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An Explanation for the Absence of Extraterrestrials on Earth

Michael H. Hart

(Advanced Study Program, National Center for Atmospheric Research*, Boulder, Colorado 80303)

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SUMMARY

We observe that no intelligent beings from outer space are now present on Earth. It is suggested that this fact can best be explained by the hypothesis that there are no other advanced civilizations in our Galaxy. Reasons are given for rejecting all alternative explanations of the absence of extraterrestrials from Earth.

Are there intelligent beings elsewhere in our Galaxy? This is the question which astronomers are most frequently asked by laymen. The question is not a foolish one; indeed, it is perhaps the most significant of all questions in astronomy. In investigating the problem we must therefore do our best to include all relevant observational data.

Because of our training, most scientists have a tendency to disregard all information which is not the result of measurements. This is, in most matters, a sensible precaution against the intrusion of metaphysical arguments. In the present matter, however, that policy has caused many of us to disregard a clearly empirical fact of great importance, to wit: *There are no intelligent beings from outer space on Earth now.* (There may have been visitors in the past, but none of them has remained to settle or colonize here.) Since frequent reference will be made to the foregoing piece of data, in what follows we shall refer to it as 'Fact A'.

Fact A, like all facts, requires an explanation. Once this is recognized, an argument is suggested which indicates an answer to our original question. If, the argument goes, there were intelligent beings elsewhere in our Galaxy, then they would eventually have achieved space travel, and would have explored and colonized the Galaxy, as we have explored and colonized the Earth. However, (Fact A), they are not here; therefore they do not exist.

The author believes that the above argument is basically correct; however, in the rather loose form stated above it is clearly incomplete.

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After all, might there not be some other explanation of Fact A? Indeed, many other explanations of Fact A have been proposed: however, none of them appears to be adequate.

The other proposed explanations of Fact A might be grouped as follows:

(1) All explanations which claim that extraterrestrial visitors have never arrived on Earth because some physical, astronomical, biological or engineering difficulty makes space travel infeasible. We shall refer to these as 'physical explanations'.

(2) Explanations based on the view that extraterrestrials have not arrived on Earth because they have chosen not to. This category is also intended to include any explanation based on their supposed lack of interest, motivation or organization, as well as political explanations. We shall refer to these as 'sociological explanations'.

(3) Explanations based on the possibility that advanced civilizations have arisen so recently that, although capable and willing to visit us, they have not had time to reach us yet. We shall call these 'temporal explanations'.

(4) Those explanations which take the view that the Earth *has* been visited by extraterrestrials, though we do not observe them here at present.

These four categories are intended to be exhaustive of the plausible alternatives to the explanation we suggest. Therefore, if the reasoning in the next four sections should prove persuasive, it would seem very likely that we are the only intelligent beings in our Galaxy.

PHYSICAL EXPLANATIONS

After the success of Apollo 11 it seems strange to hear people claim that space travel is impossible. Still, the problems involved in interstellar travel are admittedly greater than those involved in a trip to the Moon, so it is reasonable to consider just how serious the problems are, and how they might be overcome.

The most obvious obstacle to interstellar travel is the enormity of the distances between the stars, and the consequently large travel times involved. A brief computation should make the difficulty clear: The greatest speeds which manned aircraft, or even spacecraft, have yet attained is only a few thousand km hr^{-1}. Yet even travelling at 10 per cent of the speed of light ($\sim$one billion km hr^{-1}) a one-way trip to Sirius, which is one of the nearest stars, would take 88 years. Plainly, the problem presented is not trivial; however, there are several possible means of dealing with it:

(1) If it is considered essential that those who start on the voyage should still be reasonably youthful upon arrival, this could be accomplished by having the voyagers spend most of the trip in some form of 'suspended animation'. For example, a suitable combination of drugs might not only put a traveller to sleep, but also slow his metabolism down by a factor of 100 or more. The same result might be effected by freezing the space voyagers near the beginning of the trip, and thawing them out shortly before arrival. It is true that we do not yet know how to freeze and revive warm-blooded animals but: (a) future biologists on Earth (or biologists in advanced civilizations elsewhere) may learn how to do so; (b) intelligent beings arising in other solar systems are not necessarily warm-blooded.

(2) There is no reason to assume that all intelligent extraterrestrials have life spans similar to ours. (In fact, future medical advances may result in human beings having life expectancies of several millenia, or even perhaps much longer.) For a being with a life span of 3000 years a voyage of 200 years might seem not a dreary waste of most of one's life, but rather a diverting interlude.

(3) Various highly speculative methods of overcoming the problem have been proposed. For example, utilization of the relativistic time-dilation effect has been suggested (though the difficulties in this approach seem extremely great to me). Or the spaceship might be 'manned' by robots, perhaps with a supplementary population of frozen zygotes which, after arrival at the destination, could be thawed out and used to produce a population of living beings.

(4) The most direct manner of handling the problem, and the one which makes the fewest demands on future scientific advances, is the straightforward one of planning each space voyage, from the beginning, as one that will take more than one generation to complete. If the spaceship is large and comfortable, and the social structure and arrangements are planned carefully, there is no reason why this need be impracticable.

Another frequently mentioned obstacle to interstellar travel is the magnitude of the energy requirements. This problem might be insurmountable if only chemical fuels were available, but if nuclear energy is used the fuel requirements do not appear to be extreme. For example, the kinetic energy of a spaceship travelling at one-tenth the speed of light is:

$$\mathrm{KE} = (\gamma - 1)\, Mc^2 = ([1{\cdot}0 - 0{\cdot}01]^{-1/2} - 1)\, Mc^2 = 0{\cdot}005\, Mc^2 . \quad (1)$$

Now the energy released in the fusion of a mass F of hydrogen into helium is approximately $0{\cdot}007\, Fc^2$. In principal, the mechanical efficiency of a nuclear-powered rocket can be more than 60 per cent (**1, 2**). However, let us assume that in practice only one-third of the

nuclear energy could actually be released and converted into kinetic energy of the spacecraft. Then the fuel needed to accelerate the spaceship to 0·10 c is given by:

$$0{\cdot}005\, Mc^2 = 0{\cdot}007\, Fc^2/3\,. \qquad (2)$$

This gives: $F = 2{\cdot}14\, M$, and $T = 3{\cdot}14\, M$, where T is the combined mass of spaceship and fuel. The necessity of starting out with enough fuel first to accelerate the ship, and later to decelerate, introduces another factor of 3·14; so initially we must have $T = 9{\cdot}88\, M$. In other words, the ship must start its voyage carrying about nine times its own weight in fuel. This is a rather modest requirement, particularly in view of the cheapness and abundance of the fuel. (The enormous fuel-to-payload ratios computed by Purcell (**3**) are a result of his considering only relativistic space flight; a travel speed of 0·1 c seems more realistic.) Furthermore, there are several possible ways of reducing the fuel-to-payload ratio, including (a) refuelling from auxiliary craft; (b) scooping up H atoms while travelling through interstellar space; (c) greater engine efficiencies; (d) travelling at slightly lower speeds (travelling at 0·09 c instead of 0·10 c would reduce the fuel-to-payload ratio to 6·5:1); and (e) using methods of propulsion other than rockets. For some interesting possibilities see Marx (**4**) and other papers listed by Mallove & Forward (**5**).

It can be seen that neither the time of travel nor the energy requirements create an insuperable obstacle to space travel. However, in the past, it was sometimes suggested that one or more of the following would make space travel unreasonably hazardous: (a) the effects of cosmic rays; (b) the danger of collisions with meteoroids; (c) the biological effects of prolonged weightlessness; and (d) unpredictable or unspecified dangers. With the success of the Apollo and Skylab missions it appears that none of these hazards is so great as to prohibit space travel.

SOCIOLOGICAL EXPLANATIONS

Most proposed explanations of Fact A fall into this category. A few typical examples are:

(a) Why take the anthropomorphic view that extraterrestrials are just like us? Perhaps most advanced civilizations are primarily concerned with spiritual contemplation and have no interest in space exploration. (The Contemplation Hypothesis.)

(b) Perhaps most technologically advanced species destroy themselves in nuclear warfare not long after they discover atomic energy. (The Self-Destruction Hypothesis.)

(c) Perhaps an advanced civilization has set the Earth aside as their version of a national forest, or wildlife preserve. (The Zoo Hypothesis (**6**).)

In addition to variations on these themes (for example, extraterrestrials might be primarily concerned with artistic values rather than spiritual contemplation) many quite different explanations have been suggested. Plainly, it is not possible to consider each of these individually. There is, however, a weak spot which is common to all of these theories.

Consider, for example, the Contemplation Hypothesis. This might be a perfectly adequate explanation of why, in the year 600 000 BC, the inhabitants of Vega III chose not to visit the Earth. However, as we well know, civilizations and cultures change. The Vegans of 599 000 BC could well be less interested in spiritual matters than their ancestors were, and more interested in space travel. A similar possibility would exist in 598 000 BC, and so forth. Even if we assume that the Vegans' social and political structure is so rigid that no changes occur even over hundreds of thousands of years, or that their basic psychological make-up is such that they always remain uninterested in space travel, there is still a problem. With such an additional assumption the Contemplation Hypothesis might explain why the Vegans have never visited the Earth, but it still would not explain why the civilizations which developed on Procyon VI, Sirius II, and Altair IV have also failed to come here. The Contemplation Hypothesis is not sufficient to explain Fact A unless we assume that it will hold for *every* race of extraterrestrials—regardless of its biological, psychological, social or political structure—and at *every* stage in their history after they achieve the ability to engage in space travel. That assumption is not plausible, however, so the Contemplation Hypothesis must be rejected as insufficient.

The same objection, however, applies to any other proposed sociological explanation. No such hypothesis is sufficient to explain Fact A unless we can show that it will apply to every race in the Galaxy, and at every time.

The foregoing objection would hold even if there *were* some established sociological theory which predicted that most technologically advanced civilizations will be spiritually oriented, or will blow themselves up, or will refrain from exploring and colonizing. In point of fact, however, there is no such theory which has been generally accepted by political scientists, or sociologists, or psychologists. Furthermore, it is safe to say that no such theory will be accepted. For any scientific theory must be based upon evidence, and the only evidence concerning the behaviour of technologically advanced civilizations which political scientists, sociologists and psychologists have comes from the human species—a species which has neither blown itself up, nor confined itself exclusively to spiritual contemplation, but which has explored and colonized every portion of the globe it could. (This is *not* intended as proof that all extraterrestrials must behave as we have; it *is* intended to

show that we cannot expect a scientific theory to be developed which predicts that most extraterrestrials will behave in the reverse way.)

Another objection to any sociological explanation of Fact A is methodological. Faced with a clear physical fact astronomers should attempt to find a scientific explanation for it—one based on known physical laws and subject to observational or experimental tests. No scientific procedure has ever been suggested for testing the validity of the Zoo Hypothesis, the Self-Destruction Hypothesis, or any other suggested sociological explanation of Fact A; therefore to accept any such explanation would be to abandon our scientific approach to the question.

TEMPORAL EXPLANATIONS

Even if one rejects the physical and sociological explanations of Fact A, the possibility exists that the reason no extraterrestrials are here is simply because none have yet had the time to reach us. To judge how plausible this explanation is, one needs some estimate of how long it might take a civilization to reach us once it had embarked upon a programme of space exploration. To obtain such an estimate, let us reverse the question and ask how long it will be, assuming that we are indeed the first species in our Galaxy to achieve interstellar travel, before we visit a given planet in the Galaxy?

Assume that we eventually send expeditions to each of the 100 nearest stars. (These are all within 20 light-years of the Sun.) Each of these colonies has the potential of eventually sending out their own expeditions, and their colonies in turn can colonize, and so forth. If there were no pause between trips, the frontier of space exploration would then lie roughly on the surface of a sphere whose radius was increasing at a speed of $0{\cdot}10\,c$. At that rate, most of our Galaxy would be traversed within 650 000 years. If we assume that the time between voyages is of the same order as the length of a single voyage, then the time needed to span the Galaxy will be roughly doubled.

We see that if there were other advanced civilizations in our Galaxy they would have had ample time to reach us, unless they commenced space exploration less than 2 million years ago. (There is no real chance of the Sun being accidentally overlooked. Even if the residents of one nearby planetary system ignored us, within a few thousand years an expedition from one of their colonies, or from some other nearby planetary system, would visit the solar system.)

Now the age of our Galaxy is $\sim 10^{10}$ years. To accept the temporal explanation of Fact A we must therefore hypothesize that (a) it took roughly 5000 time-units (choosing one time-unit $\equiv 2 \times 10^6$ years) for the first species to arise in our Galaxy which had the inclination and

ability to engage in interstellar travel; but (b) the second such species (i.e. us) arose less than 1 time-unit later.

Plainly, this would involve a quite remarkable coincidence. We conclude that, though the temporal explanation is theoretically possible, it should be considered highly unlikely.

PERHAPS THEY HAVE COME

There are several versions of this theory. Perhaps the most common one is the hypothesis that visitors from space arrived here in the fairly recent past (within, say, the last 5000 years) but did not settle here permanently. There are various interesting archaeological finds which proponents of this hypothesis often suggest are relics of the aliens' visit to Earth.

The weak spot of that hypothesis is that it fails to explain why the Earth was not visited earlier:

(a) If it is assumed that extraterrestrials have been able to visit us for a long time, then a sociological theory is required to explain why they all postponed the voyage to Earth for so long. However, any such sociological explanation runs into the same difficulties described earlier.

(b) On the other hand, suppose it is assumed that extraterrestrials visited us as soon as they were able to. That this occurred within 5000 years (which is only 1/400 of a time-unit) of the advent of our own space age would involve an even more remarkable coincidence than that discussed in the previous section.

Another version of the theory is that the Earth was visited from space a very long time ago, say 50 million years ago. This version involves no temporal coincidence. However, once again, a sociological theory is required to explain why, in all the intervening years, no other extraterrestrials have chosen to come to Earth, and remain. Of course, any suggested mechanism which is effective only 50 per cent (or even 90 per cent) of the time would be insufficient to explain Fact A. (For example, the hypothesis that *most* extraterrestrials wished only to visit, but not to colonize, is inadequate. For colonization not to have occurred requires that *every* single civilization which had the opportunity to colonize chose not to.)

A third version, which we may call 'the UFO Hypothesis', is that extraterrestrials have not only arrived on Earth, but are still here. This version is not really an explanation of Fact A, but rather a denial of it. Since very few astronomers believe the UFO Hypothesis it seems unnecessary to discuss my own reasons for rejecting it.

CONCLUSIONS AND DISCUSSION

In recent years several astronomers have suggested that intelligent life in our Galaxy is very common. It has been argued (7) that (a) a

high percentage of stars have planetary systems; (b) most of these systems contain an Earth-like planet; (c) life has developed on most of such planets; and (d) intelligent life has evolved on a considerable number of such planets. These optimistic conclusions have perhaps led many persons to believe that (1) our starfaring descendants are almost certain, sooner or later, to encounter other advanced cultures in our Galaxy; and (2) radio contact with other civilizations may be just around the corner.

These are very exciting prospects indeed; so much so that wishful thinking may lead us to overestimate the chances that the conjecture is correct. Unfortunately, though, the idea that thousands of advanced civilizations are scattered throughout the Galaxy is quite implausible in the light of Fact A. Though it is possible that one or two civilizations have evolved and have destroyed themselves in a nuclear war, it is implausible that every one of 10 000 alien civilizations had done so. Our descendants might eventually encounter a few advanced civilizations which never chose to engage in interstellar travel; but their number should be small, and could well be zero.

If the basic thesis of this paper is correct there are two corollary conclusions: (1) an extensive search for radio messages from other civilizations is probably a waste of time and money; and (2) in the long run, cultures descended directly from ours will probably occupy most of the habitable planets in our Galaxy.

In view of the enormous number of stars in our Galaxy, the conclusions reached in this paper may be rather surprising. It is natural to inquire how it has come about that intelligent life has evolved on Earth in advance of its appearance on other planets. Future research in such fields as biochemistry; the dynamics of planetary formation; and the formation and evolution of atmospheres, may well provide a convincing answer to this question. In the meantime, Fact A provides strong evidence that we are the first civilization in our Galaxy, even though the cause of our priority is not yet known.

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