

"Where Are They?"
Univ. of Maryland
Nov. 2-3, 1979.

THE LIKELIHOOD OF INTERSTELLAR COLONIZATION,
AND THE ABSENCE OF ITS EVIDENCE.

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According to several estimates, about half a percent of all stars may have a planet similar to our Earth, but in the average about four billion years older than Earth because our Sun is not an old star, and star formation was most productive in the early times. Regarding the origin and evolution of life, our own case is at present the only case of life we know of. Are we permitted to generalize this single case? Can we do statistics with $n=1$? As I have mentioned earlier, the laws of statistics say that $n=1$ yields an estimator for the average, but none for the mean error (which would need at least $n=2$). This means: assuming us to be average has the highest probability of being right, but we do not have any indication of how wrong this may be. Leaving statistics and arguing by analogy, we may add that most things in nature do not scatter over too large a range, up to a few powers of ten, mostly. Thus, the best we can do is to assume that we are average, but to allow for a wide (but not infinite) error of this assumption. If we now generalize our own case, then life in our Galaxy would have started on about one billion planets several billion years ago. And arguing by extrapolation, we should expect this life to have developed meanwhile extremely far beyond our own present state. However, nothing but wild guesses can be done regarding the direction, the range, and possibly the termination of such far-out developments.

What activities should we then expect, visible to us? And mainly: Why don't we see any? This is a great tantalizing puzzle.

Looking at our own present activities brings us back to Frank Drake's old question: "Is There Intelligent Life on Earth?" Our own large-scale activities are mostly self-destructive, with a world-wide arms race of 400 billion dollars per year, which is 100 times the budget of NASA or 400 times that of NSF. All the big nations spend about 25-50% of their total governmental budget, or about 5-10% of their Gross National Product, on what each side calls defense. It is clear that this enormous arms escalation cannot go on forever. We shall either blow up, sooner or later, or we must redirect this tremendous work force to peaceful endeavors, hopefully to the exploration and exploitation of all the many resources of our solar system. And to large dedicated SETI projects.

Provided we do have a future, let us guess some of our future activities. We are now using up our terrestrial resources at an alarmingly fast and still increasing rate, and after a few more generations we must develop, introduce and enforce rather elaborate and expensive recycling systems for most of the metals and some other minerals; but no recycling system can ever work a hundred percent. And we have just now begun to feel an energy crisis, the really dramatic part of which is still ahead of us. But if demands are increasing and supplies are running out, why on Earth should we stay?

The following lectures will show that large self-sustaining, growing and multiplying colonies throughout our solar system can be made, for mining and production, even with our present beginner's technology and with less money than the suicidal arms race. After some large original investments, the colonies will become quite vital and profitable when our resources on Earth

run out. These colonies will grow with their own babies and grandchildren, and, after more and more generations out in space, their people will feel less and less of their originally strong ties to the home planet Earth, probably up to some Declarations of Independence.

Larger groups of thousands of volunteers may decide to take off in huge "mobile homes" on interstellar trips lasting many generations, finally colonizing the planets of other stars. And after a certain settling time on such a planet, the same cycle may repeat, leading again to mobile homes on another interstellar trip to the next stars and their planets. In this way we would have started a wave of stepwise colonizations, finally covering the whole Galaxy from one end to the other, and every nice planet in it. The complete Galactic colonization could well be finished within some ten million years or less, even with our present limited knowledge of physics and technology.

And here we have our great puzzle. Such a wave of colonization could have been started by any one out of the billion of early civilizations in our Galaxy. Our Earth should have been colonized long ago, and we ourselves should be the descendants of some early settlers, and not the homegrown humans that we certainly are.

Should we really assume such an urge for interstellar colonization, is this reasonable and justified? First, it is only necessary that at least one civilization felt the urge strong enough to get it done, one out of a billion potential ones. Furthermore, quite in general, life shows a strong tendency to fill out every possible niche, from dry deserts to cold polar regions, from swamps to bare rocks, from caves to the tops of mountains. Life has started in the water, it has conquered first the land and soon the air; it begins right now to conquer empty space nearby, and so it may quite naturally proceed to conquer interstellar distances as well.

What enables or triggers the larger steps of this development? The decisive milestones of evolution are set by introducing and exploiting new ways of information handling. All life, self-reproductive life, began with the genetic code, which is a most ingenious way of storing and reproducing all the information needed for storing and reproducing that very information plus whatever is needed for growing the whole organism surrounding it, including information about maintenance and repair and behavior. The next large step, the development of higher life, was made possible by growing a nervous system with a brain as its main office of command, where incoming informations are evaluated, memories are stored, and outgoing instructions are given. The third large step, our whole human culture, is based on the development of speech about a million years ago, it has been drastically enhanced by the introduction of script, and now it begins another revolution by using cybernetic means. And so this whole evolution should quite naturally proceed to a large-scale network of interstellar communication, involving all the many members of the Galactic Club. And again we have our puzzle, that all this should actually have been done long ago, that the whole Galaxy should be teeming with life, "empty" space should be bristling with messages and probes, some of it obvious in many ways, whereas we have not yet found any evidence of any extraterrestrials.

Many reasons against colonization have been mentioned for explaining the puzzle. For example: self-destruction of technologies, biological degeneration, stagnation by over-stabilization against crises, complete change of cultural interests, space technology never becoming cost-effective, a repetition time for traveling and settling of more than a million years, colonization turning from an organized procedure into a random walk. All of these reasons could

very well hold in some cases, maybe even in most cases, but hardly with no exception at all in a billion. What matters is the far-out tail of a highly populated distribution.

A possible conclusion then is that we are actually alone, by some reason not yet understood. Or could it just be that one in a billion of nice habitable planets has been overlooked or neglected by the colonizers? And regarding all the other evidence to be expected: maybe we do not look for the right thing, or we do not understand what we see? The great puzzle is still unsolved.

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