the cosmos, and in the course of this develop a new sense of purpose and meaning in life. For example, viewing the Earth from afar, some astronauts and cosmonauts undergo transcendent "overview effects," which include a new appreciation of pattern and beauty in the nature, feelings of wonder and awe, and a sense of affinity with something much greater than themselves. Appreciating Earth from afar also increases appreciation for our planet's delicate ecology. Are there still other experiences (scientific insights, religious episodes, traumatic events) that alter world views, expand awareness of the grandeur of nature, and attach new meaning to the Universe? If so, what ties these disparate experiences together and why does it seem that cosmic awareness is increasing at this particular time?

In *Passport to the Cosmos,* Dr. Mack strives valiantly to come to grips with phenomena that do not seem to fall squarely within either the material or spiritual worlds. He follows two separate paths. First, he reviews physical evidence and corroborative testimony, and notes that whereas there is enough of this evidence to maintain the support of believers it is woefully inadequate to convince skeptics. Second, he discusses alternative models of reality. This is likely to meet with mixed reactions.

Some readers are likely to see this material as a "retreat into

metaphysics" brought about by the failure of the "evidence" to withstand the scrutiny of physical scientists, whereas others will see this as a courageous effort to break free of the dominant narrow scientific paradigm. Ultimately, there must be some way to prove, or disprove, new conceptions of reality.

Passport to the Cosmos may not fully satisfy readers who take abduction reports as a sign that extraterrestrials have arrived on Earth, or their polar opposites who attribute all such reports to a combination of ignorance, mental health problems, or fraud. It offers no final answers, but, largely because of its conspicuous attempts to be even handed and the introduction of cross-cultural material it breaks new ground. *Passport to the Cosmos* does not come with a free round-trip ticket to Alpha Centauri, but it does shed some light on how we see ourselves in the universe. All things considered, this reviewer found John Mack's most recent book a credible work on an incredible topic and worth reading.

Contact: Are We Ready For It?

by Peter Schenkel

Minerva Press, London, 1999 (ISBN 0-75410-432-X)

reviewed by Kendrick Frazier, Editor, *Skeptical Inquirer*

We don't normally note fiction in this column, but this new novel about the repercussions of first contact with aliens will appeal to many rationalists and skeptics. Written in a realistic style, reminiscent of novels on the same first-contact theme by scientists Harrison Brown and Carl Sagan, this one focuses not on technology and science, but on the political, social, and ethical problems that might arise on first hearing from aliens. The main characters include the president of the United States and a clearly Saganesque astronomer and SETI expert, and the interactions at the international political level seem especially well handled, not surprising since the author is a political scientist. There is also great understanding of forces of irrationalism, the dynamics of the media, and the interactions of all with the scientific community. ❖

Executive Director H. Paul Shuch confers with Advisory Board member Sir Arthur C. Clarke, during the former's visit to Sri Lanka earlier this year.

Event Horizon

SearchLites' readers are apprised of the following conferences and meetings at which SETI-related information will be presented. League members are invited to check our World Wide Web site (www.setileague.org) under *Event Horizon*, or email to us at info@setileague.org, to obtain further details. Members are also encouraged to send in information about upcoming events of which we may be unaware.

May 19 - 21, 2000: *ARRL National Convention* and *Dayton Hamvention*, Dayton OH.

June 2 - 4, 2000: *ARRL Atlantic Division Convention* and *Rochester Hamfest*, Rochester NY.

June 8 - 10, 2000: 19th Annual Meeting of *the Society for Scientific Exploration* , London Ontario Canada.

July 5 - 9, 2000: *Mensa Annual Gathering*, Philadelphia PA.

July 13, 2000: *International Planetary Society*, Montreal Quebec.

July 16 - 19, 2000: *Society of Amateur Radio Astronomers*, NRAO Green Bank WV.

July 20 - 23, 2000: *Central States VHF Conf.*, Winnipeg Manitoba.

August 7 - 19, 2000: *XXIVth International Astronomical Union General Assembly*, Manchester University, UK.

August 31 - September 4, 2000: *Chicon 2000* World Science Fiction Convention, Chicago IL.

September 9 - 10, 2000: *Second Convention of the European Radio Astronomy Club*, Heppenheim Germany.

September 9 - 10, 2000: *45th Weinheim VHF Convention*, Mannheim Germany.

September 28 - October 1, 2000: *Microwave Update*, Trevose PA**.**

October 2 - 6, 2000: *International Astronautical Congress*, Rio de Janeiro, Brazil.

October 19, 2000: *Searching for Life Among the Stars*, Science North, Sudbury ON Canada.

October 26 - 30, 2000: *18th AMSAT Annual Meeting and Space Symposium*, Portland ME.

January 22 - 24, 2001: *OSETI III*, Third International Conference on Optical SETI, San Jose CA.

March 2 - 4, 2001: *Contact 2001*, Santa Clara, CA.

April 21, 2001: Third annual SETI *League Ham Radio QSO Party*, 14.204 MHz.

April 29, 2001: SETI League *Annual Meeting*, Little Ferry, NJ.

May 18 - 20, 2001: *Dayton Hamvention*, Dayton OH.

May 25 - 28, 2001: *Balticon 35*, Baltimore MD.

August 30 - September 3, 2001: *Millennium Philcon* World Science Fiction Convention, Philadelphia PA.

October, 2001 (date TBA): *Microwave Update*, Arkansas.

May 17 - 19, 2002: *Dayton Hamvention*, Dayton OH.

August, 2002 (proposed): *Bioastronomy '02*, Hamilton Island (Great Barrier Reef), Australia.

October, 2002 (date TBA): *Microwave Update*, Washington DC.

May 16 - 18, 2003: *Dayton Hamvention*, Dayton OH.

October, 2003 (date TBA): *Microwave Update*, Dallas TX.

October, 2004 (date TBA): *Microwave Update*, Seattle WA.

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My Forty Years of SETI

by Philip Morrison

Editor's Note: *This essay, by one of the fathers of modern SETI, was originally written for the SETI@home website. It is used here by the kind permission of Dr. Morrison and SETI@home chief scientist Dan Werthimer.*

Proposing the Microwave Search

My wartime service as neutron combat engineer over, by the mid-fifties I had made my way to high-energy astronomy. After the success of radio astronomy, the notion of opening new channels was appealing. In 1958, I came to see that gamma rays promised another new channel and worked out early predictions. One point was their easy crossing of the entire dusty plane of the Galaxy, unlike starlight yet at light speed. My ingenious friend and Cornell colleague, Giuseppe Cocconi, came to me with a question. "We already make gamma-ray beams. (The electron synchrotron at Cornell was then brand-new.) Why not send them out across space to see if anyone out there can detect them?" It was a surprising question, but most stimulating. My reply was that we should look at the whole spectrum, radio to gamma rays, and choose the best band for such signals.

By mid-1959, we had learned enough to propose microwave radio as the band best suited for listening -- not yet sending -- to any others as finite as ourselves. Cornell's own big radio dish near Arecibo in Puerto Rico would soon be able to detect another dish like itself at interstellar distances if well-aimed and powered, and a counterpart of the transmitter readied for Arecibo would be able to reach well across the Galaxy. Gamma rays were far less mastered, and optical light had to compete with the stars. Arecibo microwaves, with directed beam and sharp-tuned frequency, would far outshine the Sun's diffuse microwaves, and the Galaxy's as well, at 1420 megahertz (21 centimeters), the hydrogen line, best-studied of natural radio emissions.

The Galaxy has changed little in 40 years, but our technology and our insight have changed a lot. Strange but true, among Earth's many radio dishes, Arecibo remains the biggest, and arguably the best to search with. Microwave receivers have improved, but not by orders of magnitude. Interfering artificial signals in microwave are far more numerous now, but experience has shown us ways to mitigate their impact (perhaps one day to listen only from a crater bottom on the unseen side of the moon, shadowed from most interfering signals!).

Searching

To search, you must decide where to point, when to point, and how long to dwell at each chosen direction, what frequencies to cover, how weak a signal to delve for, and of what form? Only a handful of systematic searches have been made, mostly with marginal resources, for a task we are still defining. We are constrained both by the knowable properties of the natural world, and by the intangible choices any putative sender might make. The first of all SETI efforts was carried out in 1960 (independent of our own proposal, but fully compatible with it) at Green Bank, by Frank Drake, a real radio astronomer. He pointed a good-sized dish at a few of the nearest sun-like stars, one by one and found transient interference from unidentified human sources.

Frank Drake

Consider the rough scale of the task. To search a wide patch of sky is possible without a big dish, but it demands incredible power from the transmitter that must light up many directions at once. The Arecibo microwave receiving beam can discriminate several thousand directions in a patch of sky one degree on edge. Forty thousand such patches cover the sky (don't forget the southern sky hemisphere, where we have lately looked for awhile). Would you look at all directions, or choose some special points? So far, it has seemed best to try both: narrow beams one after another to multiple identifiable targets like nearby stars, and a full sky coverage again spot by spot for less sensitive searches. It is not easy to foresee the power our ambitious unknown counterparts might assign for transmissions. Most of Galactic space is far away, of course, and might have rare but powerful senders among so many stars, while close-by stars are few by comparison and do not need rare capabilities.

The physics of the dilute gases adrift between the stars in the Milky Way implies that even the sharpest signals will smear out in frequency rather soon as they travel, perhaps to acquire an enforced width of 0.1 hertz; if that holds, it is not much use to look for still narrower ones. Even if we accept our old naïve recommendation of the 1420 megahertz band, a hundred million dial settings are none too many for a plausible search of that one band. Multiply frequency choices by directions, and a really full search requires a trillion brief periods of listening. Of course, we will consider laser-made signals in the infrared and optical bands -- a modest try is being made now and follow other leads along the entire spectrum.

Only one visit to each possible choice? A sender sweeping the stars to economize on power has to face the fatal chance that his blind choice of time at the right direction and the right frequency has ended any chance of success. The answer is to repeat, repeat, repeat, or burn power steadily. These alternatives have been studied, and plausible choices made (doubtless to be remade) as we learn more.

Multiplicity

SETI@home participants themselves demonstrate the major change in technology since 1960, not new dishes, new receivers, or even new knowledge of stars and their medium. It is the multiplicity of choice implied by the amazing rise in computer power. The early proposals expected a thousand channels at once to be recorded during the search , a good start at shortening the search time. Today we operate rather inexpensive systems that can receive data in one hundred million channels all at once. Nor is the limit clearly at hand. The million and more volunteer CPUs put to use now to help analyze a backlog of recent search data from Arecibo is only a sign of what lies ahead in the next century of signal processing.

Searching in Time

SETI seeks one day to search the space of this Galaxy, a home to a few hundred million suitable suns. An extra-galactic reach opens so many possibilities that an experimenter is daunted, even though his pencil beam covers a large area of stars all at once in a distant galaxy. All of them are millions of

light years away. Any sender way out there has to wait out the round trip as a minimum time for an answer. So much does this transcend our idea of history—our own species is maybe 100,000 years old -- that we find it hard to plan. One brief search was made at Arecibo years ago of the nearest big galaxy, the Andromeda spiral; it brought no signal. How little we understand of what to expect and how to act over such depths of time!

Andromeda Galaxy

But there is a much smaller time delay -- still more than we ordinarily face in experiment design -- when we restrict our search within our own home spiral, the Milky Way. First of all, the nearest 100 stars, most of them faint red dwarf stars much dimmer than the Sun, occupy a sphere about 50 light years across. Before 1960 or so, we had no way to know whether or not every nearby star was actively sending our way. We are less worried now about a crowded dial. Those common fainter stars do not promise much; they seem unlikely to warm a planet steadily and safely, and there are sun-like stars by the billion farther out.

The marvelous 1995 discovery of a planet in orbit around a distant sun-like stable star has shown that planets resembling our own neighbor Jupiter accompany a few percent of all the sun-like stars we have examined near us, out as far as 150 light years or so. We know about three dozen such sun-planet systems, though not yet one earth-like planet, for our present methods are too crude to detect such small rocky planets as Earth even if they are present. We can presently find only the gas giants. That should change within the next decade or so, once we have launched new space-borne instruments able to detect earths -- if they are there.

Looking for Peers

Begin with symmetry, which promises the possibility of life and astronomers resembling ourselves in goal, if not in appearance. To find 100 candidates, we need to examine many planetary systems, even if we make the most optimistic guess that earths – so far not seen near any star but our Sun -- will be found, and not merely the hot Jupiters in tight orbits about their star that now fill our initial lists. An optimist would propose looking among the billion stars up to 1000 light years away, our near galactic neighbors. It follows at once that we should listen for hundreds of years before we need try to send, on the good grounds that we are not likely to be the first astronomers among hundreds of star-warmed earths. Even though we cannot exclude our priority, we cannot claim any evidence for it, save our own single example. It makes sense to listen for a century or two before we enter after consensus on a serious phase of transmission on our own —systematic sending is far more costly than listening. So we say "keep on listening," and improve our efforts, possibly with other signal types, until some day, maybe in the year 2100, the issue of sending might be raised.

But we know this: we did not begin radio astronomy (or lasers or gammas or neutrinos or what you will) on a new planet. Rather, life grew here on Earth for about half the age of the galaxy before we humans even knew that the Sun was a star among the stars. Our single species itself was 500 centuries old before we knew our place in the sky. Reflection has led me to argue that we had to number on the order of a billion thinking human beings before our Earth could become home to such devices as sensitive microwave receivers, longer still for the alternatives. Only a population at such scale can have given rise to the innumerable special discoveries, skills, insights and resources that comprise modern technology: from copper to mathematics, with theory and practice worldwide that underlie all of astronomy and its imaginative dreams. But can that specialization appear if many more people still have not long been growing crops, digging in the mines, voyaging, writing, drawing -- yes, and dreaming. A hunting band, however wise its individuals, is not persuasive as a realistic basis for interstellar signaling, our SETI. A billion humans lived on Earth around 1800 (of course, I mean only that magnitude, not a precise figure). Technology is a social phenomenon spread among billions whose diverse lifework led to what we now can do. IQ does not alone create means for detecting signals from the stars. Intelligence is necessary but it is insufficient. The first firemakers of the caves, the Cro-Magnon flint knappers, the Europeans around Galileo and Newton—admirable discoverers all, but none could make an interstellar search with any chance of success.

A rough estimate of one social, adept, thoughtful species of a billion members implies a few billion years of evolution as far as we now know — true, though from only one example. That tentatively defines the timescale. Without a synchronizing feature we do not notice at all in the Galaxy, we cannot expect a good match to our quite new status, for we have known of radio astronomy for less than one century out of all Earth history. One sees at once that detectable counterparts are likely to be ahead of our level of technology, while the rest of them, still silent and undetectable, are far behind on the human scale of time.

What we see as possible is an ambitious project, old by any human standards, defined by a timescale we do not know, undertaken perhaps intermittently by some curious, effective, but by no means all-powerful, species of billions of beings of our technological kind dwelling somewhere out there among the many, many stars. They too must pay the energy bills and await an answer, perhaps not for the first time. Their presence is a conjecture only. Most likely they reside among the tens of millions of planetary systems which we now expect through a very small, close-by sample of two dozen gaseous planets. A planet near a stable sun is the lowest rung of a ladder of still only conjectural nature that may follow the one case we now know by upward rung after rung to another earth, to life, to evolution, and eventually — perhaps — to sentience, curiosity, and capability. SETI is an audacious but direct search for the top rung of the ancient ladder.

Digging for more evidence, finally the physical signals we hope for, SETI is the task of our time. It will last many years, until we succeed or at least until we accept the other amazingly unlikely case, that we are the very first to attempt distant exchange among the 400 billion stars of the Milky Way. After all, if we are to hear any authentic signal among the stars that functionally resembles what we do, such conjectures must have been true and enacted in reality somewhere out there in earlier times.

Close with a salutation very old among our clever forebears: Good hunting! ❖

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