SearchLites

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The Quarterly Newsletter of The SETI League, Inc.

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In Memoriam:

Gregory Dale Bear
(August 20, 1951 – November 19, 2022)

The SETI League is saddened to report the recent death of our dear friend and advisor, noted author Greg Bear. One of the "Three Bees" of science fiction (along with his longtime friends David Brin and Gregory Benford), Bear was known for his many short stories, and over fifty novels in the hard sci-fi genre, as well as works of fantasy. His writing garnered five Nebula Awards and two Hugo Awards. His 1987 Locus and Nebula award nominated novel *The Forge of God* presented one possible explanation for the Fermi Paradox that underlies much SETI research and speculation.

When The SETI League was founded in 1994, Greg Bear's father-in-law, Sci-Fi Grand Master Poul Anderson, was the first person appointed to our Advisory Board (to be joined later by such luminaries as Dr. Frank Drake and Arthur C. Clarke). Following Anderson's death in 2001, Greg graciously agreed to assume his father-in-law's seat as a SETI League advisor. The photo below of Bear and SETI League Executive Director H. Paul Shuch was taken at the 2018 World Science Fiction Convention.

Greg died on November 19, 2022, at the age of 71, following heart surgery from which he never awoke. He had suffered multiple strokes, caused by clots that had been hiding in a false lumen of the anterior artery to the brain since an earlier surgery in 2014. After being on life support for two days and not expected to recover, per his advance healthcare directive life support was withdrawn. Our hearts go out to his wife Astrid Anderson Bear and their two children.

Green Bank Artist in Residence Report
by Daniela De Paulis

As an artist, I have been visiting several radio observatories while working with radio technologies. For more than a decade I have been collaborating with operators and astronomers from around the world and this methodology increasingly showed me how radio antennas can connect humans from different countries and cultures in a meaningful and engaging way. I first visited the Green Bank Observatory in July 2019, for the Moonshots and Earthshots, in the Search for Life beyond Earth workshop that brought together leading researchers in the fields of astronomy, astrobiology, philosophy and art.

I returned to the GBO last October to work on my current project A Sign in Space, in collaboration with an international team of SETI researchers. My two months stay at the observatory is supported by the Baruch Blumberg Fellowship in Astrobiology, awarded by the scientific committee at the GBO. This is an exceptional opportunity and I feel truly honored for being the recipient of such a prestigious award and for having the possibility of spending precious research time at the observatory. The fact that the scientists here truly appreciate and foster a cultural, interdisciplinary exploration of radio astronomy, is a remarkable aspect of this unique scientific facility.

There are many other exceptional aspects to this place. Upon arrival in early October, I had to instantly adapt to the strict regulations of the radio quiet environment which here covers the area of the observatory and the nearby towns. I quickly learnt that some locals are not in favor of the limitations regulating the usage of Wi-Fi and mobile phones. On the other hand, some people move to Green Bank thanks to the radio quiet zone, as highlighted by film director Werner Herzog in his 2016 documentary Lo and Behold. Adjusting to a lifestyle that reminds me of the pre-mobile phone era, has been challenging for the first few days, after which I started appreciating that people here take time to talk to each other and attend public events without being distracted by their phones or laptops.

Overall, here there is a sense that events still unfold at a human pace instead of following a rhythm punctuated by instant messages, instant photos, ringtones and selfies. Interestingly, the many school children and students visiting the facilities for a few days, seem to adapt very quickly to exploring the surrounding nature, the scientific facilities and to interacting with each other, instead of focusing on their virtual life on social media. The sound, and mostly silence, of nature and wildlife inhabiting the dense vegetation that surrounds the observatory is occasionally interrupted by the hissing, almost eerie sound of the majestic radio telescopes that move to track celestial objects. Since landing here, I witnessed the vegetation changing from autumnal bright red, yellow and green colors to the wintery brown and grayish tones, while perceptibly noticing the changes of the light from golden to cooler shades.

The stunning natural surroundings are punctuated by the highly technological architectures, the very large antennas conducting various types of observations and, above all, by the majestic Green Bank Telescope, the largest movable structure in the world. There is a noticeable sense here that while humans conduct their daily activity, these machines access an inscrutable reality, relaying the mysteries of the cosmos back to our earthly dimension. During my stay, I had the opportunity to visit the Green Bank Telescope twice, climbing on top of its imposing structure. While directly facing the 300 feet diameter dish, coated in white paint, I experienced some shifting in my spatial references. I felt like standing in front of a white sea, an abstract space of reverberating light on a far away planet. The GBT is the principal character of the observatory. Scientists from all over the world travel to the observatory to work with the Green Bank Telescope, conducting cutting edge research, including the Search for Extraterrestrial Intelligence. The control room is detached from the radio telescope and features state of the art computing and cooling facilities that are continuously upgraded to make the observations more precise. During my residency here, I had the opportunity to visit the control room and directly observe the work conducted by prominent SETI researchers affiliated with the Breakthrough Listen team at UC Berkeley. I learnt about their observations and gained a realistic insight into the work of SETI scientists.

The permanent research staff at the GBO has been equally welcoming and all the astronomers here showed great interest in my artistic work and in the project A Sign in Space, for which the Green Bank Observatory is one of the collaborating organizations, together with the European Space Agency and the SETI Institute. During the first few weeks of my stay, I gave a lunch talk for the scientific staff at the GBO and I will be giving another talk for the National Radio Astronomy Observatory staff in Charlottsville at the end of November, just before resuming my residency here.

In my talks I present the artistic research I have been developing for the past thirteen years, focusing on radio technologies and interdisciplinary collaborations. In my work I often combine radio astronomy with neuroscience, cosmology and philosophy. The scientists at the GBO have been offering specialist feedback on several aspects of my research and appreciate the various cultural ramification of radio astronomy into fundamental existential questions. Besides the professional interaction with all the scientists and staff working at the facilities, I treasure being part of a community of open minded and interesting individuals, with whom I share daily lunch conversations, walks and dinner parties. It is inspirational to experience how this relatively small community of researchers, living in a remote rural area, established a balanced and supportive environment in which people seem to feel at ease with each other. As the first Artist in Residence, I am honored I can be part of this stimulating community and contribute to the scientific and cultural work conducted at the observatory. I will treasure this unique experience for many years to come.

Guest Editorial:

Quintessence
by Dan Duda

from the October 2022 issue of *Penn Central*,the monthly newsletter of Central Pennsylvania Mensa,used by permission

When scientists observe a phenomenon that they don't understand, they develop a hypothesis to try to explain what they see. In the 1970s, astronomer Vera Rubin observed that the volume of visible matter inside galaxies couldn't provide sufficient gravity to hold them together. So why don't galaxies fly apart? That question sent shock waves through the cosmological community.

And Dark Matter is the term they developed to rationalize Rubin's finding. According to Rubin, in a spiral galaxy, the ratio of dark-to-light matter is about a factor of ten. That's probably a good number for the ratio of our ignorance-to-knowledge. We're out of kindergarten, but only in about third grade.

Let's go back to gravity. We know that mass (matter) generates gravity. Objects are attracted to each other; the larger the mass, the more powerful the attractive force. That led scientists to expect that the speed of universal expansion should be slowing down due to all the mass. In the early 1900s, one thing was fairly certain about the expansion of the universe ... gravity was certain to slow the expansion as time went on. But with the finding that the concentrated mass of a galaxy isn't enough to hold it together, let alone the whole universe, the dark matter hypothesis nicely filled the gap.

So let's focus on the rate of expansion of the entire universe. Until recently cosmologists knew that the rate of expansion was decreasing due to gravity, including the effects of dark matter. It just made sense. However, cosmologist Saul Perlmutter won a Nobel Prize for his discovery that instead of slowing, the speed of expansion is increasing.

That discovery sent a second wave of shock into the cosmological community. How's that for generating the need for a new hypothesis? And another "dark" term emerged. "Dark energy" entered the scientific lexicon. Regarding dark energy, more is unknown than is known. We know how much dark energy there is because we know how it affects the universe's expansion. Other than that, it is a complete mystery. With this finding, we've graduated to Rubin's fourth grade.

Now, we're refining our concepts about these mysterious dark forces, and "quintessence" enters our vocabulary. This has been proposed to help us focus on the dark mysteries (but we still don't really understand what's going on).

Quintessence is believed to be a substance that is the opposite of the force of gravity (in the interest of brevity allow me to refer to gravity as a force). Instead of being attractive, quintessence is repulsive. (Keep in mind that we're not talking about human characteristics). As numerous observations and experiments reshape the field, many cosmologists are exploring the possibility that the vast majority of the energy in the universe is in the form of a hitherto undiscovered substance called 'quintessence'.

The choice of this name has classical precedence. In ancient Greece it meant the fifth element after 'air, earth, fire and water.' So, this promotes us to Rubin's fifth grade.

The constant changes in scientific thinking, especially in cosmology, make its study irresistible, at least to me. Whether or not we're getting closer to understanding reality is questionable, but the possibility is endlessly intriguing. To quote Paul Davies, "For me, science is already fantastical enough. Unlocking the secrets of nature with fundamental physics or cosmology or astrobiology leads you into a wonderland compared with which beliefs in things like alien abductions pale into insignificance."

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SETI League members are encouraged to nominate SETI-relevant websites for our monthly SETI SuperStar Award. Nominating emails to our Awards Committee may be sent to:

Awards_at_setileague_dot_org

Please be sure to indicate the URL of the candidate website you are nominating, and a brief explanation as to why you consider the site worthy of recognition.

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.

Please note that the global COVID-19 pandemic has resulted in the cancellation or rescheduling of many planned scientific meetings and conferences. We recommend you check with the event sponsors for updates before making travel arrangements.

April 16, 2023, 1 PM EDT (tentative): *SETI League Annual Membership Meeting,* virtually, via the Zoom platform.

June 19 – 22, 2023: *Second Penn State SETI Symposium*, State College, PA.

August 23 - 29, 2023: *81st World Science Fiction Convention*, Chengdu, China.

September 25 - 29, 2023: *74th International Astronautical Congress*, Baku, Azerbajian.

October 11 - 18, 2024: *75th International Astronautical Congress*, Milan, Italy.

August 8 - 12, 2024: *82nd World Science Fiction Convention*, Glasgow, Scotland.

September 29 - October 3, 2025: *76th International Astronautical Congress,* Sydney, Australia.

Frank Drake, Father of Observational SETI
28 May, 1930 – 2 September, 2022
Remembered by H. Paul Shuch, Executive Director Emeritus

It was an idea whose time had come, but nobody dared admit that out loud. Frank Drake, in particular, was keeping silent. Like many of his generation, he had long speculated about the existence of extraterrestrial life, and pondered how we humans might probe for direct evidence of our cosmic companions. Now, in 1959, the young astronomer was finally in a position to do more than ponder. At 29, he had just completed graduate school, the ink on his Harvard diploma as wet as he was behind the ears. As the new kid on the block at the National Radio Astronomy Observatory, he had access to the tools necessary to mount a credible search for radio evidence of distant technological civilizations. Drake knew enough to tread lightly; a publicly announced hunt for Little Green Men would be tantamount to professional suicide. So, he approached his superior with understandable trepidation.

Fortunately, NRAO director Otto Struve was sympathetic, even as he counseled caution. Having theorized that the slowed rotation rate of certain stars suggested that their angular momentum had been dissipated in the formation of planets, Struve himself speculated on the probable existence of extraterrestrial civilizations. So, he authorized Drake to use the 85 foot diameter Howard Tatel telescope in his off-duty time, to conduct what was to become the world's first observational SETI experiment. Only, do so quietly, Struve warned; we don't want the word getting out that we're using a government facility to hunt for aliens.

Drake had already run the numbers. He knew the most likely frequency on which to search, and the best receiver circuitry to employ. He had picked his candidate stars, two nearby sunlike ones which he reasoned were likely to harbor habitable planets. He had selected his research methodology, and proceeded (very quietly) to assemble his listening station.

And then, the Nature article hit the newsstands. "Searching for Interstellar Communications" was written by two Cornell University professors, Giuseppe Cocconi and Philip Morrison, and it proposed, in brief but clear detail, the very experiment which Drake was preparing to conduct!

This very first scientific article in the not-yet-named discipline of SETI was complete, down to the selection of frequencies and target stars – and it paralleled Drake's work exactly. Neither the team of Morrison and Cocconi, nor that of Drake and Struve, knew anything about the others' interest in this esoteric study. Both groups had arrived at the same crossroads in history, completely independently, in an elegant example of what I like to call the Parenthood Principle: when a great idea is ready to be born, it goes out in search of a parent. Sometimes, it finds more than one.

Now, Schrodinger's Cat was out of the bag, and Drake had no choice but to go public. The publicity he received was widespread, and generally enthusiastic; the scientific community, it appeared, was ready to embrace the notion of SETI. Struve began writing about the possibility of extraterrestrial life: "An intrinsically improbable event may become highly probable if the number of events is very great… it is probable that a good many of the billions of planets in the Milky Way support intelligent forms of life. To me this conclusion is of great philosophical interest. I believe that science has reached the point where it is necessary to take into account the action of intelligent beings, in addition to the classical laws of physics."

His cover now blown, Drake soon found himself in the company of other open-minded scientists and technologists, who collectively found themselves unwitting parents to a newly emerging scientific discipline. Among those contacting Drake after reading about his nascent experiment were microwave communications expert Bernard M. Oliver,

then vice-president of engineering at Hewlett-Packard (and, later, president of the Institute of Electrical and Electronic Engineering); Dana Atchley, president of Microwave Associates in Massachusetts; and a young planetary scientist, Berkeley post-doctoral researcher Carl Sagan. These individuals, as well as Struve, Morrison, and a handful of others, were ultimately to become SETI's patriarchs. (Cocconi, though having co-authored the seminal SETI article with Morrison, went on to distinguish himself in particle physics research at CERN, never to return to the SETI fold.)

Drake named his search Project Ozma, after the princess of Oz in the L. Frank Baum books, as he saw his efforts leading humans to a far-off and exotic land. Launched in April of 1960, and running only through May of that year, Ozma searched but two stars, on a single frequency, for mere dozens of hours, but established the protocols, and laid the groundwork, for all subsequent SETI experiments. It was a paradigm-shifting endeavor, successful for its audacity, if not for its discoveries.

And yet, for one brief moment early on, Frank Drake thought he had hit paydirt. As he slewed his antenna off of Tau Ceti and onto Epsilon Eridani, he was greeted with a strong, periodic, pulsed signal on 1420 MHz, the hyperfine transition emission line of interstellar hydrogen atoms proposed by Cocconi and Morrison, and still favored as a promising hailing frequency for interstellar communications. "My god," Frank mused, "can it really be this easy?"

The next day, when the signal reappeared, Drake was ready with a second, low-gain antenna. The pulses were there as well, sadly disproving their extraterrestrial origin. But they were not exactly terrestrial interference, either. The rate at which the phantom signal traversed the sky suggested that it was emanating from an aircraft cruising at unprecedented altitude – perhaps eighty thousand feet! Of course, in April of 1960, no known aircraft could reach the stratosphere. Such an aircraft, as it happened, didn't "come into existence" until the following month, when Francis Gary Powers was shot down over the Soviet Union. (Frank wisely decided to withhold publication of this positive result, so he never did receive proper credit for "discovering" the U-2.)

A year after Project Ozma's brief tenure, Drake convened at Green Bank the first scientific conference devoted to modern SETI. He gathered together ten scientists from disparate disciplines. They spent a week contemplating areas from the physical, biological, and social sciences which had relevance to the question of extraterrestrial technological civilizations, and how to communicate with them.

The assembly included the six SETI patriarchs already mentioned, along with J. Peter Pearman of the National Academy of Sciences' space science board, Su Shu Huang of NASA, University of California chemist Melvin Calvin (whose Nobel prize was to be announced during the Green Bank meeting), and neuroscientist John C. Lilly, who was then studying the language of dolphins, and attempting to communicate with these intelligent Earth mammals. The group called themselves the Order of the Dolphin, a tribute to Lilly's studies into human-dolphin communication, which they deemed a worthy metaphor for the challenge of interspecies communications on a grander, cosmic scale.

Drake chalked on a blackboard seven topics for discussion, which would comprise the agenda for the weeklong meeting. They included stellar formation, planetary formation, the existence of planets within habitable zones, the emergence of life, the evolution of intelligence, communications technology, and the longevity of technological civilizations.

Having established that the emerging discipline of SETI was to encompass fields as diverse as stellar evolution, planetary astronomy, environmental science, biology, anthropology, engineering, and sociology, Drake next did something almost whimsical, which assured his lasting fame: he strung these seven factors together into an equation.

The idea was to multiply seven unknowns together, and in so doing, to estimate N, the number of communicative civilizations in our Milky Way galaxy. The Drake Equation, as it is now called, appears in every modern astronomy textbook. It is a marvelous tool for quantifying our ignorance: never intended for quantification, but quite useful in narrowing the search parameters. We still use it, not to seek a numerical solution, but rather to help us to focus our thinking in designing our searches for life.

Drake's seven factors are cleverly ordered, from solid to speculative. Today's astrobiology and bioastronomy meetings are similarly structured. When the equation was first published, only the first factor (the rate of stellar formation) was known to any degree of certainty. In the intervening decades, Drake's equation has guided our research in an orderly manner, from left to right, so that today we have a pretty good handle on Drake factors two and three (planetary formation, and habitable zones). The remaining four factors are still anybody's guess, and it may well take decades more before our research begins to quantify those areas of our ignorance. But the Drake Equation is most valuable in guiding our research, because it asks the important questions. It is still up to us to answer them.

The lessons learned during the brief course of Project Ozma, amplified and expanded at the Order of the Dolphin meeting, have informed and enriched every subsequent SETI experiment. The interdisciplinary nature of the science now known as SETI was articulated at the outset. Drake's work clearly showed that Earth's technology was at last approaching the level at which a disciplined search for extraterrestrial microwave emissions was becoming feasible. The quietest part of the electromagnetic spectrum was explored then, as now. Highly directional, high gain parabolic antennas, coupled to very low noise microwave preamplifiers, remain our preferred observational tools. Although the advent of multi-channel spectrum analyzers means we no longer have to select a single channel to scan, SETI scientists continue to speculate as to universal calling frequencies that alien civilizations might employ to make their presence known. Concentrating our efforts on known, nearby sun-like stars remains an accepted technique for planning targeted searches, one of the two primary search modalities still practiced.

Most importantly, Frank Drake's early efforts began to lend legitimacy to an endeavor previously considered fringe science. Today, the preponderance of informed opinion holds that we inhabit a universe teeming with life. The only matter for speculation is whether we yet possess the technology necessary to detect it. The emphasis here is on yet. Most of us contemplating such a detection no longer argue "if," but rather "when."

Drake subsequently distinguished himself as Director of the famed Arecibo Observatory, from which he orchestrated the Arecibo Message, humankind's first deliberate microwave transmission to the stars. His astronomical research has led to important discoveries about pulsars and Jovian radio emissions. Long a distinguished academic, he is today remembered as the godfather of observational SETI. For the balance of his life Frank remained much in demand as a speaker at scientific meetings. He was deeply involved in SETI science fully six decades after Project Ozma, serving as a Director of the SETI Institute in California, and on the scientific advisory board of the nonprofit SETI League. Still working toward contact, he died three days before Labor Day, 2022, at the age of 92.

This, then, is Frank Drake's legacy: more than just a friend and mentor to all the world's SETI scientists, he singlehandedly turned science fiction into credible, respectable science.

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