

Z. PAPROTNY

Is SETI a Science?

A glimpse into the past and future

Possibility of extraterrestrial intelligent life has always been one of the most fascinating topics of popular beliefs - but also of scientific investigations. The word "scientific" applied for centuries to philosophical speculations. After all, "natural philosophy" once was name of what we now call "science". From pre-Socratic philosophers of ancient Greece (best exemplified by Metrodorus of Chios' famous sentence) up to medieval thinkers (St. Augustine, Nicholas Cusanus) the idea was always present in human thought though on a purely speculative level. Essential for putting the question of extraterrestrial life in a proper astronomical perspective were revolutionary concepts of infinite Universe introduced by Giordano Bruno and of "vortexes" being

the consequence of Cartesian cosmology. The idea of plurality of inhabited worlds blossomed, particularly in XVIIth and XVIIIth centuries, when virtually all celestial bodies were thought to be populated, not without support of such outstanding figures of that time like Kant, Huygens or Fontenelle. XIXth century brought Gauss' ideas of communication with other planets using geometrical figures of multikilometer size and was crowned by Schiaparelli's "detection" of Mars' *canali* in 1877.

Attitude of the scientific community in the modern era has been, on the other side, closely tied to currently prevailing theories of planetary cosmogony. Catastrophic scenarios for the origin of the Solar system, resulting in disbelief that its analogs might have originated elsewhere in the Universe, made astronomers skeptical for nearly half of the XXth century. It was only revival of Kant - Laplace nebular hypothesis that has changed the minds. As it soon appeared, the time for idea of extraterrestrial intelligence has come. Its contemporary period began in 1959 with two quite independent facts: publication of a seminal paper by Cocconi and Morrison in *NATURE* and first radio search for extraterrestrial intelligent signals realized by Drake. In 60's and 70's almost every aspect of ETI (Extra Terrestrial Intelligence) and SETI (Search for ETI) has been analyzed, both in scientific journals and in course of numerous symposia and conferences. The august organizations like Paris-based International Academy of Astronautics or International Astronomical Union identified SETI as area of research deserving support (corresponding member of the IAA from 1977 and ordinary member from 1989, since 1966 Professor Mieczysław Subotowicz is a member of the IAA's SETI committee, serving also from 1983 as a consultant to IAU's commission 51 - "Bioastronomy". In 1983 he became member of the Polish Academy of Sciences' Space Research Committee).

Since pioneering Drake's SETI programme over 50 searches have been realized throughout the world, mainly on radio but also on optical and IR frequencies. Fraction of the thus far explored search space is so tiny ($\cong 10^{-17}$) that the programmes

were in fact doomed to fail. Contemporary stage of SETI research will culminate on Columbus Day, 1992, with launching of NASA's Microwave Observing Program - MOP (date depending on NASA's FY 1989 budget approval). The bimodal strategy adopted for MOP foresees targeted searches in 1-3 GHz bandwidth in direction of a few hundred sun-like stars as well as all-sky search trading sensitivity for spatial and frequency coverage (4π radians and 1-10 GHz). Note that terrestrial technological civilization would NOT be discovered by extraterrestrial counterpart of MOP since it has been designed for detection of intentional signals ("call" beacons) - which, contrary to a widespread opinion, are not being beamed from Earth. The future of SETI (if any, should the MOP fail) may thus belong to searches aimed at detection of internal transmissions of possible ET civilizations (in certain bandwidths even Earth is more powerful source of radiation than Sun) - assuming that highly advanced civilizations don't bother of leakages. But who will finance a $\$10^{11}$ or so project giving no guarantee of success?

Is SETI a science?

Why the problem of ETI, a beloved topic of sci-fi stories for a few decades, has suddenly become recognized as a valid science (as demonstrated by, e.g., IAA and IAU)? One answer is that a critical mass of scientists decided publicly to associate with the topic. However, this bare fact is no proof for SETI being the science. Let's take for example question of SETI's object of research. If compared with well defined objects of "classic" areas of science the object of SETI looks dim, most frequently being a mere projection of life and intelligence as-we-know-it from Earth. Nobody knows if there is anybody out there, on what level of social organization, disposing of what kind of technology. In this respect problem of ETI may resemble Lem's "dracology" or science of non-existing. Though no ETI has yet been discovered, exactly as no dragon, there is however a difference. We know we exist. We know that radio waves can penetrate depths of the Universe. We know that technology of radio communication is available to any civilization on early

stage of its development - once it enters technological way of evolution. In this context what we search for are transmitters - not civilizations ! If, as thought by paradigms of modern science, life on Earth came into existence in a natural way one may believe that ETI's (whatever they are) operating their transmitters may have evolved elsewhere in Cosmos. The possibility may be extremely small but there is no other way to estimate it than to search. Belief that carrying SETI makes sense has been strengthened by discovery of a multitude of (abiogenic) organic compounds which seem to be ubiquitous in such diverse environments as cometary nuclei, planetary atmospheres and interstellar clouds. Even more important (for SETI) are recent advances in searches for extrasolar planetary systems, as we know no better place for life than planetary surface. Several projects in that area are currently under way, sparked by IRAS' discovery of cold material orbiting Vega and other stars.

Intrinsic difficulties in defining what is the object of SETI may stem directly from its interdisciplinary nature. The single hypothesis for the time being the science of SETI should try to prove or disprove can thus be presented in form of a following question :

Do exist in the galactic neighbourhood of the Sun sources of electromagnetic transmissions that would bear recognizable signature of intelligent origin in form of a coding achieved by modulation of some of transmissions' characteristics ?

Negative answer to this question may mean that we are the single intelligent species in the Galaxy (if not the Universe), but may also be quite meaningless - if we don't choose the right frequency or direction. Be the answer positive, the consequences can hardly be overestimated. Even reception of a string like 31415926536 would bring more food for thought than its trivial content. The only way to check, even with spatially and/or temporally limited conclusions is to search. Unlike orthodox science present-day SETI is not able to falsify its working hypothesis. What it is able to do is putting upper limits on probability of existence of signals being sought. If the signals

are to be recognized as artificial they possibly must contain some sort of information. All criteria of artificiality applying to physical characteristics of the signal or the emitting source (point-like appearance, circular polarity, non-Gaussian distribution of power, time variability, etc.) have been fulfilled by scores of natural sources. A spectacular example is SS433 system which demonstrates blue- and red-shifting of the same lines in its spectrum - phenomenon once proposed as evidence of source's artificial nature.

The most challenging aspect of SETI methodology may well be the question of our ability to comprehend hypothetical message, or to put it in another way - to get into semantic contact with its senders. What is the common field of semantic reference for civilizations which evolved in a different cosmic contextes and probably along different pathways ? To what degree is experience of our technological society universal ? How long-lived are exponential trends characteristic of activities of terrestrial life ? What, at last, is our future ? Answers to those and similiar questions are of utmost importance not only to SETI but to all humankind as well. If only for this reason it is worthwhile to pursue SETI. It may bring us some knowledge about ubiquity of intelligence and technology in the Universe, but it surely will give us a deeper insight into question of our place in it. So - let's go SETI !

Bibliography

Instead of usual bibliography, this note ends with listing of SETI-related publications authored by Professor Mieczysław Subotowicz (extracted from "Bibliography of Interstellar Travel and Communication" we compile for the *JOURNAL OF THE BRITISH INTERPLANETARY SOCIETY*). Some of them advanced for the first time in the SETI literature such topics as using neutrinos for interstellar communication (ref.4), carrying SETI from Earth's satellite orbit (ref.18), application of unf iled aperture radiotelescopes for SETI (ref.28), or propulsion aspects of nuclear matter compression and muon "cold" fusion (ref.44). Ref.34 will appear in vol.18, 1989, of *ACTA ASTRONAUTICA*.

- [1] Subotowicz M.
"Theory of the n-step relativistic rocket"
PROC. 10TH INTERNATIONAL ASTRONAUTICAL CONGRESS (LONDON, 1959)
Springer Verlag, Vienna, 1960, 852-864 (in German)
- [2] Subotowicz M.
"Project Orion"
ASTRONAUTYKA, no. 2, 1963, cover pg. (in Polish)
- [3] Subotowicz M.
"Critical comments on interstellar flights. II. Energy aspects of interstellar flights"
ASTRONAUTYKA, v. 7, no. 4, 1964, 21-25 (in Polish)
- [4] Subotowicz M.
"Critical comments on interstellar flights. III. Interstellar communication using electromagnetic or neutrino signals"
ASTRONAUTYKA, v. 10, no. 2, 1967, 19-24 (in Polish)
- [5] Subotowicz M.
"Neutrinos for interstellar communication"
POSTĘPY TECHNIKI JADROWEJ, v. 11, 1967, 475-479 (in Polish)
- [6] Subotowicz M.
"Search for extraterrestrial scientific-technical civilizations"
PROBLEMY, v. 24, no. 1, 1968, 16-20 (in Polish)
- [7] Subotowicz M.
"Far perspectives of astronautics. I. Flights to distant planets, interstellar flights and communication"
ASTRONAUTYKA, v. 11, no. 2, 1968, 23-25 (in Polish)
- [8] Subotowicz M.
"Far perspectives of astronautics. II. Stages of the physical and chemical evolution of matter"
ASTRONAUTYKA, v. 11, no. 3, 1968, 18-20 (in Polish)
- [9] Subotowicz M.
"Far perspectives of astronautics. III. Basic biological solvent: water, basic bioelement: carbon"
ASTRONAUTYKA, v. 11, no. 4, 1968, 15-17 (in Polish)
- [10] Subotowicz M.
"Symposium on communication with extraterrestrial intelligent beings"
ASTRONAUTYKA, v. 11, no. 4, 1968, 22 (in Polish)
on a cancelled Prague SETI symposium, planned for 1969
- [11] Subotowicz M.
"In search of extraterrestrial civilizations. I. The background, realization and goals of the Cyclops program"
ASTRONAUTYKA, v. 16, no. 4, 1973, 2-4 (in Polish)
- [12] Subotowicz M.
"In search of extraterrestrial civilizations. II. The Cyclops program for establishing interstellar contact"
ASTRONAUTYKA, v. 16, no. 5, 1973, 2-6 (in Polish)

- [13] Subotowicz M.
"Conditions for the development and the danger of collapse of technological civilizations"
PROBLEMY OCHRONY SRODOWISKA
University of Lublin, Lublin, Poland, 1974, 21-46 (in Polish)
- [14] Subotowicz M.
"Near and far future of astronautics"
ASTRONAUTYKA, v. 17, no. 2-3, 1974, 35-41 (in Polish)
- [15] Subotowicz M.
"Problems of search for extraterrestrial civilizations"
POSTEPY ASTRONAUTYKI, no. 4, 1976, 7-22 (in Polish)
- [16] Subotowicz M.
"Problems of communication with extraterrestrial civilizations"
ASTRONAUTYKA, no. 2, 1977, 9-10 (in Polish)
- [17] Subotowicz M.
"Interstellar communication"
PROBLEMY, no. 9, 1977, 11-14 (in Polish)
- [18] Subotowicz M.
"CETI from an Earth satellite orbit"
J. BRIT. INTERPLANETARY SOC., v. 31, no. 3, 1978, 109-110
IAF Congress paper, Anaheim, 1978
- [19] Subotowicz M.
"On interstellar communication (CETI)"
ASTRONAUTYKA, v. 21, no. 4, 1978, 4-8 (in Polish)
- [20] Subotowicz M., Usowicz J., Paprotny Z.
"On the active and passive CETI from the Earth's satellite orbit"
ACTA ASTRONAUTICA, v. 6, no. 1-2, 1979, 203-212
IAF Congress paper IAF-77-A-48, Prague, 1977
- [21] Subotowicz M.
"CETI conferences in Katowice (Poland)"
POSTEPY ASTRONAUTYKI, no. 1, 1979, 9-12 (in Polish)
- [22] Subotowicz M.
"On interstellar communication (CETI) using space radio telescopes"
POSTEPY ASTRONAUTYKI, v. 12, no. 1, 1979, 73-90 (in Polish)
- [23] Subotowicz M.
"Progress in CETI and SETI"
ASTRONAUTYKA, no. 2, 1979, 2-7 (in Polish)
on 1978 Dubrovnik IAF Congress SETI symposium
- [24] Subotowicz M.
"On the communication with neutrino beams"
POSTEPY ASTRONAUTYKI, v. 12, no. 3, 1979, 153-156 (in English)

- [25] Subotowicz M.
"Interstellar communication by neutrino beams"
ACTA ASTRONAUTICA, v. 6, no. 1-2, 1979, 213-220
IAF Congress paper, Amsterdam, 1974
- [26] Subotowicz M.
"CETI and SETI during the XXXth Congress of the International Astronautical Federation"
ASTRONAUTYKA, no. 2, 1980, 9-12 (in Polish)
- [27] Subotowicz M.
"Communication with extraterrestrial civilizations"
ASTRONAUTYKA, no. 6, 1980, 5-9 (in Polish)
on 1980 Tokyo IAF Congress SETI symposium
- [28] Subotowicz M.
"Space radiotelescope with the unfilled aperture for CETI, SETI and astronomy"
POSTĘPY ASTRONAUTYKI, v. 14, no. 3, 1981, 7-34 (in English)
IAF Congress paper IAF-78-A-46, Dubrovnik, 1978
- [29] Subotowicz M.
"Advances in CETI and SETI"
ASTRONAUTYKA, no. 3, 1982, 4-9 (in Polish)
on 1981 Rome IAF Congress SETI symposium
- [30] Subotowicz M., Paprotny Z.
"Impact of CETI-SETI on the development of biology, astronomy, radioastronomy, astrophysics, and culture"
SPACE - MANKIND'S FOURTH ENVIRONMENT
Pergamon Press, Oxford, 1982, 385-396
IAF Congress paper IAA-81-297, Rome, 1981
- [31] Subotowicz M.
"SETI Tallinn 81"
POSTĘPY ASTRONAUTYKI, v. 15, no. 4, 1982, 65-81 (in Polish)
- [32] Subotowicz M.
"CETI-SETI: many questions without answers"
ASTRONAUTYKA, no. 2, 1983, 6-11 (in Polish)
on 1982 Paris IAF Congress SETI symposium
- [33] Subotowicz M.
"CETI-SETI in Budapest"
ASTRONAUTYKA, no. 6, 1983, 5-11 (in Polish)
on 1983 Budapest IAF Congress SETI symposium
- [34] Subotowicz M.
"Threats to CETI-SETI, possible solutions, and the anthropic principle (AP)"
IAF Congress paper IAA-84-247, Lausanne, 1984
condensed in: J. BRIT. INTERPLANET. SOC., v. 38, no. 6, 1985, 279-280
- [35] Subotowicz M.
"Cosmic crooks: UFO's, visitors from space"
ASTRONAUTYKA, no. 2, 1984, 11-18 (in Polish)
- [36] Subotowicz M.
"On some time, mass, energy and power characteristics of the interstellar flights in a one-step rocket"
ACTA ASTRONAUTICA, v. 11, no. 10-11, 1984, 679-686
IAF Congress paper IAA-82-271, Paris, 1982

- [37] Subotowicz M.
"Mass-, time-, and energy-characteristics of the interstellar flights during the long proper time of astronauts"
ACTA ASTRONAUTICA, v. 12, no. 1, 1985, 45-48
IAF Congress paper IAA-83-284, Budapest, 1983
- [38] Subotowicz M.
"New tendencies in CETI-SETI"
J. BRIT. INTERPLANETARY SOC., v. 38, no. 6, 1985, 287-288 [C]
- [39] Subotowicz M.
"On CETI-SETI in another way"
ASTRONAUTYKA, no. 3, 1985, 12-19 (in Polish)
on 1984 Lausanne IAF Congress SETI review meeting
- [40] Subotowicz M.
"Cosmological and anthropic principles, cosmic and planetary events, and the existence of life in the Universe"
POSTEPY ASTRONAUTYKI, v. 18, no. 3-4, 1985, 113-131 (in English)
- [41] Subotowicz M.
"On the possible existence of only terrestrial-like, scientific-technical civilizations throughout the Galaxy ..."
J. BRIT. INTERPLANETARY SOC., v. 39, no. 11, November 1986, 499-502
IAF Congress paper IAA-85-477, Stockholm, 1985
- [42] Subotowicz M.
"Interstellar travel"
SPACEFLIGHT, v. 28, no. 2, 1986, 79
on 1985 Stockholm IAF Congress "Interstellar Travel" session
- [43] Subotowicz M.
"CETI-SETI"
SPACEFLIGHT, v. 28, no. 2, 1986, 81
on 1985 Stockholm IAF Congress SETI sessions
- [44] Subotowicz M.
"Energy for interstellar flights delivered through nuclear matter compression in heavy nuclei collisions and in muon ..."
J. BRIT. INTERPLANETARY SOC., v. 39, no. 7, 1986, 312-316
- [45] Subotowicz M.
"New ideas in CETI-SETI"
ASTRONAUTYKA, no. 2, 1986, 14-16 (in Polish)
continued in no. 3, 18-19 (on 1985 IAF Congress SETI sessions)
- [46] Subotowicz M., Paprotny Z.
"Unconventional and non-microwave methods of CETI and SETI"
PROBLEMA POISKA ZHIZNI VO VSELENNOI. TRUDY TALLINSKOGO SIMPOZYUMA
Nauka Publishing House, Moscow, 1986, 161-169 (in Russian)
IAF Congress paper 80-IAA-52, Tokyo, 1980
- [47] Subotowicz M.
"On CETI-SETI in another way"
ASTRONAUTYKA, v. 30, no. 2, 1987, 18-20 (in Polish)
- [48] Subotowicz M.
"How to fulfill expectations of faster advances in CETI-SETI ?"
ASTRONAUTYKA, no. 3, 1987, 9 (in Polish)

- [49] Subotowicz M.
"Five-year plan of the IAA SETI Committee activities"
ASTRONAUTYKA, no. 3, 1987, 20 (in Polish)
- [50] Subotowicz M.
"Evolution of the Universe"
POSTĘPY ASTRONAUTYKI, v. 20, no. 3-4, 1987, 7-60 (in Polish)
- [51] Subotowicz M.
"Propulsion concepts for nuclear matter compression energy and "cold" fusion energy sources in interstellar flight"
ACTA ASTRONAUTICA, v. 17, no. 8, 1988, 937-942
IAF Congress paper IAA-87-608, Brighton, 1987
- [52] Subotowicz M.
"Bioastronomy - future directions"
ASTRONAUTYKA, v. 31, no. 3, 1988, 14-16 (in Polish)
- [53] Subotowicz M.
"One more solution to the Fermi paradox"
BIOASTRONOMY-THE NEXT STEPS
Kluwer Academic Publishers, Dordrecht, 1988, 287-288
- [54] Subotowicz M.
"Rise of interest in CETI-SETI and in interstellar flights"
POSTĘPY ASTRONAUTYKI, v. 21, no. 3-4, 1988, 169-175 (in Polish)
- [55] Subotowicz M.
"Earth's atmosphere and life's origin and evolution"
POSTĘPY ASTRONAUTYKI, v. 21, no. 3-4, 1988, 15-32 (in Polish)
- [56] Subotowicz M.
"Guaranteed mutual destruction or secured common survival (on SDI)"
POSTĘPY ASTRONAUTYKI, v. 21, no. 3-4, 1988, 120-143
- [57] Subotowicz M.
"In search of extrasolar planetary systems"
DELTA, no. 3, 1989, 6-7 (in Polish)
- [58] Subotowicz M.
"Improvement of technical SETI instruments"
ASTRONAUTYKA, v. 32, no. 3, 1989, 19-21 (in Polish)
on 1988 Bangalore IAF Congress SETI symposium