A HISTORICAL INTRODUCTION TO THE SEARCH FOR EXTRATERRESTRIAL LIFE

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ABSTRACT. The possibility that life, primitive or advanced, might exist in other places of the Universe has occupied the thoughts of scientists and laymen for thousands of years. It is only in the last 25 years, however, that we have entered the experimental phase of the search for extraterrestrial life, where considerable progress has already been made.

1. THE EARLY PERIODS

The literature on the plurality of living worlds stretches back several thousand years (Bell, 1982; Goldsmith, 1980; Dick, 1982). As early as around 400 B.C., in his book "On Nature" the ancient Greek philosopher Metrodorus of Chios was writing: "It is unnatural in a large field to have only one shaft of wheat and in the infinite Universe only one living world." Also around 50 B.C. in his book "De Rerum Natura" the Roman poet-philosopher Lucretius was writing: "Nothing in the Universe is unique and alone, and therefore in other regions there must be other earths inhabited by different tribes of men and breeds of beasts."

This subject has been debated extensively through the centuries, at times even with severe recriminations such as the execution by the Inquisition of the Italian monk Jordano Bruno (burned at the stake on February 17, 1600), who had espoused the heliocentric theory of Copernicus and insisted that in the Cosmos there must be "an infinite number of suns with planets with life around them."

About a century later the famous Dutch physicist Christian Huygens wrote in 1690 a book entitled "Cosmotheoros" arguing in it that life can exist in many other planets. He also tried to reconcile the beliefs of the Church with the idea of the plurality of worlds by saying that "barren planets, deprived of living creatures which speak most eloquently of their Divine Architect are unreasonable, wasteful and uncharacteristic of God, who has a purpose for everything."

The first scientific proposal to communicate with extraterrestrial intelligence was made around 1830 by the famous German astronomer and mathematician Carl Friedrich Gauss, who suggested to plant a colossal

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forest in the form of an orthogonal triangle to signal to extraterrestrials, who might be observing the Earth with their powerful telescopes, that our planet is inhabited by intelligent beings who are familiar with the Pythagorean Theorem. Gauss, of course, did not suceed in building his forest, but he did manage to plant the idea to try to communicate with extraterrestrial intelligence

2. THE BEGINNING OF THE MODERN ERA

The modern era, which is characterized by the experimental search for both primitive and advanced life outside of our planet, had its beginning for both types in 1959. This was the year that the USSR launched the first Sputnik (October 4, 1959), which opened the new frontier of outer space, and was also the year that Giuseppe Cocconi and Philip Morrison (1959) published in NATURE their pioneering paper "Searching for Interstellar Communications" (September 19, 1959).

The advent of the space era made possible the exploration of our solar system where we have searched already for primitive life on the Moon (Apollo missions - 1969) and on Mars (Viking landers - 1975), and have landed repeatedly (Venera missions) on the infernal surface of Venus. We have also obtained excellent photographs and other scientific data for planets and their moons spanning from Mercury to Saturn, with Uranus to be reached soon by the Voyager probes, while the Pioneer probes, now at more than 30 AU, are already beyond Pluto and are getting ready to enter the interstellar space. Though no signs of extraterrestrial life have been discovered so far in our Solar System, and the prospects for the future are not very encouraging, still these explorations are yielding extremely valuable data both on organic compounds of importance to life throughout our solar system and on planetary evolution, which are helping us understand the conditions that made it possible for life to appear on our planet and then to slowly evolve to an advanced civilization.

The search for extraterrestrial technological civilizations, SETI as it has come to be known, turned to other solar systems after the ideas of Percival Lowell (1855-1917) about Martian water-canals, etc., were abandoned, ideas which had excited the imagination of many people during the first half of this century. In their 1959 paper to NATURE, Cocconi and Morrison suggested to search specifically for radio signals from other stellar civilizations, because according to their estimates the radio domain is the most efficient region of the electromagnetic spectrum for interstellar communications. They also recommended, of the almost infinite frequency choices possible, to choose the 1,420 MHz (21 cm) line of atomic hydrogen, which as they said "must be known to every observer in the Universe." The hydrogen line was discovered by E.M. Purcell (Nobel Laureate for the discovery of NMR) and H.I. Ewen (his thesis student) only in 1951, and in 1959 was the only radio line known. Today we know more than 60 such radio lines, but the hydrogen line continues to dominate our searches, possibly because of inertia but also because hydrogen is the first and most abundant chemical element in the Universe.

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The last sentence of the Cocconi and Morrison paper was, and continues to be a stimulating call for action. "The probability of success is difficult to estimate" they wrote "but if we never search the chance of success is zero." This call was answered almost immediately by Frank Drake, a young (29) radioastronomer working at the U.S. National Radio Astronomy Observatory (NRAO) in Green Bank, West Virginia. In April 1960, Drake in his celebrated Project Ozma used the 85 ft. radio telescope of NRAO to search for radio signals at the 21-cm hydrogen line from two nearby Sun-like stars, Epsilon Eridani (10.7 l.y.) and Tau Ceti (11.9 l.y.). In spite of some exciting false alarms, the results were negative, but the door for SETI had finally been opened.

A reprint of the Cocconi and Morrison paper together with a commentary (Twenty Years After...) by Philip Morrison, and an article by Frank Drake on his first search (A Reminiscence of Project Ozma), appeared in the first issue (January 1979) of COSMIC SEARCH, which was published and edited by Robert Dixon and John Krauss of the Ohio State University. Both these articles have many interesting tid-bits and are a "must" for any one interested in this field. Unfortunately COSMIC SEARCH, a fine magazine, was a little ahead of its time and after three years it was forced to close. During our IAU Symposium, Prof. John Krauss donated to Commission 51 sixty sets of all 13 issues of the magazine, which were sold very fast because they are rapidly becoming a collectors item. Those interested in getting such sets may write directly to Prof. John Krauss, Dept. of Astronomy, Ohio State University, Columbus, Ohio 43210, USA.

3. FERMENTATION IN THE LATE 1970'S

After the pioneering work of Frank Drake in 1960, progress in SETI was slow in the 1960's and 1970's. The search for extraterrestrial intelligence was viewed by the scientific community with considerable reservation and was often associated with UFO's, science fiction, etc. As a result only a few brave scientists, mostly from the USA and the USSR, with little if any support even from their own institutions, continued to conduct radio searches, to write books such as the classic one by Shklovskii and Sagan (1966), and to organize international meetings, such as the one held September 5-11, 1971 in the Soviet Union at the Byurakan Astrophysical Observatory, which was co-sponsored by the US and the USSR Academies of Science and its proceedings were published by the MIT Press (Sagan, 1973).

In the late 1970's, however, the situation began to change drastically. A very encouraging harbinger of better days to come was the acceptance by the IAU, generally perceived as a rather conservative body, of my suggestion to hold a one day session on "Strategies for the Search for Life in the Universe" during the 17-th IAU General Assembly in Montreal. The meeting was very successful, and when Frank Drake and Michael Papagiannis summarized its results in an Open Evening Session, the large auditorium of the University of Montreal was packed with more than 1,000 astronomers from all around the world. The Proceedings were

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published in 1980 in the Astrophysics and Space Science Library of the D. Reidel Publ. Co. (Papagiannis, 1980).

It is important to note also that during the late 1970's a kind of revolt occurred within the SETI community sparked primarily by a paper by Michael Hart (1975), and followed by several others (Papagiannis, 1978; Tipler, 1979; etc.) culminating with the conference "Extraterrestrials - Where Are They?" in November 1979 at the University of Maryland (Hart and Zuckerman, 1982). The revolt was based on the belief, supported by a considerable number of scientists, that interstellar voyages at V = 0.01 - 0.05c by large, self-sufficient space colonies would be not only feasible but essentially inevitable for advanced technological civilizations. As a result the colonization wave would sweep through the Galaxy in approximately 10 million years, establishing space colonies around every well-behaved star of the Galaxy including our own Solar System. This is actually a very short period when compared to the more than 10 billion years age of our Galaxy, and therefore if indeed our Galaxy has been harboring advanced civilizations for billions of year they must have colonized our Solar System, along with all the other stars, long time ago. But then, where are they?

The debate on the number N of advanced civilizations in our Galaxy was a very spirited session in our meeting in Montreal (Papagiannis, 1980) where the four possible alternatives (N very small, N very large, N neither very small nor very large, N either very large or very small) were forcefully presented respectively by M. Hart, T. Kuiper, F. Drake, and M. Papagiannis. These debate continued both in meetings and in the literature and for a while they seemed to threaten the continuation of SETI. In retrospect, however, they appear to have been a healthy development because they brought more people into the SETI family and now, after several heated debates, a consensus is beginning to emerge that none of us can claim to know how extraterrestrial civilizations, far more advanced than ours, are likely to behave. Would they engaged in interstellar travelling and galactic colonization? Would they continue to beam radio messages for newcomers for hundreds of thousands of years? Would they be interested in making physical or radio contact with a new civilization that has not yet settled its own problems? etc. Realizing that these debates could never lead to an agreement without any data, we were finally led to the most obvious conclusion: Let not these debates slow down the momentum we have gained in experimental SETI. Let us forge ahead, but let us also encourage the expression of alternative points of view through parallel experimental searches. This new concept of a multi-path approach to SETI was one of the most encouraging developments that surfaced in our IAU Symposium 112. This, I believe, is a very healthy development because it promises a more democratic and more broad-based participation in SETI, which with many new ideas and new faces can only become stronger.

It must also be noted that during the late seventies a small group of NASA, headed by John Billingham made a valiant effort to keep the SETI effort going with several workshops, meetings, and publications (Morrison and Billingham, 1977; Billingham, 1981). They also worked hard to put together a long-term plan for SETI, including the development of new instrumentation, signal recognition algorithms, etc.

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It is to the credit of this NASA group at Ames and JPL that they managed to keep the flame alive, while the U.S. Congress was trying to extinguish it by refusing NASA any support for SETI work. One must also acknowledge the contributions of Jill Tarter of this NASA group who has been involved in more SETI projects than any other person, encouraging and stimulating international participation by using not only radio telescopes in the United States but also in several other countries. She is also maintaining the only active file for all the searches made around the world. Going into more names one would risk leaving out inadvertently some important contributors. It is fair to say, however, that the list of the participants to our IAU Symposium and to these Proceedings constitute a nearly complete list of Who's Who in this young field.

4. SCIENTIFIC RECOGNITION IN THE EARLY 1980'S

Following the fermentation and build-up period of the late 1970's, there were several important developments in the early 1980's which finally established the scientific credibility and validity of this effort. These developments included:

I. The publication of the report (Field, 1982) of the Astronomy Survey Committee of the U.S. Academy of Science, which was charged to study and recommend the priorities for Astronomy and Astrophysics in the 1980's. For the first time the report included SETI among these objectives, and recommended the allocation of $20,000,000 for SETI in the decade of the 1980's.

II. NASA obtained finally in 1982 permission from the US Congress to fund SETI related projects and has since been doing so at the rate of 1.5 - 2,000,000 million dollars per year.

III. Carl Sagan produced an international petition in support of the continuation of the search for extraterrestrial intelligence. It was signed by 70 prominent scientists from around the world, including 8 Nobel Laureates, and was published in Science (Sagan, 1982), and reprinted in several other journals and magazines.

IV. The international Astronomical Union, following the success of the one-day session in Montreal mentioned above, decided in its 18-th General Assembly at Patras, Greece in 1982 to establish a new IAU Commission (Section) under the title: IAU Commission 51 - Search for Extraterrestrial Life. Its first officers, elected for the period 1982-85, were: Michael D. Papagiannis, President; Nikolai S. Kardashev and Frank D. Drake, Vice Presidents. The new Commission grew rapidly (Papagiannis, 1983) and now numbers more than 250 members (about 210 Astronomers members of the IAU, and about 40 Consultants from other related scientific fields) from over 25 countries.

V. IAU Commission 51 held its first IAU Symposium June 18-21, 1984, in Boston, USA, bringing together nearly 150 prominent scientists and other participants from 18 countries spanning all five continents. The symposium received extensive coverage from several of the respected news media, with whole page articles by W. Sullivan in the New York Times, Robert Cowen in the Christian Science Monitor, and Robert Cook

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and David Chandler in the Boston Globe. It is also important to note that the Symposium was co-sponsored by four other IAU Commissions (15 - Comets, Asteroids and Meteorites; 16 - Planets; 24 - Astrometry; 40 - Radio Astronomy) and by four other major international organizations representing related fields: IAF (International Astronautical Federation); COSPAR (International Committee on Space Research); ISSOL (International Society for the Study of the Origin of Life); IUBS (International Union of Biological Sciences).

5. A LANDMARK REACHED

IAU Symposium 112 in 1984 was indeed a landmark in the search for extraterrestrial life. It was also interesting that it happened to coincide with the publication in NATURE of the paper by Cocconi and Morrison which ushered in the experimental era in the Search for Extraterrestrial Life. This occasion was properly recognized during the Symposium with a special event and reception at Boston's Museum of Science where Philip Morrison gave an inspiring talk and was honored by IAU Commission 51 with a plaque commemorating this important anniversary and his many outstanding contributions to this field.

A quarter of a century is an important landmark in a new field. The experimental search for extraterrestrial life and intelligence has made tremendous progress in these 25 years, and though at times progress appeared to be frustratingly slow we can now look back and see that indeed we have gone a long way in these 25 years. This new field is now well established and has the support of Governments, Academies, and International Scientific Organizations. It also has a significant number of highly qualified scientists working diligently in advancing the technology for SETI and in optimizing the search strategy. We can look with gratification on what has been accomplished, honor the pioneers who made it possible, and reinforce our commitment to continue our different searches in an effort to answer this profound question "Is there any other life, primitive or advanced, in the Universe?", which has occupied the minds of scientists and laymen alike for thousands of years.

I believe that the progress and the accomplishments of the past 25 years, permit us to take stock at this landmark with pride and look into the future with considerable confidence and optimism.

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