SearchLites

Vol. 18 No. 4, Autumn 2012

The Quarterly Newsletter of The SETI League, Inc.

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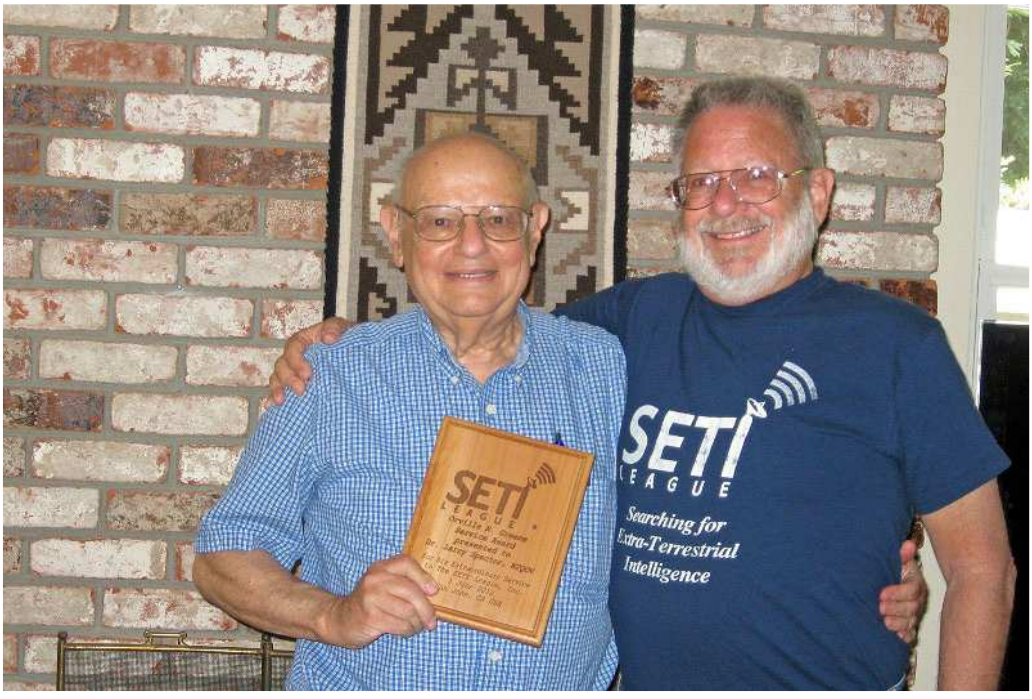
SETI League Announces Annual Service Award

Dr. Clarence Spector is not, and has never been, a member of the nonprofit SETI League. He is neither a major donor nor a researcher involved in the Search for Extraterrestrial Intelligence. Nevertheless, Larry Spector is indirectly responsible for the membership-supported science group's very existence. While visiting Spector in his San Jose home in June, Prof. H. Paul Shuch, the group's executive director emeritus, presented him with its Orville Greeene Service Award for extraordinary (though in this case, totally unwitting) contributions to The SETI League, Inc.,

A quarter century ago Spector, then a senior scientist at the IBM Almaden research facility, chanced to introduce two longtime friends who shared several of his interests. Richard Factor and H. Paul Shuch were, like Spector, lifelong ham radio enthusiasts, pilots, and electronics technologists. That introduction proved to be (in the immortal words of Rick Blaine at the end of *Casablanca*) the beginning of a beautiful friendship. In 1994 Factor, a New Jersey industrialist, went on to found The SETI League, hoping to privatize research once conducted by NASA under public funding. He tapped Dr. Shuch, then a respected academic, to head the organization. The two have worked closely together ever since, without ever forgetting that it was Spector who brought them together.

The SETI League's annual service award honors the memory of New York City patent attorney Orville N. Greene, who passed away in 1997. As an enthusiast in the search for extraterrestrial intelligence, and to fulfill his dream of the time when we will achieve contact, it was Orville, with his extremely generous donations to The SETI League, who helped give it its start. To ensure its future, he has also generously and substantially provided ongoing support to meet its financial needs. Through the time, energy, and efforts of SETI League members around the world, we are coming ever closer to confirming Orville's dream that "We are not alone."



Guest Editorial:

Rethinking SETI's Targets

by Paul Gilster
from the *Centauri Dreams* website, used by permission

Have you ever given any thought to intergalactic SETI? On the face of it, the idea seems absurd - we have been doing SETI in one form or another since the days of Project Ozma and without result. If we can't pick up radio signals from nearby stars that tell us of extraterrestrial civilizations, how could we expect to do so at distances like M31's 2.573 million light years, not to mention even the closest galaxies beyond? Herein lies a tale, for what intergalactic SETI exposes us to is the baldness of our assumptions about the overall SETI attempt, that it is most likely to succeed using radio wavelengths, and that it may open up two-way communications with extraterrestrials. It's the nature of these assumptions that we need to explore today.

The Visibility of a Galactic Culture

Let's suppose, for example, that Nikolai Kardashev's thoughts about types of civilizations are compelling enough to put to the test. A Kardashev Type III civilization is one that is able to exploit the energy resources not just of its home star but of its entire galaxy. So unimaginably beyond our present capabilities is a Kardashev Type III that we scarcely know how to describe it, but it is within the realm of reason that signs of astro-engineering on this scale might be detectable in at least nearby galaxies if such a civilization had gone to work on them. And indeed, James Annis has made such a study, concluding that neither our Milky Way nor M31 or M33, our two large, neighboring galaxies, has been transformed by the work of a Type III civilization.

It should hardly be necessary to point out how preliminary such results are, and how rare such studies have been. What's striking about Annis (and related work by Richard Carrigan and P.S. Wesson) is that these scientists are pursuing ideas that are well outside the SETI mainstream. There is a new paradigm here, one that operates without any notion of 'contact' and subsequent exchange of ideas between civilizations. It is a search for artifacts, for artificial structure and signs of engineering. It is all about discovery. And just as we can have no two-way conversation with Mycenaean Greece as we dig for information about the era of Agammemnon, we may with this stellar archaeology discover something just as unreachable but likewise well worth the study.

Toward a Dysonian SETI

In a recent paper*, Robert Bradbury, Milan Cirkovic (Astronomical Observatory, Belgrade) and George Dvorsky (Institute for Ethics and Emerging Technologies) consider whether intergalactic SETI may be an example of what they call a 'Dysonian' approach to SETI, one that is a 'middle ground' between the traditional radio-centric view (with contact implications) and the hostile reaction of SETI detractors who see no value in the enterprise whatsoever and think the money better spent elsewhere. The nod to Freeman Dyson is based on the latter's conjecture that a truly developed society would surmount the limits of planetary living space and energy by building a Dyson shell, capturing most or all of the energy from the star near which it lived.

A Dyson sphere immediately changes the terms of SETI because it is in principle detectable, but unlike nearby radio signals (either from a beacon or as unintentional 'leakage' from a civilization's activities), a Dyson shell might be spotted at great astronomical distances through its infrared signature. Carl Sagan was one of the first to pick up on the idea and ponder its implications. Dyson was much in favor of attacking the question in a disciplined way, using our astronomical tools, as he once wrote, ".to transpose the dreams of a frustrated engineer into a framework of respectable astronomy." And here again, we have seen attempts, especially by the aforementioned Richard Carrigan, to study infrared data for signs of such Dyson constructs.

The new direction in SETI that the three authors of the new paper champion is one that employs a broader set of tools. Rather than limiting itself to radio dishes or dedicated optical facilities, it broadens our workspace for extraterrestrial civilizations to include astronomical data that can be gathered in tandem with other research projects, scanning a far wider and deeper field. In the authors' view, Dysonian SETI also takes into account new developments in astrobiology and even extends into computer science and the possibility of post-biological intelligence. They advocate a Dysonian SETI drawing on four basic strategies to supplement older methods:

- The search for technological products, artifacts, and signatures of advanced technological civilizations.
- The study of postbiological and artificially super-intelligent evolutionary trajectories, as well as other relevant fields of future studies.
- The expansion of admissible SETI target spectrum.
- The achievement of tighter interdisciplinary contact with related astrobiological subfields (studies of Galactic habitability, biogenesis, etc.) as well as related magisteria (computer science, artificial life, evolutionary biology, philosophy of mind, etc.)

The expansion of SETI into these areas would not replace ongoing SETI methods but would significantly expand the overall process in line with the great goal of learning whether other intelligent beings share the galaxy and the nearby universe with us. The paper offers more fruitful speculation than I can fit into a single entry, so we'll be looking at these ideas over the course of the next few days. If there really is a Great Silence, to use David Brin's phrase, these authors argue it's one that we can only ponder usefully if we broaden our search toward the potentially observable achievements of cultures far more advanced than our own. That study has only recently begun.

* The paper is Bradbury, Cirkovic and Dvorsky, "Dysonian Approach to SETI: A Fruitful Middle Ground?" JBIS Vol. 64 (2011), pp. 156-165. ❖

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Encyclopedia Galactica

by Jon Lomberg

(from his *Citizen of the Galaxy* blog, used by permission)

Forty years have now passed since Carl Sagan and I met. He was the truest Citizen of the Galaxy that ever was.

In early 1972 I wrote him a fan letter motivated by the launch of NASA's Pioneer missions, the first to reach Jupiter and Saturn. They were the first spacecraft to leave the solar system, containing the now iconic plaque of interstellar greeting devised by Carl and Frank Drake, featuring humans beautifully drawn by Linda Salzman Sagan, then Carl's wife. Nobody knows whether the message will ever reach extraterrestrials, but it certainly reached me. I was thrilled and inspired by the idea that real astronomers, not UFO loonies, were attempting interstellar communication, attempting to log onto the Encyclopedia Galactica (that's what Carl called it then; today I guess we'd speak of the Galactic Internet.)

One of the first paintings I did in homage to Sagan's vision was titled Encyclopedia Galactica. It shows the user interface of a search engine to find galactic civilizations - and how our own entry might read in English translation. This was the first painting of the Milky Way Galaxy that I ever did.

In 1972, shortly after I had moved to Toronto, I wrote Carl a letter of appreciation for his words and deeds, trying to express how powerfully I had been affected by his ideas and by their manifestation in the Pioneer plaque. He wrote back an enthusiastic letter in which he said some nice things about my paintings. And he invited me to meet him in the Toronto airport, where he was making a flight connection on his way back from Nova Scotia. He had been there to observe the solar eclipse on July 10, as a guest of the Canadian industrialist and philanthropist Cyrus Eaton.

Carl had told me the day and approximate time he would arrive, but neglected to mention the airline, flight number, or which city he was flying in from. It was actually remarkably similar to the central problem of interstellar communication: How do you find someone you are looking for when you haven't pre-arranged a meeting place? The problem is the same whether you are searching the vastness of New York City or the electromagnetic spectrum. You could search at random, with little chance of success. Or you might concentrate your search on landmarks known to you both, such as the Empire State Building (in the case of New York) or the natural emission frequency of interstellar hydrogen (in the case of the radio spectrum).

The airport was a simpler case. I could position myself so that most of the disembarking passengers from domestic Canadian flights would have to walk past me. But neither Carl nor I knew the other's appearance. What landmark would both of us recognize? The solution I came up with was the Drake Equation, written N=R*FpFlFiFc x L. Carl had discussed this formula at great length in Intelligent Life In The Universe, a groundbreaking book he co-authored with the Russian astrophysicist Iosep Shklovskii. I reasoned that on that particular day in the Toronto International airport he, and only he, would be able to recognize and understand it. [Frank Drake invented the equation that bears his name as a way of calculating the number of civilizations in the galaxy as a function of various factors such as the fraction of stars that have planets, the fraction of planets that have life, and so forth. It was one of the most well known equations among scientists interested in extraterrestrial life.]

I wrote the equation in black magic marker on a big piece of paper, taped it to the outside of my portfolio, and went to the airport. I wandered around the gates as planes arrived. Many people eyed me suspiciously, wondering what cult I was hawking, until a tall, dark-haired man came towards me with a big grin and outstretched hand saying, "Hi, I'm Carl. That was a great method for finding me. I thought you'd have me paged, but this is far more elegant"

We talked for two hours in the airport about astronomy, science fiction, art, and the Encyclopedia Galactica. Then he had to catch another plane back to Ithaca. "Look", he said" I've just signed a contract with Doubleday to write a book for a popular audience. Would you like to illustrate it? Yes? Good! Can you come down to Ithaca within the next few weeks and we'll talk about it?"

Shortly afterward I drove down to Ithaca, New York, home of Cornell University and Sagan's Laboratory for Planetary Studies. The back of my car was filled with artwork I wanted to show him.

When he saw the Encyclopedia Galactica painting, Carl's reaction was "I've been waiting to see this painting my whole life!" He asked to use it as the cover for his book Communication with Extraterrestrial Intelligence [MIT Press, 1972 the proceedings of a now-classic international conference held in 1972 in Byurakan, Soviet Armenia.]

Carl bought the painting and he paid me in something far more precious than money - he gave me a back-up Pioneer plaque, one of the spares they had left over. He, Frank, and Linda all signed the back of it. It was like receiving a signed home run baseball from the World Series. It hung in my home for years, then spent 15 years on display at the National Air and Space Museum, part of the gallery Where Next Columbus?, for which I was commissioned to paint my Portrait of the Milky Way.

In the years that followed I did several more paintings in this series, most of them after discussions with him or Frank Drake. The concept of the Encyclopedia Galactica eventually found its way into the COSMOS series as title of Episode12.

It has been 40 years since my journey with Carl began, and I like to think of it continuing still, beyond even our deaths, as our Voyager Record cruises towards the stars.

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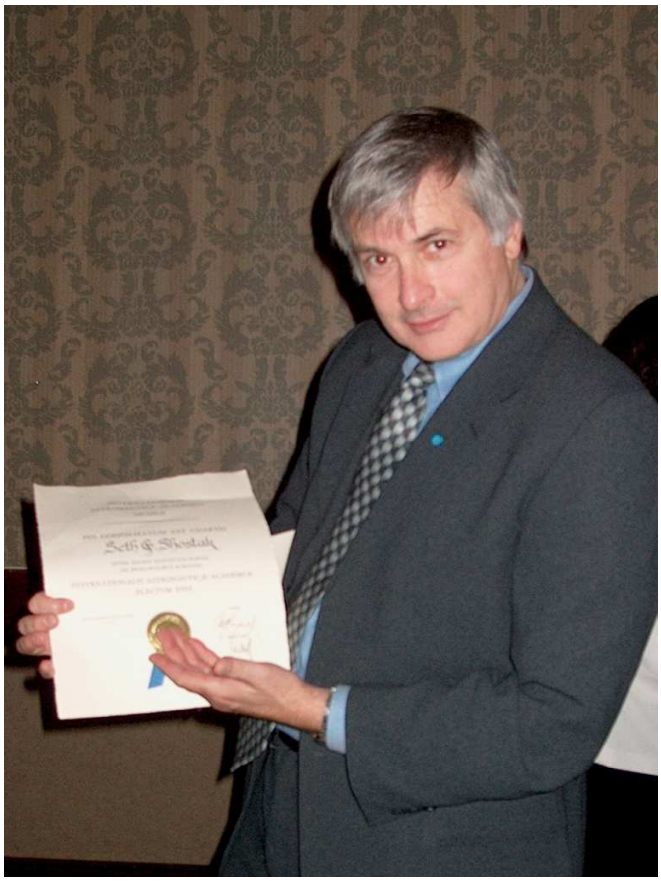
Shostak Completes Leadership Term

The SETI League thanks Dr. Seth Shostak, senior astronomer at the SETI Institute in California, for extraordinary service to the SETI community, having served two successive five-year terms as Chairman of the International Academy of Astronautics SETI Permanent Committee. Under Shostak's leadership, the Committee, on which several SETI League members serve, has introduced ordinal scales for analysis of SETI candidate signals and evaluation of the impact of transmissions from Earth, and adopted a revised set of SETI post-detection protocols.

As its bylaws limit any Chair to a maximum of ten years of service, the SETI Committee will be electing a new Chair at its upcoming meeting in Naples, Italy next month. The results of that election will be reported in the Winter 2013 issue of SearchLites, and before that, on The SETI League's website, http://www.setileague.org.



Seth Shostak's 2002 induction into the International Academy of Astronautics (SETI League photo)

Neutrino Communications: **An Interstellar Future?**

by Paul Gilster

The news that a message has been sent using a beam of neutrinos awakened a flood of memories. Back in the late 1970s I was involved with the Society for Amateur Radio Astronomers, mostly as an interested onlooker rather than as an active equipment builder. Through SARA's journal I learned about Cosmic Search, a magazine that ran from 1979 through 1982 specializing in SETI and related issues. I acquired the entire set, and went through all 13 issues again and again. I was writing sporadically about SETI then for Glenn Hauser's Review of International Broadcasting and later, for the SARA journal itself.

Cosmic Search is a wonderful SETI resource despite its age, and the recent neutrino news out of Fermilab took me right back to a piece in its third issue by Jay Pasachoff and Marc Kutner on the question of using neutrinos for interstellar communications. Neutrinos are hard to manipulate because they hardly ever interact with other matter. On the average, neutrinos can penetrate four light years of lead before being stopped, which means that detecting them means snaring a tiny fraction out of a vast number of incoming neutrinos. Pasachoff and Kutner noted that this was how Frederick Reines and Clyde Cowan, Jr. detected antineutrinos in 1956, using a stream of particles emerging from the Savannah River reactor.

The Problem of Detection

In his work at Brookhaven National Laboratory, Raymond Davis, Jr. was using a 400,000 liter tank of perchloroethylene to detect solar neutrinos, and that's an interesting story in itself. The tank had to be shielded from other particles that could cause reactions, and thus it was buried underground in a gold mine in South Dakota, where Davis was getting a neutrino interaction about once every six days out of the trillions of neutrinos passing through the tank. We've had a number of other neutrino detectors since, from the Sudbury Neutrino Observatory in Ontario to the Super Kamiokande experiments near the city of Hida, Japan and MINERvA (Main Injector Experiment for v-A), the detector used in the Fermilab communications experiment.

The point is, these are major installations. Sudbury, for example, involves 1000 tonnes of heavy water contained in an acrylic vessel some 6 meters in radius, the detector being surrounded by normal water and some 9600 photomultiplier tubes mounted on the apparatus' geodesic sphere. Super Kamiokande is 1000 meters underground in a mine, involving a cylindrical stainless steel tank 41 meters tall and almost 40 meters in diameter, containing 50,000 tons of water. You get the idea: Neutrino detectors are serious business requiring many tons of matter, and even with the advantages of these huge installations, our detection methods are still relatively insensitive.

But Pasachoff and Kutner had an eye on neutrino possibilities for SETI detection. The idea has a certain resonance as

we consider that even now, our terrestrial civilization is growing darker in many frequency bands as we resort to cable television and other non-broadcast technologies. If we had a lively century in radio and television broadcast terms just behind us, it's worth considering that 100 years is a vanishingly short window when weighed against the development of a technological civilization. Thus the growing interest in optical SETI and other ways of detecting signs of an advanced civilization, one that may be going about its business but not necessarily building beacons at obvious wavelengths for us to investigate.

Neutrinos might fit the bill as a communications tool of the future. From the Cosmic Search article:

Much discussion of SETI has been taken up with finding a suitable frequency for radio communication. Interesting arguments have been advanced for 21 centimeters, the water hole, and other wavelengths. It is hard to reason satisfactorily on this subject; only the detection of a signal will tell us whether or not we are right. Neutrino detection schemes, on the other hand, are broad band, that is, the apparatus is sensitive to neutrinos of a wide energy range. The fact that neutrinos pass through the earth would also be an advantage, because detectors would be omnidirectional. Thus, the whole sky can be covered by a single detector. It is perhaps reasonable to search for messages from extraterrestrial civilizations by looking for the neutrinos they are transmitting, and then switch to electromagnetic means for further conversations.

The First Message Using a Neutrino Beam

Making this possible will be advances in our ability to detect neutrinos, and it's clear how tricky this will be. The recent neutrino message at Fermilab, created by researchers from North Carolina State University and the University of Rochester, is a case in point. Fermilab's NuMI beam (Neutrinos at the Main Injector) fired pulses at MINERvA, a 170-ton detector in a cavern some 100 meters underground. The team had encoded the word 'neutrino' into binary form, with the presence of a pulse standing for a '1' and the absence of a pulse standing for a '0'.

3454 repeats of the 25-pulse message over a span of 142 minutes delivered the information, corresponding to a transmission rate of 0.1 bits per second with an error rate of 1 percent. Out of trillions of neutrinos, an average of just 0.81 neutrinos were detected for each pulse, but that was enough to deliver the message. Thus Fermilab's NuMI neutrino beam and the MINERvA detector have demonstrated digital communications using neutrinos, pushing the signal through several hundred meters of rock. It's also clear that neutrino communications are in their infancy.

From the paper on the Fermilab work:

"…long-distance communication using neutrinos will favor detectors optimized for identifying interactions in a larger mass of target material than is visible to MINERvA and beams that are more intense and with higher energy neutrinos than NuMI because the beam becomes narrower and the neutrino interaction rate increases with neutrino energy. Of particular interest are the largest detectors, e.g., IceCube, that uses the Antarctic icepack to detect events, along with muon storage rings to produce directed neutrino beams."

Thinking about future applications, I asked Daniel Stancil (NCSU), lead author of the paper on this work, about the possibilities for communications in space. Stancil said that such systems were decades away at the earliest and noted the problem of detector size - you couldn't pack a neutrino detector into any reasonably sized spacecraft, for example. But get to a larger scale and more things become possible. Stancil added "Communication to another planet or moon may be more feasible, if local material could be used to make the detector, e.g., water or ice on Europa."

A Neutrino-Enabled SETI

Still pondering the implications of the first beamed neutrino message, I returned to Pasachoff and Kutner, who similarly looked to future improvements to the technology in their 1979 article. What kind of detector would be needed, they had asked, to repeat the results Raymond Davis, Jr. was getting from solar neutrinos at Brookhaven (one interaction every six days) if spread out to interstellar distances? The authors calculated that a 1 trillion electron volt proton beam would demand a detector ten times the mass of the Earth if located at the distance of Tau Ceti (11.88 light years). That's one vast detector but improvements in proton beam energy can help us reduce detector mass dramatically. I wrote to Dr. Pasachoff to ask for a comment on the resurgence of his interstellar neutrino thinking. His response:

We are such novices in communication, with even radio communications not much different from 100 years old, as we learned from the Titanic's difficulties with wireless in 1912. Now that we have taken baby steps with neutrino communication, and checked neutrino oscillations between distant sites on Earth, it is time to think eons into the future when we can imagine that the advantages of narrow-beam neutrinos overwhelm the disadvantages of generating them. As Yogi Berra, Yankee catcher of my youth, is supposed to have said, "Prediction is hard, especially about the future." Still, neutrino beams may already be established in interstellar conversations. I once examined Raymond Davis's solar-neutrino records to see if a signal was embedded; though I didn't find one, who knows when our Earth may pass through some random neutrino message being beamed from one star to another - or from a star to an interstellar spaceship.

Neutrino communications, as Pasachoff and Kutner remarked in their Cosmic Search article, have lagged radio communications by about 100 years, and we can look forward to improvements in neutrino methods considering near-term advantages like communicating with submerged submarines, a tricky task with current technologies. From a SETI perspective, reception of a strong modulated neutrino signal would flag an advanced civilization. The prospect the authors suggest, of an initial neutrino detection followed by a dialogue developed through electromagnetic signals, is one that continues to resonate.

The Pasachoff and Kutner paper is "Neutrinos for Interstellar Communication," Cosmic Search Vol. 1, No. 3 (Summer, 1979). The Fermilab work is described in Stancil et al., "Demonstration of Communication using Neutrinos," submitted to Modern Physics Letters A 27 (2012). ❖

The Movie *Contact*

by Robert J. Sawyer

I got asked recently what my favorite parts of the movie *Contact* were - the questioner took it as a given that I must love the film. Well, I know we're all supposed to like it because it was based on a book by Carl Sagan, and because, y'know, it's about a kick-ass female scientist, but I actually have real problems with it.

Don't get me wrong: I love SETI, and I was the only novelist invited to speak at the SETI Institute's first SETIcon in 2010 - and was the only novelist invited to speak at the second SETIcon, held this year. But in Rollback, my own novel about SETI, my character of Sarah Halifax, herself a SETI astronomer, reflects on the movie's problems:

> Like most astronomers, Sarah fondly remembered the movie *Contact*, based on Carl Sagan's novel of the same name. Indeed, she argued it was one of the few cases where the movie was actually better than the overlong book. She hadn't seen it for decades, but a reference to it in one of the news stories about the attempts to decrypt the response from Sigma Draconis had brought it to mind. With pleasant anticipation, she sat down next to Don on the couch to watch it on Wednesday night. Slowly but surely she was getting used to his newly youthful appearance, but one of the reasons she felt like watching a movie was that she'd be doing something with Don in which they'd be sitting side by side and not really looking at each other.
>
> Jodie Foster did a great job portraying a passionate scientist, but Sarah found herself smiling in amusement when Foster said, "There are 400 billion stars out there, just in our galaxy alone," which was true. But then she went on to say, "If only one out of a million of those had planets, and if just one out of a million of those had life, and if just one out of a million of those had intelligent life, there would be literally millions of civilizations out there." Nope, a million-million-millionth of 400 billion is so close to zero as to practically be zero.
>
> Sarah looked at Don to see if he'd caught it, but he gave no sign. She knew he didn't like being interrupted by asides during movies - you couldn't memorize trivia the way he did if you weren't able to concentrate - and so she let the screenwriter's minor flub pass. And, besides, despite its inaccuracy, what Foster had said rang true, in a way. For decades, people had been plugging numbers made up out of whole cloth into the Drake equation, which purported to estimate how many intelligent civilizations existed in the galaxy. Foster's wildly inaccurate figure, pulled out of the air, was actually quite typical of these debates.
>
> But Sarah's amusement soon turned to downright cringing. Foster went to see a large corporation to get funding for SETI, and, when it initially turned her down, she went ballistic, exclaiming that contacting an extraterrestrial civilization would be the biggest moment in human history, more significant than anything anyone had ever done or could possibly imagine doing, a species-altering moment that would be worth any cost to attain.
>
> Sarah cringed because she remembered giving such patently ridiculous speeches herself. Granted, the detection of the original signal from Sigma Draconis had been page-one news. But until the second message had been received, it had been over thirty years since a mention of aliens had appeared on the front page or main screen of any newspaper that didn't have the words "National" and "Enquirer" in its title.
>
> It wasn't just SETI researchers who had overhyped the impact of such things. Sarah had forgotten that then-president Bill Clinton appeared in *Contact*, but there he was, talking about how this breakthrough was going to change the world. Unlike the cameos by Jay Leno and Larry King, though, which had been specifically staged for the movie, she immediately recognized the Clinton speech as archival footage - not about the detection of alien radio messages, but about the unveiling of ALH84001, the Martian meteorite that supposedly contained microscopic fossils. But despite the presidential hyperbole, that hunk of rock hadn't changed the world, and, indeed, when it was ultimately discredited several years later, there was almost no press coverage, not because the story was being buried, but rather because no one in the public even really cared. The existence of alien life was a curiosity to most people, nothing more. It didn't change the way they treated their spouses and kids; it didn't make stocks rise or fall; it just didn't matter. Earth went on spinning, unperturbed, and its denizens continued to make love, and war, with the same frequency.
>
> As the film continued, Sarah found herself getting increasingly pissed off. The movie had its extraterrestrials beaming blueprints to Earth so humans could build a ship that could tunnel through hyperspace, taking Jodie Foster off to meet the aliens face-to-face. SETI, the movie hinted, wasn't really about radio communication with the stars. Rather, like every other cheapjack Hollywood space opera, it was just a stepping stone to actually going to other worlds. From the beginning with Jodie Foster's cockeyed math, through the middle with the stirring speeches about how this would completely transform humanity, to the end with the totally baseless promise that SETI would lead to ways to travel across the galaxy and maybe even reunite us with dead loved ones, Contact portrayed the hype, not the reality. If Frank Capra had made a propaganda series called "Why We Listen," *Contact* could have been the first installment.

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Jill Tarter Announces Retirement

Dr. Jill Tarter, the radio astronomer whose name has become almost synonymous with SETI research, recently announced her retirement from the California-based SETI Institute, after a long and distinguished career. Jill Tarter held the Bernard M. Oliver Chair for SETI Research and was Director of the Center for SETI Research at the SETI Institute in Mountain View, California. Tarter received her Bachelor of Engineering Physics Degree with Distinction from Cornell University and her Master's Degree and a Ph.D. in Astronomy from the University of California, Berkeley. She served as Project Scientist for NASA's SETI program, the High Resolution Microwave Survey, and has conducted numerous observational programs at radio observatories worldwide. Since the termination of funding for NASA's SETI program in 1993, she has served in a leadership role to secure private funding to continue the exploratory science. Currently, she serves on the management board for the Allen Telescope Array, a joint project between the SETI Institute and the UC Berkeley Radio Astronomy Laboratory. When this innovative array of 350 6-m antennas becomes fully operational at the UC's Hat Creek Radio Observatory, it will simultaneously survey the radio universe for known and unexpected sources of astrophysical emissions, and speed up the search for radio emissions from other distant technologies by orders of magnitude.

Tarter's work has brought her wide recognition in the scientific community, including the Lifetime Achievement Award from Women in Aerospace, two Public Service Medals from NASA, Chabot Observatory's Person of the Year award (1997), Women of Achievement Award in the Science and Technology category by the Women's Fund and the San Jose Mercury News (1998), and the Tesla Award of Technology at the Telluride Tech Festival (2001). She was elected an AAAS Fellow in 2002 and a California Academy of Sciences Fellow in 2003. In 2004 Time Magazine named her one of the Time 100 most influential people in the world, and in 2005 Tarter was awarded the Carl Sagan Prize for Science Popularization at Wonderfest, the biannual San Francisco Bay Area Festival of Science.

Tarter has long been deeply involved in the education of future citizens and scientists. In addition to her scientific leadership at NASA and SETI Institute, Tarter has been the Principal Investigator for two curriculum development projects funded by NSF, NASA, and others. The first, the Life in the Universe series, created 6 science teaching guides for grades 3-9 (published 1994-96). Her second project, Voyages Through Time, is an integrated high school science curriculum on the fundamental theme of evolution in six modules: Cosmic Evolution, Planetary Evolution, Origin of Life, Evolution of Life, Hominid Evolution and Evolution of Technology (published 2003). Tarter is a frequent speaker for science teacher meetings and at museums and science centers, bringing her commitment to science and education to both teachers and the public. Many people are now familiar with her work as portrayed by Jodie Foster in the movie *Contact*. ❖

SETI League Executive Director Emeritus H. Paul Shuch presented member Jill Tarter with the coveted Giordano Bruno Memorial Award in 2009, for extraordinary contributions to SETI science. The presentation was made at the National Radio Astronomy Observatory, Green Bank WV, home to the world's first observational SETI experiment in 1960, and host to the first ever SETI conference in 1961.

Jill Tarter scales the great decimetric wave radio telescope at Nancay, France, in this 2008 SETI League photo

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