

15 Years Developing SETI from a Developing Country

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Argentina is the only developing country that has been performing **SETI** observational activities from a national astronomical facility over the last 15 years. In 1985, a group of students of physics from the University of Buenos Aires organized at the School of Exact and Natural Sciences, an international meeting to discuss the probable distribution of intelligent life in the universe. During three days, a distinguished group of scientists examined the main theories of the origin and evolution of life, the probable distribution of extrasolar planets, the appearance of intelligence and technical societies, the radioastronomical strategies to discover evidences of extraterrestrial technological activities and the social and anthropological consequences of the discovery of life elsewhere (Lemarchand, 1986 and 1992). The first consequence of this conference was the establishment of a **SETI** target search around 90 solar-type nearby stars located in the southern hemisphere, using the available facilities of the Instituto Argentino de Radioastronomía (Colomb, et al., 1988 and 1992). The IAR's facilities belongs to the National Research Council of Argentina(**CONICET**).

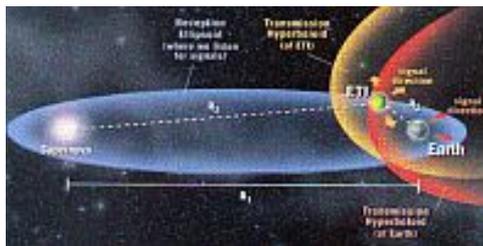


The Group of students of physics that organized the First Latin American Interdisciplinary Meeting on Intelligent Life in the Universe (Facultad de Ciencias Exactas y Naturales from the Universidad de Buenos Aires, December 20-23, 1985). Stand up in the back is Bruce Crow a JPL SETI scientist with his wife.

For the conference, NASA Jet Propulsion Laboratory and The Planetary Society (**TPS**) arranged the participation of Bruce Crow a **SETI** scientist who initiated the first contacts for mutual collaboration in **SETI** matters between **TPS** and **CONICET** (Lemarchand 1986, McDonough, 1987).

Just after the first year of observation around nearby stars, we initiated a

systematic search around the recently discovered SN1987A. Ivan Almar (1988) called our attention of an interesting way to synchronize the reception of unknown **ETI** signals. The greatest difficulty in making the first contact stems from the requirement that the incoming signal must arrive at the same time that the target civilization—us—has its receiver pointed toward the unknown transmitter. This synchronization of transmission and SETI search strategy. However, an extraterrestrial civilization using this kind of "active" broadcasting search method, (in contrast to our "passive" search method of listening only), might overcome this problem by using a natural astronomical phenomenon—probably a supernova — as a "beacon" that would attract the attention of other civilizations observing cosmic events. The sending civilization would then transmit its own message in the antipode direction of the supernova as seen from the transmitting planet, but would structure its signal in such way that anyone observing the cosmic event would be able to identify their signal as a separate, artificial, intelligently-generated communication, also coming to them from the same supernova direction.



Strategy to use Supernova as a beacon can narrow the search for extraterrestrial signals, which is assumed to rely on the exploding star as a source of attention. Earth radio telescopes would look for signals among stars that fall within an ellipsoidal region space defined by Earth's distance to the supernova (R_1), and to the possible ETI planet (R_2), and by the distance from the supernova to the ETI (R_3).

The relation $R_2 + R_3 - R_1 = a$ constant for each specific time after the supernova explosion. The ellipsoid enlarges over time, and R_1 and R_3 can be several hundreds thousands light-years. Moreover, we could transmit greetings to stars that fall within a particular region, which is a "hyperboloid of transmission" –a shape defined by time and the supernova's position in the sky. It basically corresponds to a zone that provides the best view of the supernova and Earth, so that an ETI studying the supernova would also see our signal coming to it from the same direction. Likewise, Earth would fall in the transmission hyperboloid of the ETI, if the ETI chose an identical strategy.

From November 1987, we began a series of observations around the SN1987A SETI ellipsoid, looking for continuous wave narrow band signals.

Different frequencies (1420 ± 5 MHz and 1667 ± 5 MHz $\Delta f/f \sim 10^{-6}$) were observed at several epochs, using IAR's antenna No.1. Some years later we started a search for ultra narrow band signals ($\Delta f/f \sim 10^{-11}$) inside the area determined by the ellipsoid projection on the sky. No **CW** signal at a level of 4×10^{-24} W m⁻² was detected (Lemarchand 1992, 1994, 1998b, and Lemarchand & Tarter 1994).



The author with Prof. Paul Horowitz at the Oak Ridge Observatory, in January 1988, while he was writing the proposal for the construction of a META twin system to be installed in the Southern Hemisphere.

In 1988, an agreement between CONICET and The Planetary Society (TPS) was signed to build an 8.4 million-channel analyzer, similar to the one that was in operation by Prof. Paul Horowitz at Harvard. The Society provided the funds for the construction, while CONICET provide the funds for the operation of one of the two 30 meter antennas of IAR for 12 hours a day during five years of continuous SETI observations. In 1989, two Argentine engineers spent a year with Horowitz at Harvard to duplicate the spectrum analyzer. Finally, on October 12, 1990 the META II system was dedicated.

The META II (Megachannel ExtraTerrestrial Assay) analyzer was used to perform a full-sky survey for artificial narrow-band signals the 1420 MHz line of neutral hydrogen, using an 8.4×10^6 channel Fourier spectrometer of 0.05 Hz resolution and 400 kHz of instantaneous bandwidth. The observing frequency was corrected both for motions with respect to three astronomical inertial frames, and for the effect of Earth's rotation, which provides a characteristic changing signature for narrow-band signals of extraterrestrial origin. Five Southern Hemisphere surveys ($-90^\circ \leq \delta \leq -10^\circ$) were completed during the first 7 years of observations. Almost 4×10^{13} different signals were analyzed and more than 18,000 hours of observations were registered.



Antenna No.1 of the Instituto Argentino de Radioastronomía (IAR), that is located 35 km from Buenos Aires. The institute that belongs to the National research Council of Argentina (CONICET) was founded in 1966 and has been performing radio astronomical research since then. On October 12, 1990 the META II system was dedicated and the first Southern Hemisphere full-sky SETI survey was initiated (Photo by Donald Tarter, 1990).

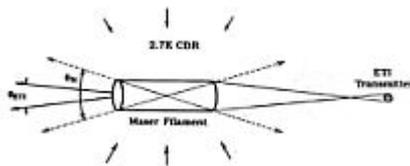
Between 1990 and 1995 the first high-resolution southern target search around 71 stars ($-90^{\circ} \leq \delta \leq -10^{\circ}$), was performed. For this search, we have selected, "all" the stars at distances nearer than 5 pc and those stars that are falling between +0.6 and +1.0 in the (B-V) color index, with spectral class V, that are at distances nearer than 15.5 pc. Stars bluer than +0.6 have main sequence lifetimes that are too short to provide long-term environmental stability, while stars redder than +1.0 cannot presently be detected. The observations were done with the same spectrometer, tracking each star, at least for 60 minutes, at three different epochs. The third observational strategy of the program done during the period 1990-1996 consisted in observing simultaneously identical celestial coordinates ($-30^{\circ} \leq \delta \leq -10^{\circ}$) between the Harvard/Smithsonian and the IAR's radio telescopes (Lemarchand et al. 1997).

In 1997, with the economical sponsorship of The Planetary Society we initiated a complete reform of the META II data acquisition system that transformed substantially the data analysis capability of the original system. With this upgrade we are able to make observations with the two IAR's 30-m antennas at 1.4; 1.6 and 3.3 GHz frequencies, to extend the instantaneous bandwidth and to fix a complete set of observational variables that were not possible with the original design (Lemarchand, 1998a).



The META II spectrum analyzer at the Instituto Argentino de Radioastronomía control room. The new data acquisition system allows to expand the instantaneous bandwidth from the original 400 kHz to 2 MHz and to make integration of the frequency windows over several hours. The maximum spectral resolution is of 0.05 Hz and the available observing frequencies are 1.4; 1.6 and 3.3 GHz.

New software tools were implemented and several new observational strategies are under development, e.g. following a suggestion by T. Gold (1976) and J. M. Cordes (1993) to make a complete survey of the OH masers for narrow band artificial signals. The same ideas were developed independently by Lemarchand (1992). Interstellar and circumstellar masers are natural amplifiers of high gain, so long as they are not saturated. Weak ETI sources, otherwise detectable at only parsec distances, may be rendered detectable across the Galaxy if viewed through a maser. These considerations imply that SETI in the directions of known interstellar masers (especially OH at 1.67 GHz and methanol at 6.6 GHz). OH maser gains could be of the order of 10^7 to 10^{11} . It appears highly desirable to search for narrow band signals in those maser frequencies and in the direction of the galactic known masers.



Amplification of the background, narrow beam ETI source and the cosmic blackbody radiation by a maser filament. Natural emission has a beam angle of $q_N \gg q_{ETI}$ and, hence, much smaller brightness temperature (After Cordes, 1993).

By the end of this year, we will be able to finish the first high spectral resolution survey of galactic disk OH masers in the Southern Hemisphere to test these theories. Other observations were performed with the new system using the 1.4 and 3.3 GHz receivers around nearby stars. We are initiating observations around the recently discovered eight new very low mass companions to Southern Hemisphere solar-type stars discovered at La Silla (ESO, 2000). We are also developing other plans to organize verifying and checking processes of candidate signals with observations that are carrying out from the 64-m observatory at Parkes (Australia) with the SERENDIP-type device.

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