



SearchLites

Vol. 6 No. 2, Spring 2000

The Quarterly Journal of The SETI League, Inc.

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Seven Reasons for Widening the Search

by Allen Tough (email: AllenTough@aol.com)

SETI has reached an interesting stage. Having relied primarily on a single strategy for 40 years, the field is now actively considering a wider array of promising options. This is a highly appropriate change. There are at least seven reasons why it is appropriate for the SETI field to widen the array of search strategies that it encourages and supports.

First, the history of scientific discoveries teaches us the value of widening the array of research methods. It is quite common for a breakthrough to result from a new, fresh, unorthodox strategy or research method.

Second, the SETI field is trying to detect something that is totally unknown and presumably deeply alien. We have no idea of the origins, history, thought patterns, emotions, ethics, core values, purposes, technological capacities, or other major characteristics of extraterrestrial intelligence. It is likely that ETI will turn out to be surprisingly different from what we expected -- deeply alien, puzzling, unlike anything we have ever encountered before. It has, after all, likely advanced to a level of knowledge and technology that is thousands or millions of years beyond our current human level. Faced with such a profound unknown, an attitude of humility seems appropriate. The pursuit of a somewhat diverse array of search strategies seems wiser than keeping the methodology too narrow.

Third, we must remember the likelihood that more than one extraterrestrial civilization is available to be detected. It is all too easy to think only about the first detection, ignoring the likelihood of multiple detections over time. If several civilizations exist in our galaxy, as most SETI scientists hypothesize, then we may detect several of them during the next millennium. For example, we may detect an artificial radio signal and an encyclopedic laser message and a large probe parked in the asteroid belt and a tiny probe near the Earth's surface.

Fourth, widening the assumptions and strategies of the SETI field may reinvigorate the people, conferences, and writing in the field. Fresh ideas and bold conceptualization, some attention to long-term visions, and a wider variety in conference papers can retain the field's intellectual excitement and avoid a feeling of boredom, fatigue, and disappointment.

Fifth, science and technology have changed greatly in the 40 years since the SETI field chose radio telescopes as its key strategy. That was a logical choice 40 years ago. Radio telescopes were just becoming popular among astronomers, two eminent scientists wrote a paper urging their use for SETI, and a distinguished engineer wrote a paper claiming that interstellar propulsion is impossibly slow and expensive. But our scientific and engineering knowledge today is dramatically different from what it was 40 years ago. Today's decisions about appropriate strategies should be based on the science and technology that we can confidently anticipate today. Today's choices have to take into account our recent advances in such fields as computer science, artificial intelligence, robotics, surveillance methods, molecular manufacturing (nanotechnology), propulsion, space exploration, lasers, and fiber optics.

Sixth, although the SETI field is 40 years old, it has not yet produced any confirmed evidence of ETI. That fact points up the need to expand the array of search strategies. Fortunately, several fairly new and highly promising strategies are readily available.

Seventh, there is no need to let the reputation of the UFO field frighten us into unduly restricting our own strategies. All of us in the SETI field worry about being confused with the UFO field. We encounter this confusion in our classrooms, at the faculty club, at social gatherings, in legislatures, and in donors' offices. But there is no need to let our fear and anger lure us into poor decisions about our own scientific strategies. If our sober assessment concludes that smart probes could have readily reached our solar system, for instance, then we should have the courage to search for them. To reduce confusion, we should frequently point out that our scientific approach differs from the UFO field in three key ways: (a) we are deeply committed to skepticism, verification, peer review, and the scientific method; (b) we build in strict safeguards against hoaxes, self-delusion, and erroneous data; and (c) we adopt protocols to avoid premature and immodest claims.

All in all, a reasonably wide array of search strategies seems likelier to lead to success than reliance on just one or two. The phenomenon we are trying to detect is so unknown, so old, so advanced, that we cannot be sure which of our strategies is most likely to succeed. Faced with this situation, we should proceed vigorously with all promising strategies in order to enhance our chances of achieving contact. ♦

Introducing:
Our Volunteer Coordinator for Malaysia
email: Storr@pc.jaring.my

Yusrizam Bin Sharifuddin was born in mid-December 1980 in Kuala Lumpur. He grew up normally in various places in Malaysia because his father is a businessman and his mother a full-time housewife. He loves reading so much that he could not play football well and treasured doctors' letters to his P.E. teachers. His interests range from history to math, from politics to sciences and from Star Wars to Contact.

Yusrizam discovered science fiction at the age of 10 and bought his first microscope and telescope at 13. In school, he served as Deputy Head of Prefects, school Librarian for five consecutive years, a member of his School Disciplinary Board, President of the English Language Society, Science Club committee member, Secretary and then President of PSAMMA (Mahmud Mat SpaceScience Society), a PRS (Junior Counselor appointed by the school), and as English Language SMART Tester.

He was accepted as a member of Malaysian Mensa at the age of 16, Intertel a year later, and now is an ISPE (International Society of Philosophical Inquiry) associate. He joined The SETI League in early February of 1999 and keeps blaming the Internet for not informing him and others suspected in this conspiracy for keeping him away from the League.

Now a student of Biological Sciences Matriculation, University of Malaya, after being offered a semester of study earlier at the Pahang Professionals Development Institute (IKIP) while his colleagues were enjoying their seven months holiday, Yusrizam is a bigger and better reading machine determined to be a medical doctor and to be among the first to discover ET. In just a few months he has learned new and exciting things (thanks to *SearchLites* and his fellow VolCors) and plans to introduce SETI League to Malaysians. One day he will build his own Project Argus station to scan for signals or have a chat with Lord Darth Vader personally. ❖

Our Volunteer Coordinator for Southwest US
email: rjfear@adaptv.com

Robert J. (R.J.) Fear was born in Marion Indiana in 1959. His mother (now living in Maryland) spent many years working in data processing and his late father began a life-long career with AT&T at the age of 20.

After taking all of the math and science he could get his hands on, R.J. began attending technical school concurrently in his junior year of high school. At the same time he began working as a systems engineer and a musician.

Upon graduation from high school and technical school (the equivalent of an Associate Degree in Electrical Engineering) R.J. interrupted his love of Electrical Engineering to take a position as a professional musician (union card included). Life as a musician lasted for two years and ended with the realization that artists truly do starve. It wasn't long before he traded his trombone and flute for a soldering iron and DVM and returned to the engineering world.

R.J. is a member of the Society of Amateur Radio Astronomers, is an active participant in The SETI League's Project Argus, and is a contributing author to the RAOOS (Radio As-

tronomy Observatory Operating System) program. He maintains and operates a multipurpose Radio Telescope at 1.4, 10, 23, and 33GHz.

R.J.'s current goals are to obtain a software and/or hardware engineering position at a large Radio Astronomy facility and to do big science. With sights set on the MMA Project of the NRAO, R.J. begins down the long road of career change.

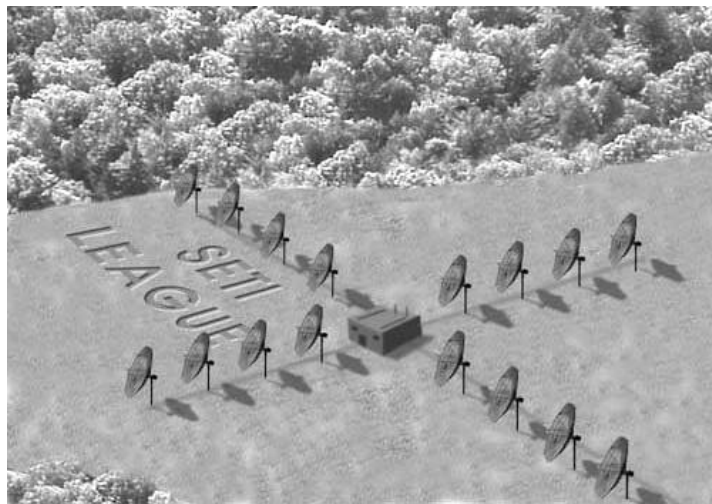


SETI League Plans Next-Generation Telescope

The SETI League, Inc., nonprofit leaders in a grass-roots Search for Extra-Terrestrial Intelligence, has begun the design of *Array2k*, a new kind of radio telescope which will be taking shape over the next few years at a remote Northern New Jersey location. The name refers not to the new year, but rather to the instrument's more than 2000 square feet of collecting area. This is equivalent to a single dish antenna over 50 feet in diameter, but at about a tenth the cost.

The *Array2k* design combines sixteen standard satellite TV antennas into a single, powerful radio telescope. The SETI League pioneered the use of backyard satellite TV dishes for SETI research four years ago with the launch of its *Project Argus* all-sky survey. The concept has been embraced by other scientific organizations, including the prestigious SETI Institute in California, which last year announced its considerably more ambitious 1HT (One Hectare Telescope) project to combine 500 such dishes into a grand SETI array.

The SETI League's more modest design will support the individual efforts of its 1100 members worldwide as a follow-up detection device to help confirm their observations. It will also be used for direct astronomical research, and serve as a test-bed for SETI League engineers to develop the technologies which will someday allow them to unite thousands of members' small, backyard telescopes into a huge, planetary array. ❖



Proposed Array2k Configuration
Artist's Conception by Jon Lomberg

Hardly a Waste of Time

by Philip J. Hughes (email pjhughes@islandnet.com)

Many years ago, as a student at university, a math professor told me that I "lacked focus" (to use a current rubric; back then, I think it was ambition that I lacked). Having been wandering about for some years, I was classified as a mature student. (My mother could not understand this. She knew better.) I was sent to a very pretty, young counselor to get my worldview straightened up. When she asked what I was interested in, I replied that there were many things that interested me, but none to the exclusion of the others.

Before he died, my father took me to science-fiction movies, which I think he enjoyed. And he showed me the stars, so I became interested in astronomy. He had been a prospector in his youth, so I became interested in geology too. At some point I learned about Darwin and became interested in biology. By 1955, I was corresponding with Wernher von Braun and dreaming (night and day) with visions derived largely from Chesley Bonestell's paintings. Then, as time passed, I was attracted to questions involving foundations and the history and philosophy of science. It was only much later that I came to terms with myth and religion. I did not know then that the path I was following was just that: a path, a way followed by others. I was an only child, and there were none then with whom I could share the experience.

The first books about SETI that I recall began appearing in the early 'sixties: Sullivan, a collection of reprints edited by A. G. W. Cameron, and, by the time I was in university, the book by Sagan & Shklovskii. The dean of science at my university suggested that I read a little book by Loren Eisely, and I found a kindred spirit. But by the time I saw the counselor, my interests were broadening -- not, alas, deepening.

As we talked, the counselor took notes, and after we had finished, she looked them over. Then, after a few moments, she exclaimed: "Oh! I see what you are interested in!"

"Eh?" I replied. This is a uniquely Canadian expression. It can mean just about anything.

"You are interested in Time!" she said. "And Story!" she added, smiling brightly. And then she carefully explained how all my interests were centered about the narrative history of the world and my place in it.

To this day, I don't know if she was unusually perceptive, or if I just read something into what she said. (Maybe I should have asked her out. Maybe we could have gotten married. Instead, I married a fellow student, a mathematician.) Perhaps she simply provided a trigger for a coalescence of ideas that would have happened anyway. In any event, from then on my interests no longer seemed so unrelated.

That was thirty years ago. I was never able to make a career out of my "interests." I became a meteorological technician. But how does a man define himself? By his job? My job -- my "career," if you like -- served only to support my family. I was reasonably good at it, but it was in a sense incidental. It was for my interests (and, of course, my family) that I lived. At least the job took us to some interesting places: the Canadian Arctic, the middle of the Aleutian Gulf, and finally the West Coast. And it provided the solitude to pursue my "hobby" and the money to buy books, both for me and my wife. What it did not provide, and what I now know is essential, is a means of discourse with others.

At least I have managed to survive Flying Saucers, Positivism, Elvis, Creationism, National Destiny, and all the other ideological

diseases (I like to call them oncomemes, but that is a conceit) that plague wayfarers in the world of ideas. (I think that it was Chesterton who observed that when we give up believing in something, we end up believing in anything and everything.) When others asked me what I did, I learned to answer: "Weatherman." And when they asked me what I was interested in, what my "hobby" was, I would usually say "Astronomy." It has never occurred to me to say "SETI," any more than I might answer "Evolution" or "Time." Or "The Meaning of Life."

But I'm not really an amateur astronomer. I do have a telescope, but I don't do serious observing any more than I do serious number-crunching or serious programming. I guess I could describe myself as an armchair astronomer. Again, "SETI hobbyist" doesn't really come to mind, and I wince at being called a dilettante -- too close to home, I guess.

I'm retired now. That is, I have retired from my job; I still have my "hobby." We live on a small island with dark night skies, so I spend more time stargazing than in the past. And I have my books. And this ridiculous computer with which I have wasted far more time than I might ever have done on my old job. (Which, of course, was not a waste at all, since it provided money.) I suppose that I have learned a little more about the "universe story" and the "Grand Analogy." But, once again, productive learning needs discourse; my wife and I share many intellectual interests, but that isn't enough. This surely is part of the reason why cranks become cranks: they are removed from a community of discourse. And I know nothing as to how the orbit of the self's journey intersects the larger narrative of the world in which it is embedded.

The self, at least, perceives other selves. We have a sense of "Otherness" -- I don't mean God, just the observation that there are other folks more-or-less like us, other humans: a community of people with something in common, something that invariably issues from their history. Similarly, we can talk about other communities, other cultures, and even other species. But the farther we get from the self, the more "otherly" the Other becomes. We can talk about the worldview of scientists, Kalahari Bushmen, and accountants. But what about the worldview of dolphins? And, if we view the evolving autogenic imagery of the human mind as a species trait, with what shall we compare it? There are no "others." Not on Earth. Selves and cultures and species are unique, but there are others somehow like them. And what of the larger community of discourse that comprises human knowledge and values? Unquestionably, it is unique. But how unique? And are there precedents?

Perhaps that is why I am interested in SETI. All of what we have learned or can learn has a bearing on that question, "Are we alone?" And not science alone. Art, myth, religion, philosophy, all are relevant and somehow subsumed by Fermi's Paradox. But, here as elsewhere, I suspect that it is the question that is important, not the answer.

Heck of a hobby, eh? Well, I don't really think of SETI as a hobby, any more (or less) than astronomy is. I run SETI@home on a couple of computers, but that requires no effort and I doubt that anything will come of it. (But it is, after all, empirical, and I think that that is important.) I don't have any equipment for actually "listening." An Argus station would be nice. I could put a big dish up on the roof, and process the signal with a Linux box, and get a pair of headphones to listen to the hiss...

But, no. The mathematician would never go for it. She is a gardener now, and a giant antenna looming over her lovely garden would not be welcome.

Even so, it's hardly been a waste of time. ❖

Guest Editorial:

Should SETI Probe for Probes?

by Scot Stride (email ssstride@jpl.nasa.gov)

The radio SETI experiment as we know it today emerged because the technology, engineering expertise, and scientific tools became available to carry out the search. In the emerging variety of possible search strategies for ETI it makes sense to survey the scientific instruments at hand and determine how we can apply them. Optical SETI (OSETI) is an example of a strategy that has taken advantage of emergent technologies (for example, CCD detectors, DSP chips, optical analysis software, etc.), and devised a practical means of applying them in its search for optical transmissions from ETI. Because of its insistence on following scientific methods and adherence to acceptable engineering practices, OSETI has become a scientifically permissible, and welcome new strategy; the debate about its value is settled.

Debate continues within the SETI community about the merit of searching for extraterrestrial interstellar probes. The value of the search has been downplayed primarily because of arguments surrounding the cost and speed of interstellar travel, the economy of sending photons over baryons and, to a lesser degree, the Fermi paradox, which enjoys popularity as long as you don't broaden your search horizon. Since we don't know the limits of technology within the universe, it is presumptive to believe that in all cases photons are preferred over baryons. We are too young to know which is really better! As our technology matures, maybe we'll find out in the next century or so. Logically, a civilization just 2,000 years or more technologically experienced than us has determined which is better and is using the preferable technology in their exploration of the cosmos. It is very likely that autonomous intelligent probes are the tool of choice in interstellar exploration and contact. We cannot deny that Earth is a fascinating and lively place, and, if we have found it worthy of direct study, so would advanced ETI if they had the means. The arguments in favor of interstellar exploratory probes are not new, but are worthy of reconsideration based upon our own rapidly expanding exploration of the solar system using robotic spacecraft. Robert Freitas elaborates the probabilities of interstellar exploration by advanced civilizations quite convincingly in his writings, as do other respected researchers like Ronald Bracewell, Allen Tough, Bruce Cornet, and the late Chris Boyce.

If the arguments favoring a search for visiting interstellar probes are sensible, is there any overpowering reason why we should not be searching for them now? Is it too expensive? Are there no proper scientific instruments to search with? Is the scientific community staunchly opposed? Will governmental/political elite interfere? Is the public not interested? Actually, the answers to these questions is no; there is nothing really significant standing in the way of carrying out a first-rate scientific search for ETI probes. Affordable instrument technologies and expertise exist enabling the organization of a professionally staffed research project with the goal of determining if there are ETI probes surveying our solar system or planet. Indeed, it will take time and effort to build testable hypotheses, to write post-detection protocols, to justify where to methodically look, and the design, engineering, construction and deployment of

autonomous computer-controlled observational platforms to detect and collect a wide range of data. It will also take time to statistically analyze the data collected to determine if ETI has been detected.

A strategy to search for ET visitation (SETV) by robotic probes serves to complement the existing SETI efforts. Radio SETI is but one valued tool in the search for ETI and a strategy like SETV does not reject or invalidate radio SETI. It adds bandwidth by focusing on near-Earth or solar system targets rather than on distant stars. Adding new types of instruments and methods to the search will not make the traditional method of radio SETI obsolete. If those in SETI are truly interested in detecting ETI, should it matter by what scientific method? No! In fact, OSETI and SETV efforts better the odds of SETI being successful. Adding new strategies to the SETI observational experiment is analogous to becoming multilingual and international rather than monolingual and provincial.

The SETI community must grant its support to serious efforts to search for ETI probes, like SETV, and not only because the observational tools and talent exist to carry out an effective search. If probes are the exploratory device of choice among advanced extraterrestrial civilizations, then proving the existence of just one would at least answer the question "Are we Alone?" ❖

Event Horizon

- * = SETI League participation confirmed
- * **March 3 - 5, 2000:** *Contact 2000*, Santa Clara, CA.
- * **March 11, 2000:** *SETI League Canadian Regional Meeting*, Toronto, Ontario Canada.
- * **March 26, 2000:** *SETI League Annual Meeting*, Little Ferry NJ.
- * **March 31 - April 2, 2000:** *I-Con*, Long Island NY.
- April 9, 2000:** *Astronomy Day*, Hudson River Museum, Yonkers NY.
- * **April 21, 2000:** *SETI League Ham Radio QSO Party*, 14.204 MHz.
- April 14 - 15, 2000:** *Southeastern VHF Conference*, Marietta GA.
- * **April 21 - 23, 2000:** *Balticon 34*, Baltimore MD.
- * **May 6 - 7, 2000:** *Trenton Computer Fest*, Trenton NJ.
- May 12 - 14, 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 Canada.
- * **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*, Treve PA.
- * **October 2 - 6, 2000:** *International Astronautical Congress*, Rio de Janeiro, Brazil.
- * **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. ❖

Software Page

Using the GoldWave Shareware Program for Collection, Storage, and Analysis of SETI Data

by Robert A Lodder (email Lodder@pop.uky.edu)

Often the biggest problem for a SETI station is storage and analysis of data. GoldWave is a shareware program that can help, and you can try it before you buy it. GoldWave is a digital audio editor for Windows. It is usually used by people who need to work with audio for CD editing, Java applications, Web pages, games, radio and TV, etc.

GoldWave features real-time amplitude, spectrum, and spectrogram oscilloscopes, large file editing (up to 1GB in size), configurable RAM (fast) or hard disk (large) editing, numerous effects, and support for many sound formats. GoldWave can open and play .au files found in Java applications and on Web pages. It can convert to and from many sound formats including .wav, .voc, .mp3, .au, and binary and text data. The current shareware versions are GoldWave v4.02 for Windows 95/98/NT, v3.03 for Windows 3.1, and v2.14 for Windows 3.1 for old systems (a 275k zip file). The shareware cost is \$55 Canadian (about US \$40 or less) and can be paid online via a secure server at <http://www.goldwave.com/>.

The WAV file compression routines in GoldWave are excellent, requiring only 3.51 Mb of disk space for one hour of typical SETI data using WAV MSN Audio 8 kHz mono 8200 baud compression (more compression than MP3!). The MSN audio mono 8 kHz 8200 baud compressor, while not as efficient at compression as the Lernout and Hauspie CELP 4.8Kbit/sec 8000 Hz 16-bit compressor (which uses 2.06 MB of disk space per hour of SETI data), nevertheless preserves the ability to detect the smallest signal in our initial test set (a signal level at 1% of the noise) (see Figure 1). The 30-minute initial test file was constructed by digitizing noise from a microwave receiver and adjusting the gain so that the noise level peaked occasionally at full-scale on the A/D. A test signal (at 1275.1 Hz) was digitally mixed at seven different levels (100, 50, 25, 12, 6, 3, and 1% of full scale in the time domain) into the noise. Each signal was mixed into the file for one minute, starting after five minutes of noise and continuing for seven additional minutes in the noise, after which the file was filled with noise alone.

The Lernout and Hauspie CELP compressor obliterated the 1% signal (see Figure 2) preserved by the MSN compression. In addition, the Lernout and Hauspie CELP compressor introduces other significant distortions into the 4 kHz wide signal, such as forcing the noise intensity to zero at the low frequency end of the spectrum.

Perhaps more important, it appears that at least some pattern recognition algorithms can be applied directly to the MSN WAV-compressed data to detect unusual signals. The two most significant advantages to such a procedure for analysis of SETI data are reduced disk space and memory requirements, and increased speed of analysis. One hour of SETI data can require 60 to 70 MB of storage space when

using 4 kHz bandwidth, 8 bit data. The MSN-compressed format requires only 3.5 MB for the same hour of data. Because the data array can be made a factor of 20 smaller, the analysis can be made a factor of 20 faster (at least when the same pattern recognition algorithms can be used on compressed and uncompressed data).

Figure 1:

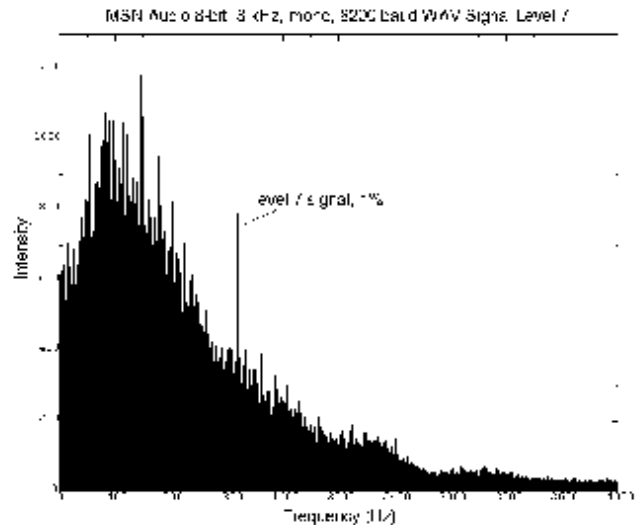
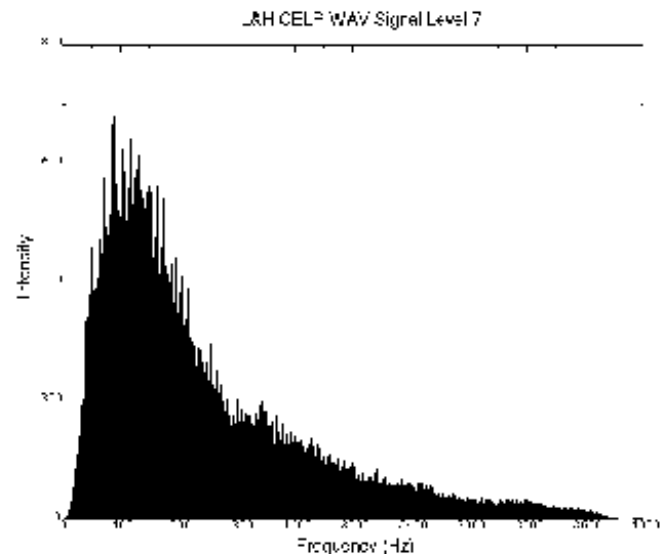


Figure 2:



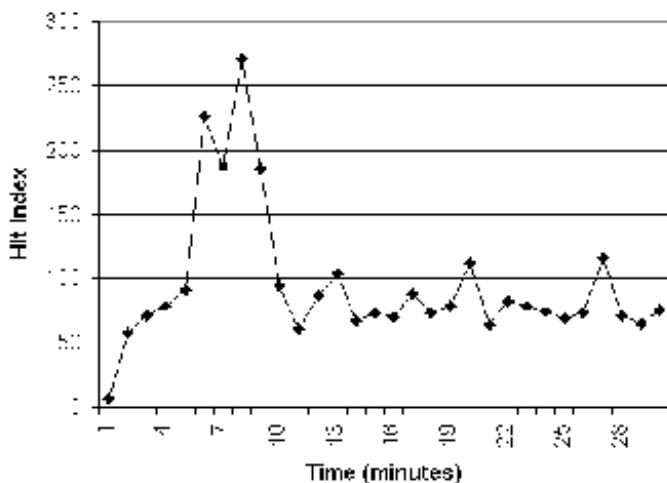
Fortunately, at least one nonparametric subcluster detection algorithm (R. A. Lodder and G. M. Hieftje, "Detection of Subpopulations in Near-Infrared Reflectance Analysis," *Appl. Spectrosc.*, 1988, 42, 1500-1512) appears to be usable on both compressed and uncompressed data.

The subcluster detection algorithm referenced above was applied to the 30-minute test file containing seven different signal levels, and produced the graph in Figure 3. The graph

assumes the position of each byte in the file is proportional to the elapsed time in the recorded data. The algorithm was apparently able to detect the unusual patterns of at least four signals without any knowledge of the MSN WAV file format or header structures. It should be noted that analysis of the uncompressed data reveals all seven test signals. The result of pattern recognition testing on the compressed data suggests that a better understanding of the MSN WAV compression algorithm will increase the effectiveness of automated detection of unusual signals on such compressed data. Nevertheless, subcluster detection can already be used as a tool to flag data blocks that should be decompressed for more thorough analysis. Further testing on compressed files is now underway.

Figure 3:

Computer SETI Test File - Intercept



Analysis and storage of radio telescope data can be a major problem for Project Argus SETI stations. GoldWave is a shareware program with compression algorithms that can help with data collection, analysis and storage, and you can try it before you buy it. At the University of Kentucky, many students use GoldWave to screen radio telescope data on our server at <http://hendrix.pharm.uky.edu/seti/volunteers.html> and seldom experience any problems despite use on all kinds of computers. New users should set temporary storage to RAM if possible in the Options / File menu as this speeds the slowest functions. It is also better to use the GoldWave clipboard instead of the Windows clipboard for large file manipulations. GoldWave displays both time domain and frequency domain signals simultaneously in different windows. Users can toggle through different display formats by clicking on the displays. At about US \$40, GoldWave offers a lot of useful functionality to SETI stations. ❖

Book Review:

Are We Alone? Philosophical Implications of the Discovery of Extraterrestrial Life

By Paul Davies (1995)

reviewed by Alex Antonites

In this book, Davies argues that SETI is challenging a long-standing view that the universe is dying -- a view influenced by the degenerative effects generated by the second law of thermodynamics.

In the chapter *A Brief History of SETI*, Davies pays attention not only to contemporary SETI projects like that of the Planetary Society, the SETI Institute and others, but shows that among the Greek and Roman philosophers we already had the first rational attempts to justify the existence of ETI. His discussion of the Roman philosopher Lucretius and the Greek atomist philosopher Epicurus in this respect, is quite well done. When he comes to the 20th Century he concludes that it is especially the post war spurt of technology and science which rekindled interest in SETI, after the first part of the 20th Century when ETI was found mostly in fictional literature. He singles out the advances in the understanding of the chemical basis of life, the discovery of the structure of DNA, and the subsequent cracking of the genetic code.

The origin of life became a serious subject of scientific inquiry and so, by implication, did SETI. Given the right conditions and appropriate chemicals, life could emerge not only spontaneously on Earth, but other planets as well. After referring to Frank Drake's Project Ozma and others, Davies emphasizes that the discovery of even a single example of extraterrestrial life would be immensely significant to the theory that life is an inevitable consequence of the outworking of the laws of chemistry and physics, given the right conditions. Such a discovery could be life in extraterrestrial rocks: "Undoubtedly the definite discovery of say, a non-contaminant living bacterium inside a meteorite would be immensely exciting and important."

Just after the publication of this book in 1995, Goldin and McKay of NASA and Stanford University announced their findings on rock ALH84001 from Mars! Debate on possible contamination continues to this day.

When one reads this book and compares it to others written on extraterrestrial life, I think what makes this book so much more interesting is that it justifies SETI from a new scientific paradigm, and that is chaos/complexity theory. This appears in almost all chapters of this book. Coherent with this, Davies philosophically criticizes classical-causal determinism which led to a mechanist paradigm in science.

Here the reader must not deduce that Davies rejects the principle of causality in science -- far from it. What he states is that the causal principle (which -- in my view -- is the basic mechanism of natural selection) is incomplete. It is to be completed by the principles of spontaneous self-organization. This rather supports a progressive self-organizing universe (not a dying one) celebrated in the works of the Nobel Prize winner Ilya Prigogine and Ernst Janisch. This makes it understandable why Davies has a much more optimistic approach to SETI than, e.g., Dawkins and Gould.

One can discern this line of his thinking in the chapter *Extraterrestrial Microbes*. Here Davies discusses three philosophical positions concerning the origin of life:

1. Miracles. He explains why he rejects this.
2. Improbable accident, which he also rejects.
3. Inevitable outcome of the working of laws of physics and chemistry, which he supports in conjunction with chaos/complexity theory.

The third position is what most SETI scientists support and this, in turn, depends on three philosophical pillars:

- a) Principle of the uniformity of nature: Laws throughout the universe are the same.
- b) Principle of plenitude: that which is possible in nature tends to become realized (this has already been invoked by Lucretius in his argument for other inhabited worlds!).
- c) The Copernican principle of mediocrity: The Earth is not special in position or status in the universe; it rather is a typical planet around a typical sun in a typical galaxy.

If life was to be the outcome of a complete random accident of infinitesimal probabilities as Position #1 maintains, then it is almost certain that there is no other life within our horizon. As opposed to this, Davies then joins with Carl Sagan and Stuart Kaufmann. Sagan defends the thesis of the abundance of life in the universe; Kaufmann works out the thesis of self-organization, which Davies then argues will support the widespread occurrence of life in the universe.

Life is much more probable than the simple solutions of random molecular shifts would indicate. Matter evolves naturally along certain pathways of evolution leading to states of ever greater complexity:

"When complexity crosses a certain threshold, a system may said to be living. There are many ways that chemical (and maybe nonchemical) processes can self-organize to the point at which life emerges, so we should not expect extraterrestrial life to resemble our own in its basic chemistry. If this so, it is likely that life can evolve in a wide range of environments. There is no need, for example, to demand liquid water or carbon."

Thus, Davies is not what Carl Sagan called himself: a *carbon chauvinist*.

In *Alien Message*, Davies explores the consequences of the detection of an alien signal. Like Carl Sagan, Davies is also interested in the relationship between science and religion/theology. There are no conclusive theological reasons against SETI, and a signal would support the view that humans are not the pinnacle of evolutionary advance in the universe. Such a detection would discredit the hypothesis that life is the result of a highly improbable random accident.

In *Against Aliens*, Davies examines the arguments of certain philosophers and other scientists against SETI. They are these three:

1. the anthropic principle.
2. Fermi's 'where are they?'
3. the Neo-Darwinian argument of contingency.

He argues in order to demolish all three.

Brandon Carter and Frank Tipler's arguments depend on the formation of life as an exceedingly improbable event. In this respect, Davies refers to the lively correspondence between Carl Sagan and Tipler. The Neo-Darwinist contingency argument assumes with many biologists that the course of evolution does not follow any law-like trend, but is purely random -- indeed a blind watchmaker, a thesis defended by Richard Dawkins and Stephen Jay Gould. Intelligence is a purely chance phenomenon, exceedingly unlikely to arise elsewhere independently. The contingency thesis strongly depends upon certain philosophical presuppositions.

I think what Davies is trying to say here is that both Dawkins and Gould are overreacting against the Argument by Design. Of course, design cannot be a scientific principle, but, saying that, it does not follow that there is nothing progressive in evolution, that everything is pure chance -- even if interpreting it as accumulation as Dawkins does. Over against Dawkins, Gould and, in a sense, also Tipler and Carter, Davies enlarges causality with self-organization and spontaneous origins of life and order. The key property of self-organization lies at the edge of chaos, where systems can suddenly and spontaneously create organized complexity with surprising efficiency. Davies thus rejects both explanation by miracles and stupendously improbable molecular accidents. Self-organization can do the trick!

"None of this is to say that Darwin is wrong: merely incomplete. Nor does it claim that evolution is directed towards some preordained goal." Contingency for Davies does indeed play a large part in the details of evolution. But the same general trend that can lead to the emergence of life and mind on Earth, can also take place elsewhere in the universe. Evolution is surely not haphazard, accidental, but biological convergence (for example, the eye) and physical - chemical laws play a large ordering role.

In *The Nature of Consciousness*, Davies points out that we humans are made of star stuff. He then defends what can be called a Platonic grounding of mathematics. Like Marvin Minsky (of MIT), although not with exactly the same arguments, Davies by implication (Minsky is more explicit and direct on this) explains why an extraterrestrial would do, basically, the same mathematics as we. It has to do with an underlying order in the universe -- a cosmic connection, as he calls it. The ability to do mathematics is not a mere accidental, trivial detail.

In *Alien Contact and Religious Experience*, Davies pays attention to the UFO phenomenon. He states that observers of UFO's are mostly genuine honest people of integrity. However, he sees this as a deep-seated religious need behind the experiences, which he thinks are subjective and not objective. It is a modern variant of a complex of experiences that infuse the folk memories of all cultures, through many ages.

I think this book is highly recommendable, especially for members of The SETI League. It will most surely stimulate further discussion, thinking and rethinking. Some chapters are better than others. (I think he could have made much more on the implications in the event of the detection of an extraterrestrial signal -- this would give his kicking off with the Greek philosophers a good roundoff.) In the main, a well-argued book -- from a philosophical perspective. ♦

SearchLites, Volume 6, Number 2, Spring 2000. *SearchLites*, ISSN 1096-5599, is the Quarterly Newsletter of **The SETI League, Inc.**, a membership-supported, nonprofit [501(c)(3)], educational and scientific corporation, dedicated to the electromagnetic Search for Extra-Terrestrial Intelligence. Entire contents copyright © 2000 by The SETI League, Inc. Permission is hereby granted for reproduction in whole or in part, provided credit is given. All opinions expressed are those of the individual contributors.

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