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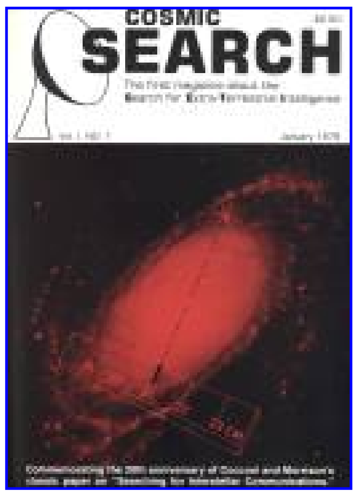

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Searching for Interstellar Communications

By: Giuseppe Cocconi* and Philip Morrison†
Cornell University, Ithaca, New York
* Now on leave at CERN, Geneva.
† Now on leave at the Imperial College of Science and Technology, London, S.W.7.

The year 1979 marks the 20th anniversary of the first publication in a scientific journal of a realistic strategy of a search for extra-terrestrial intelligence. The article, entitled "Searching for Interstellar Communications", was written by Giuseppe Cocconi and Philip Morrison, both then of Cornell University and appeared in NATURE.* By perceptive, incisive reasoning the authors develop the proposal that a search be made of some of the nearest sun-like stars for signals at or near the 21-centimeter wavelength of neutral hydrogen.

It is most appropriate that in this, the first issue of COSMIC SEARCH, this article by Cocconi and Morrison, now a classic of classics, is reproduced (with mathematics omitted). For historical interest, the first page of the article is reproduced just as it appeared. Following this article, Morrison reflects on the search from the perspective of two decades.—Eds.

* NATURE, vol. 184, no. 4690, pages 844- 846, Sept. 19, 1959. Reproduced by permission. Cocconi and Morrison's article in NATURE was sandwiched between an article on the electronic prediction of swarming in bees and one on metabolic changes induced in erythrocytes by x-rays.

No theories yet exist which enable a reliable, estimate of the probabilities of (1) planet formation; (2) origin of life; (3) evolution of societies possessing advanced scientific capabilities. In the absence of such theories, our environment suggests that stars of the main sequence with a lifetime of many billions of years can possess planets, that of a small set of such planets two (Earth and very probably Mars) support life, that life on one such planet includes a society recently capable of considerable scientific investigation. The lifetime of such societies is not known; but it seems unwarranted to deny that among such societies some might maintain themselves for times very long compared to the time of human history, perhaps for times comparable with geological time. It follows, then, that near some star rather like the Sun there are civilizations with scientific interests and with technical possibilities much greater than those now available to us.

To the beings of such a society, our Sun must appear as a likely site for the evolution of a new society. It is highly probable that for a long time they will have been expecting the development of science near the Sun. We shall assume that long ago they established a channel of communication that would one day become known to us, and that they look forward patiently to the answering signals from the Sun which would make known to them that a now society bas entered the community of intelligence. What sort of a channel would it be?

The Optimum Channel

Interstellar communication across the galactic plasma without dispersion in direction and flight-time is practical, so far as we know, only with electromagnetic waves.

Since the object of those who operate the source is to find a newly evolved society, we may presume that the channel used will be one that places a minimum burden of frequency and angular discrimination on the detector. Moreover, the channel must not be highly attenuated in space or in the Earth's atmosphere. Radio frequencies below about 1 Mc./s. (1 Mc./s. = 1 megacycle per second = 1 million cycles per second), and all frequencies higher than molecular absorption lines near 30,000 Mc./s., up to cosmic-ray gamma energies, are suspect of absorption in planetary atmospheres. The bandwidths which seem physically possible in the near-visible or gamma-ray domains demand either very great power at the source or very complicated techniques. The wide radio band from, say, 1 Mc. to 10 Mc./s., remains as the rational choice.

"No guesswork here is as good as finding the signal."

In the radio region, the source must compete with two backgrounds: (1) the emission of its own local star (we assume that the detector's angular resolution is unable to separate source from star since the source is likely to lie within a second of arc of its nearby star); (2) the galactic emission along the line of sight.

At what frequency shall we look? A long spectrum search for a weak signal of unknown frequency is difficult. But, just in the most favoured radio region there lies a unique, objective standard of frequency, which must be known to every observer in the universe: the outstanding radio emission line at 1,420 Me./s. (21 centimeter wavelength) of neutral hydrogen. It is reasonable to expect that sensitive receivers for this frequency will be made at an early stage of the development of radio-astronomy. That would be the expectation of the operators of the assumed source, and the present state of terrestrial instruments indeed justifies the expectation. Therefore we think it most promising to search in the neighborhood of 1,420 Mc./s.

In all directions outside the plane of the galaxy the 21-cm. emission line does not emerge from the general background. For stars in directions far from the galactic plane search should then be made around that wavelength. However, the unknown Doppler shifts which arise from the motion of unseen planets suggest that the observed emission might be shifted up or down from the natural co-moving atomic frequency by plus or minus approximately 300 kilocycles per second (corresponding to velocities of plus or minus 100 kilometers per second). Closer to the galactic plane, where the 21-cm. line is strong, the source frequency would presumably move off to the wing of the natural line background as observed from the direction of the Sun.

Nature of the Signal and Possible Sources

No guesswork here is as good as finding the signal. We expect that the signal will be pulse-modulated with a speed not very fast or very slow compared to a second, on grounds of band-width and of rotations. A message is likely to continue for a time measured in years, since no answer can return in any event for some ten years. It will then repeat, from the beginning. Possibly it will contain different types of signals alternating throughout the years. For indisputable identification as an artificial signal, one signal might contain, for example, a sequence of small prime numbers of pulses, or simple arithmetical sums.

The first effort should be devoted to examining the closest likely stars. Among the stars within 15 light years, seven have luminosity and lifetime similar to those of our Sun. Four of these lie in the directions of low background. They are Tau (τ) Ceti, Omicron 2 (o_2) Eridani, Epsilon (ε) Eridani, and Epsilon (ε) Indi. All these happen to have southern declinations. Three others, Alpha (α) Centauri, 70 Ophiucus and 61 Cygni, lie near the galactic plane and therefore stand against higher backgrounds. There are about a hundred stars of the appropriate luminosity among the stars of known spectral type within some fifty light years. All main-sequence dwarfs between perhaps GO and K2 with visual magnitudes less than about +6 are candidates.

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The reader may seek to consign these speculations wholly to the domain of science-fiction. We submit, rather, that the foregoing line of argument demonstrates that the presence of interstellar signals is entirely consistent with all we now know, and that if signals are present the means of detecting them is now at hand. Few will deny the profound importance, practical and philosophical, which the detection of interstellar communications would have. We therefore feel that a discriminating search for signals deserves a considerable effort. The probability of success is difficult to estimate; but if we never search the chance of success is zero.

Giuseppe Cocconi is research physicist at the Centré Européen Recherche Nucléaire (CERN) in Geneva, Switzerland where he has been for the past 16 years. Born in Como, Italy, in 1914, receiving his doctor's degree from the University of Milan in 1937, teaching physics there and at the University of Catania (Italy), he became professor of physics at Cornell University in 1947 where he stayed until going with CERN in 1963. His interests include atomic particle interactions, cosmic rays and radio astronomy.

Philip Morrison has been professor of physics at the Massachusetts Institute of Technology since 1965. Born in Somerville, New Jersey, in 1915 he earned his Ph.D. degree at the University of California in 1940 and then taught physics at San Francisco State College and the University of Illinois. Following two years as group leader at the Los Alamos Scientific Laboratory he was on the physics faculty of Cornell University from 1946 to 1965. Dr. Morrison has won a number of prizes for his work including the Pregel prize (1955), Babson prize (1957), and the Oersted Medal (1965). His interests are in the application of physics to astronomy. Author of numerous articles, many on SETI, participator in many SETI conferences and workshops, he recently was chairman of a NASA SETI advisory committee. He is a member of the Editorial Board of COSMIC SEARCH and for many years he has been book editor of "Scientific American".