QUESTIONMARKS REMAINING

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ABSTRACT: As this successful Symposium is drawing to a close, let me bring to your attention some important questionmarks that still remain unanswered and for which we will hopefully have some better answers in our next meeting in Hungary in the summer of 1987.

Drake's equation is:

$$N_C = R_* f_* p_p n_p p_\ell p_\iota p_t T_t \qquad (1)$$

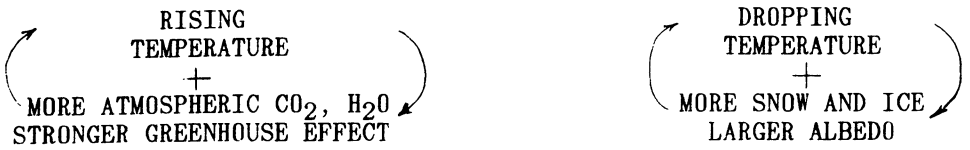
where the letters as they appear in sequence stand for the number of contemporary civilizations in the Galaxy, the rate of star formation, the fraction of stars appropriate to support life, the probability of planet formation, the average number of habitable planet around the star, the probability for the emergence of life, intelligence, technology, and finally the life expectancy of technological activity. One uncertain (and suspicious) point is the huge time gap (more than 3 billion years) between the emergence of life and the emergence of intelligence on Earth. What does this long gap say to us?

Some years ago binary stellar systems were considered to be unattractive for life. At this conference the Nemesis (or preferably: the Shiva) hypothesis indicated that a stellar companion might be advantageous for evolution. Is it true that without the starlet Nemesis evolution would stand still and that our biosphere would change exceedingly slowly? Is the rate of evolution strongly related to the orbiting period of such a wide binary system? Would it be possible to realize a much faster evolution elsewhere, even around giant stars? The possible answers may influence the value of N_C and the selection of targets for SETI.

What is the acceptable temperature range for life? Is it 273K < T < 373K (as assumed earlier) or is it 273 K < T < 600K (as suggested by the advocates of deep ocean hot springs)?

Terrestrial life probably evolved in oceans at a rather steady temperature through the past 3.5 billion years. It is hard to explain this steady temperature on Earth. The physical atmosphere is unstable due to two positive feedback mechanisms:

M. D. Papagiannis (ed.), The Search for Extraterrestrial Life: Recent Developments, 535–537.



In the past the heat input varied for several reasons including, increasing solar luminosity, decreasing radioactivity, weakening tidal friction, and changing from a CO_2+H_2O atmosphere to a N_2+O_2 atmosphere with a parallel decrease of the greenhouse effect. What did stabilize the oceanic temperature in spite of these drastic changes? If lucky cancellations of opposite effects are needed for the emergence of intelligence, the factor p_i may be negligibly small. (The very attractive Gaia hypothesis of Lovelock offers a different answer, but it does not give any explanation for the origin of a self-controlled atmosphere. Evolution by natural selection works only in populations, but not in the case of a single unconscious structure. If you intend to take both, Lovelock and Darwin, seriously, you have to speculate about the extraterrestrial origin of Gaia, considering the whole Galaxy as the stage of evolution.)

Another uncertain point in Drake's equation is T_t, the average duration of technological and scientific activity in a society. It T_t is long enough, N_c turns out to be large and there must be many contemporary civilizations with whom we could establish radio contact. One may expect positive result within a lifetime.

If, however, T_t is short, then the number N_c of contemporary civilizations may be discouragingly small. If scientific interest ends too soon (due to extinction, self destruction, disinterest, or fear), the only useful form of SETI would be astroarcheology by space probes, but the duration of such missions would exceed a human lifetime.

Terrestrial experience indicates that people become serious about a search if there is a good chance of success within their own lifetime. (Is there a universal psychological law in the Universe?) If the duration of a search is too long, it could conceivably be undertaken by the next generation of intelligence, namely by not-aging machines. (It would be better, however, to place them in airless cold corners of space, rather than on wet planets.) Where should we look for? (By the way, what might be the lifetime of intelligent creatures elsewhere?)

"If the emergence of life and intelligence is so natural, where are they?" - Fermi asked. "Why do we not see any indication for astroengineering?" - Dyson asked. Exponential growth was a common way of thinking in the 1960's. (People frightened by population pressure wanted to build big machines and dreamt about the colonization of space.) In the 1970's we learned a bitter lesson about the limits of growth. Now in the 1980's zero growth seems to be more attractive. "Small is beautiful!" Space colonization does not seem to be an economic solution to achieve a steady population. (It may be wise, however, to settle in space, to ensure survival in case of a nuclear holocaust on Earth.) We have got our smart computers. SETI looks more like a hobby than a necessity, but these small machines make it less expensive and more efficient. Do our conclusions depend so strongly on fashion, wisdom, religion, or ideology?

Will our partners in CETI be people for whom the rate of multiplication has a biological value, or smart computers the steady population of which might be competing in collecting information? I am afraid only an experimental search can provide the answers.

Let me recollect an impression from a CETI conference held about twelve years ago at the Byurakan Observatory in Armenia, where Prof. Morrison discussed in an after dinner session the possible impact of CETI on human society. At about midnight the bus was taking us down the slope of Caucasus, to our hotel in Yerevan. In the moonlight we watched the white peak of the Mount Ararat, on which Noah's Ark is said to have beached. Suddenly someone asked in the dark bus: "How will they look like?" Another voice (I think, he was Minsky) immediately answered: "They will be machines!" Noticing the disillusionment from this answer (no emotions? no love?) Minsky went on with the explanation: SETI needs a long effort and only machines will be persistent enough. He closed the discussion by saying: "The price to be paid for sex is death." Prof. Morrison remarked "I see no difference in communications with smart people or with smart machines!"

There is a saying (not fully supported by science) that Hungarians arrived from another planet. I mention this to raise your interest in attending the next Bioastronomy Symposium in Hungary three year from now. You will receive an extraterrestrially cordial welcome!

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