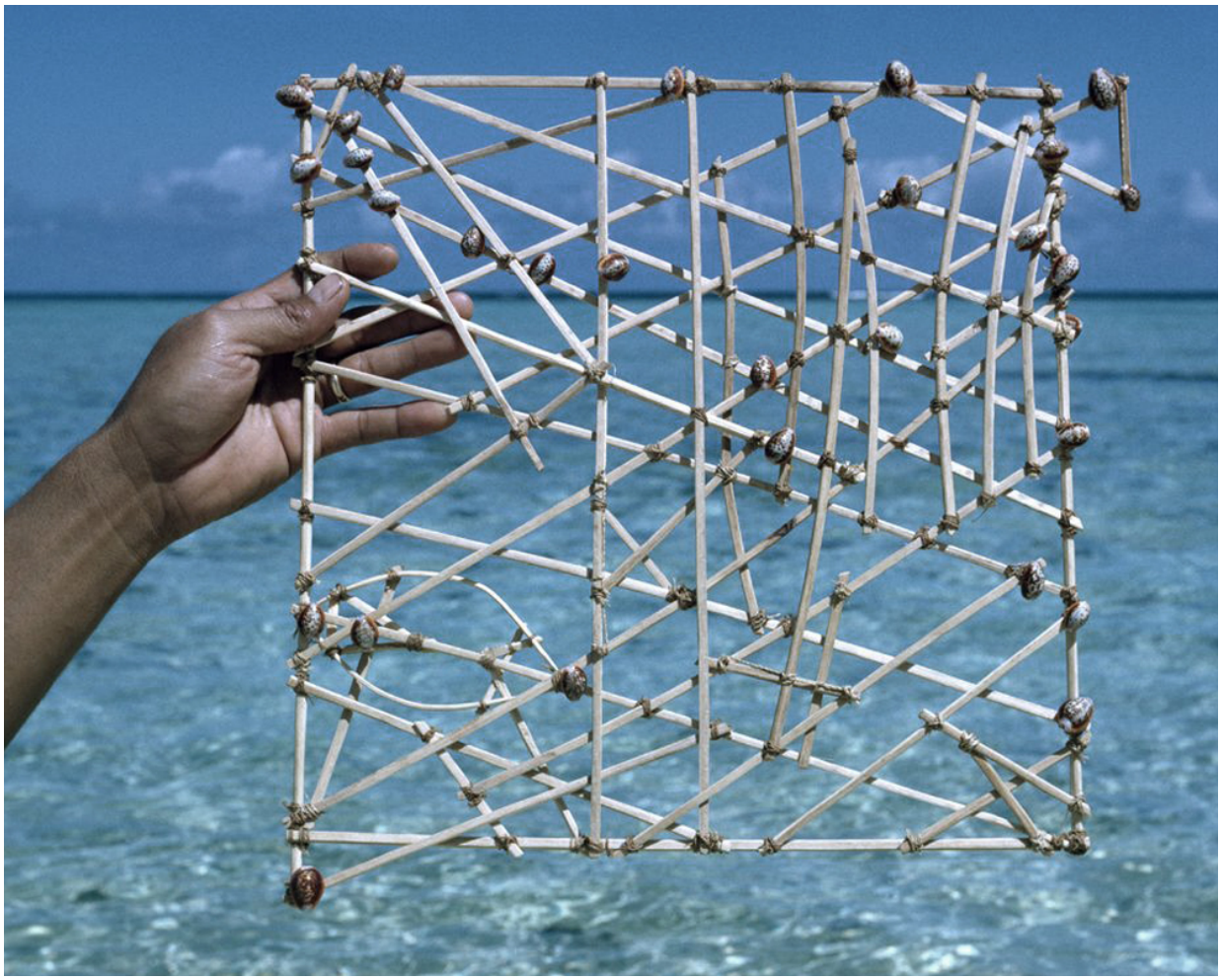
The Way of the Pacific: Glass Bead in conversation with Freeman Dyson

Freeman Dyson

Freeman Dyson is 93 years old. He is one of the most prominent physicist and mathematician of the past century. His vast contributions to science range from the unification of quantum electrodynamics to the conception of nuclear propelled spaceships. All throughout his intellectual carrier he has had a constant practice of scientific and literary thought experiments which he compiled in a great number of books and articles. Glass Bead went to meet him in his office at the Institute for Advanced Studies in Princeton to talk about these speculations. As planned, things took a cosmical tangent.



Micronesian Stick Chart (Photograph by Walter Meayers Edwards)

Glass Bead: In a 1960 article,[1] you speculated on the possibility of a mega structure built around the sun and capturing its radiation for the energetic demands of a future type of civilization which would live on its inner surface. This structure, which later came to be called a "Dyson sphere," opened the path to numerous wild interpretations and misunderstandings. What was your original intention when talking about such a structure?

Freeman Dyson: I might just say how this idea started. I have always considered the future of life in space. That was my concern since the beginning. It mostly came from my reading of science fiction and, actually, if any name should be attached to this object it should be Olaf Stapleton,[2] not mine. Anyhow, I think it was in 1960 when SETI [Search for Extra-Terrestrial Intelligence] first suggested listening to radio signals in the sky. Listening for alien signals was certainly a good idea, but I remember saying to Philipp Morrison, who was heading the program then, "But what do we do if the aliens don't want to communicate?" So it occurred to me that the thing we would need to do is to

listen for infrared radiation instead of radio. Because if you have a civilization that is using a lot of energy, it has to radiate some waste heat, and waste heat is infrared radiation which we can detect. But then, the question became: what would you actually be seeing in such a case? If you did detect infrared, it would have to be coming from a big surface because that's what it takes to radiate large amounts of power. So it had to be a big surface of some kind, and I suggested it would be coming from an "artificial biosphere." That's the word I used, and that was misinterpreted as a big round ball. Of course, it doesn't have to be a big round ball; it is most likely to be large objects orbiting around the star.

GB: So this idea of a large ball encapsulating the sun wasn't your plan? You didn't describe such an object?

FD: No, never. I simply used the wrong words. I said: if you take planet Jupiter and spread it out around the sun, it would make a sphere 5 meters thick. So that's where it comes from. Anyhow, what I was interested in at the time was not at all the structure itself and its engineering but a new way to look for aliens. If you look at what really happened, twenty years after I made this suggestion, we did have the first sky survey in infrared with the IRAS satellite. That was an infrared astronomy satellite. They did a sky survey in exactly the right wavelength, and of course the result was that the sky is full of these objects: there are millions and millions of such objects all over the sky, and obviously most of them are natural. They are actually young stars so the dust is still there. So you have a young star with dust around it, and the dust is warm; it radiates. And that is what we see: there is no way to tell whether it is artificial or natural. So in fact it is not a good way to look for aliens.

GB: Do we have any tools to detect this distinction between the natural and the artificial?

FD: Yes, of course. At the moment there is big excitement because we have the Kepler mission, which is actually looking at stars with very precise photometry by measuring the brightness of a star much more accurately than we ever did before. It is a wonderful mission. Its main purpose was initially to discover planets—and they did discover about two thousand planets going around other stars, and this is of course a huge step forward—but what is also true is that when you do that you discover a few other things as well. As a matter of fact, there is one very particular object which is now very much being talked about: it is called the KIC 8462852. It's one of these stars that shows very strange absorption of light (much more than a planet), with its light turning off something like twenty percent and coming on again, and it's not periodic, so it might be that it is truly an alien civilization. Of course everybody is thinking that it might be the

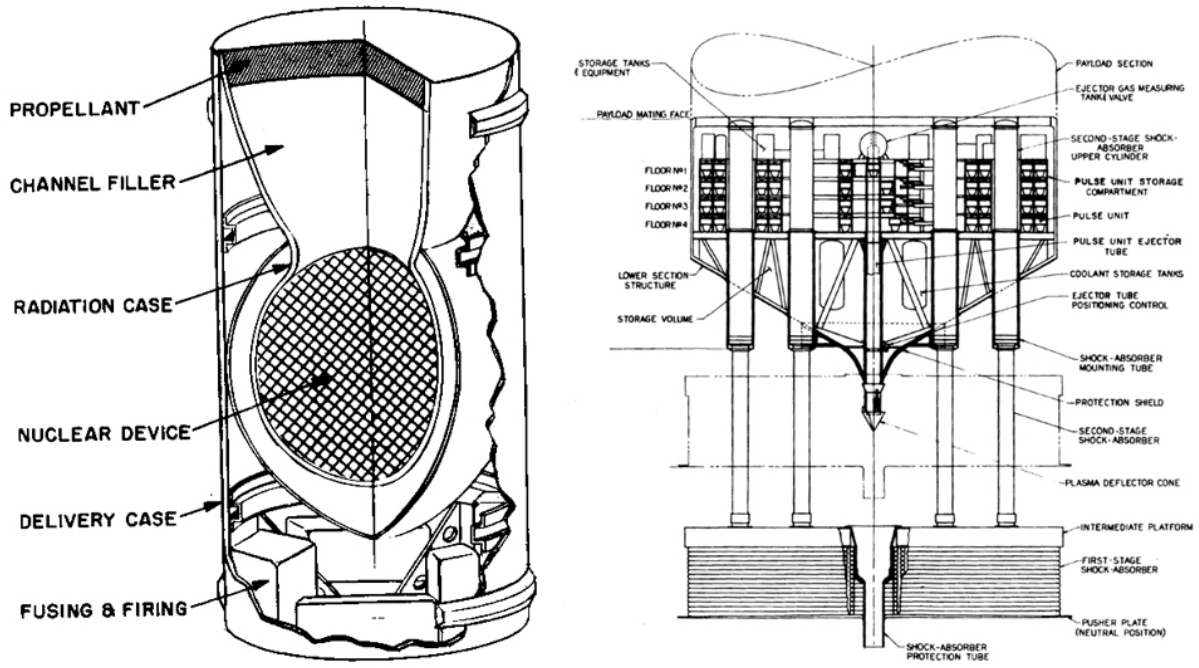
explanation, but until now we know nothing much except the light absorption. So the next thing many people are now planning to do is to observe it in different ways. And the most obvious one is to look at it with a very good radio telescope. That will be done. So with these radio signals, if it is artificial there should be something to see. But if we don't find anything in the radio, then probably it is natural, and in that case we will have to look at other channel x-rays and different good spectroscopy. This is certainly a good time for looking for aliens.

GB: You often speak of another specific technique for looking for alien life which you call "pit lamping," a Canadian hunting technique used to detect nocturnal animals by shining a spotlight in their eyes. You suggested that a similar technique could be used to detect creatures which, while living in remote parts of outer space, would have developed some kind of lens to concentrate light. Could it be used in this case?

FD: If you want to keep warm away from a star in a very cold space, you have to have something like a big mirror to concentrate star light. If you have a big mirror concentrating starlight and your living creature can be at the focus, it can stay warm. So that's what would have to happen if life were to spread far out away from a star. But unfortunately this object they have now discovered, KIC 8462852, is so far away from us. With pit lamping in this case, it would take more than two hundred years to get the light signal back. Pit lamping from Earth can work as far the Kuiper Belt, but not much further unfortunately.

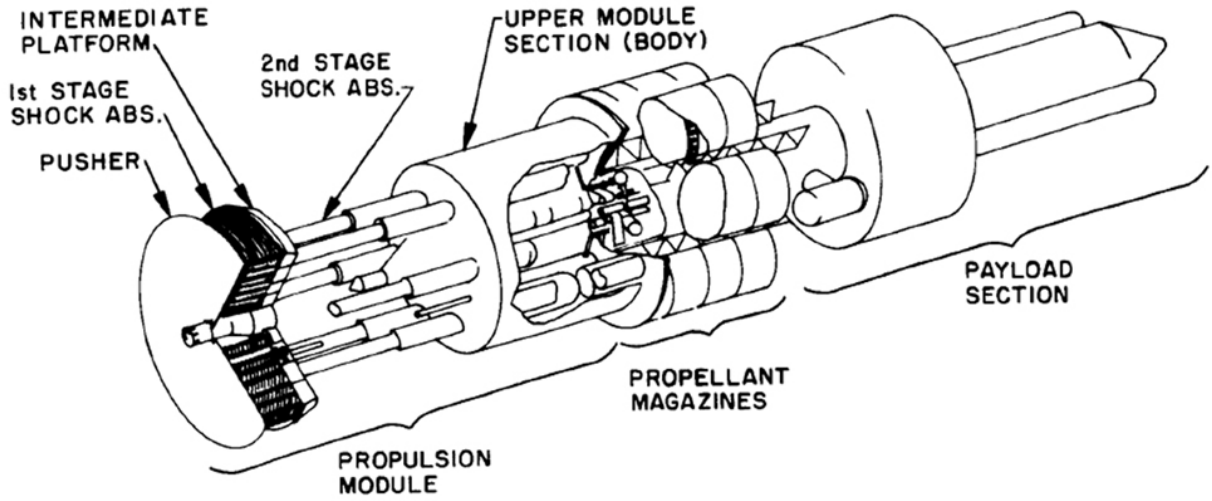
GB: Around the time you published these speculative articles and thought experiments on artificial radiations and extraterrestrial life, you were involved in an actual large scale engineering project called Project Orion,[3] the study for a spacecraft which would be propelled by atomic bombs. I even read somewhere that you were actually planning to go on board and leave. Can you tell us more about this project and your involvement in it?

FD: Well the project for that was very clear: we wanted to go first to Mars and then to Enceladus, one of the moons of Saturn. We had chosen Enceladus as a destination without knowing how interesting it actually was. Although we now know it is a very active world with all kinds of mysteries, for us at the time it was pretty much just a point in the sky.



Orion's design for Propulsion Unit and Propulsion Module. (Nasa)

This was in the days before we had long distance communications, so we were thinking of ourselves like Darwin going on board his ship the HMS Beagle for five years to explore the world, and then coming home and writing books. That was the idea we had: that we would go with this Orion ship and walk around Mars and walk around Enceladus and other places and write down everything in notebooks, and then we would come home five years later and tell the world and spend the rest of our lives writing books. That would have been a wonderful trip, even our son who was then five years old wanted to come. But anyhow it never got to fly.



Key Components of the Orion's Spacecraft (Nasa)

GB: I know the project was abandoned, but I was wondering, what could really have happened in space travel if it had been taken on?
FD: We would have been very far ahead. We would have explored the solar system fifty years sooner. But what happened is that the instruments got very much better. Now we have broadband communication even from Pluto, so that the old-fashioned kind of Darwin expedition makes no sense at all. Everything can be done in real time, communications both ways with much smaller and much more powerful instruments, so you don't actually need humans for doing scientific work. The idea of Darwin-style exploring is completely obsolete.
GB: So manned space travel has to be given up entirely?
FD: Well, it doesn't have to be given up, but it is not for science. It is an international sporting event. The public is willing to pay for sporting events, and it should be sold as such—not as science. That was the mistake they made with the moon project: it was sold as science, and of course it wasn't at all.
GB: How close were you to actually building such a spacecraft?
We were in the competition for the moon exploration and we started about the same time as the Apollo program, which was based on chemical propulsion. So I would say for about a year we were really serious. We thought we had a chance if everything went well, but of course we didn't have anything built at that time. It was only plans. By the second year it had become clear that Von Braun was going to win. He was much more organized. He had a big space center working for him, and he was also a very capable manager. For

us, most of it was purely theoretical. We had plans, but we never got to the point of doing things on a big scale. So the project lasted seven years in total, but after the second year it was really not for real.

GB: Do you think this technology could be taken on again?

FD: No, never. It is absurd. It is completely absurd when you now have instruments which are so small. The thing about Orion is that it had to have a thousand tons of payload. Now we wouldn't know what to do if we were to have a thousand tons of payload.

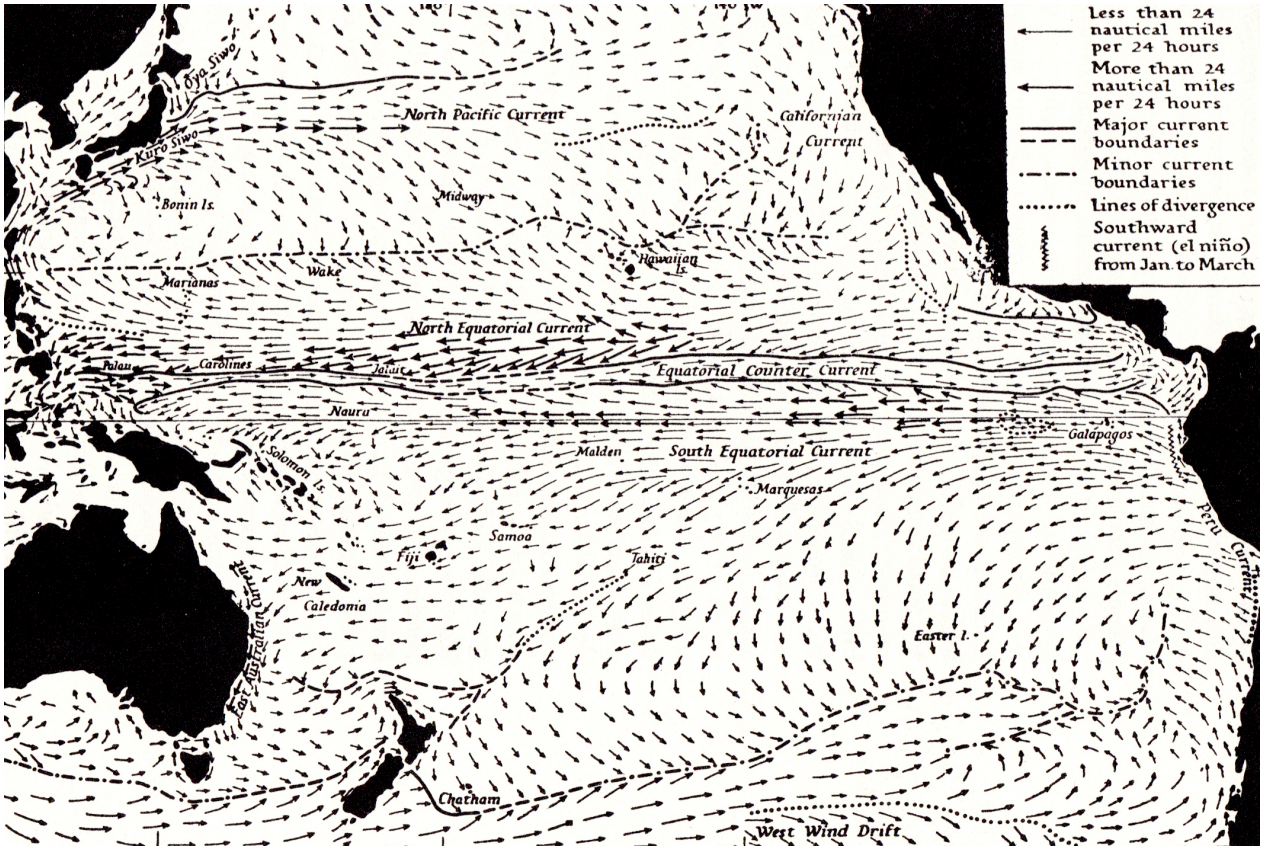
GB: What about the speed it could allow?

FD: Well, it is good for the solar system, but not good beyond. Beyond that, what you need are laser beams. They are much better. This is a public highway system, so you don't take the energy with you; rather the energy source remains fixed. You have a huge laser in space which is using sunlight as a generator. The laser beam is pointed wherever you go and then you ride the laser beam using this energy. And for sure, that's much more efficient than all the things we worked on before. There has been some quite serious engineering in that direction, and it will be built. The problem for now is that any public highway only becomes cheap after you have a lot of traffic on it. So this technology has to get over this first bump, which is not easy. I would say it would take a hundred years to have it in the vicinity of the earth. As with any apparatus of this kind, you have to have growth which is very slow for quite a long time, and then it will be much faster as it becomes cheaper. Much like airplanes, which were just toys for the rich in the early times, and became cheaper when they were developed as weapons, and then became the public highways we have today.

GB: It seems to me that space travel, at least in films and the collective imagination, is always thought of in terms of our coming back to Earth. The type of speculations that you have written seem on the contrary to invite a type of travel and exploration where there is no coming back. Could you elaborate on this distinction?

FD: Yes, for me there are two different ways of exploring: the Atlantic and the Pacific. They are really quite opposite. In the Atlantic type of exploring, you have someone like Columbus and his ships and the idea that he would get to China and then come home again. The whole idea was to make a big voyage to some place and then come back. That was his plan, and that's what he did. It just happened to be America instead of China but the system was nonetheless some kind of top-down exploring. Going and coming back. In the Pacific type, you had Polynesians going with their canoes with no interest whatsoever in coming back. They wanted to find places to live in. And they did find

islands: they found New Zealand, they found Hawaii, and went on and on as far as they could without any idea of arriving at South America, as this type of goal wasn't the point at all. Anyhow, in terms of space travel I would like the Pacific model much better because they were not linked to any limited object; they would just go further, and their children would go further in a process that has no end.



Winter circulation of currents in the Pacific Ocean (In "We the Navigators" David Lewis, Australian University Press, 1975)

By the way, did you ever read Kenneth Brower?[4] Kenneth Brower actually worked with the people in Polynesia. He organized a voyage using ancient Polynesian technology so they had a big canoe and sailed using only the Polynesian methods. They sailed from Hawaii to New Zealand, and he wrote books about this, giving a precise account of their navigation techniques. It is quite astonishing how well they can navigate; simply by following the birds and studying the patterns of waves on the ocean they are able to determine the location of islands which are quite far away. So it was in no way by random chance that they found these islands; they knew how to find islands.

GB: When thinking of space travel, what are these tricks we can use for ourselves? What is the outer-space equivalent of birds and patterns of waves in the Pacific?

FD: Warmth happens to be something we are very sensitive to; we can detect it from very far away, and our instruments are amazingly good. Anything warm of course produces radiation, so we can detect a planet certainly from a long distance away. But for the smaller objects that are cold, it is not so easy, and as I said "pit lamping" doesn't work so well because it goes with the inverse fourth power of distance. So it is not good for long distances. So that is really an unsolved problem for now.

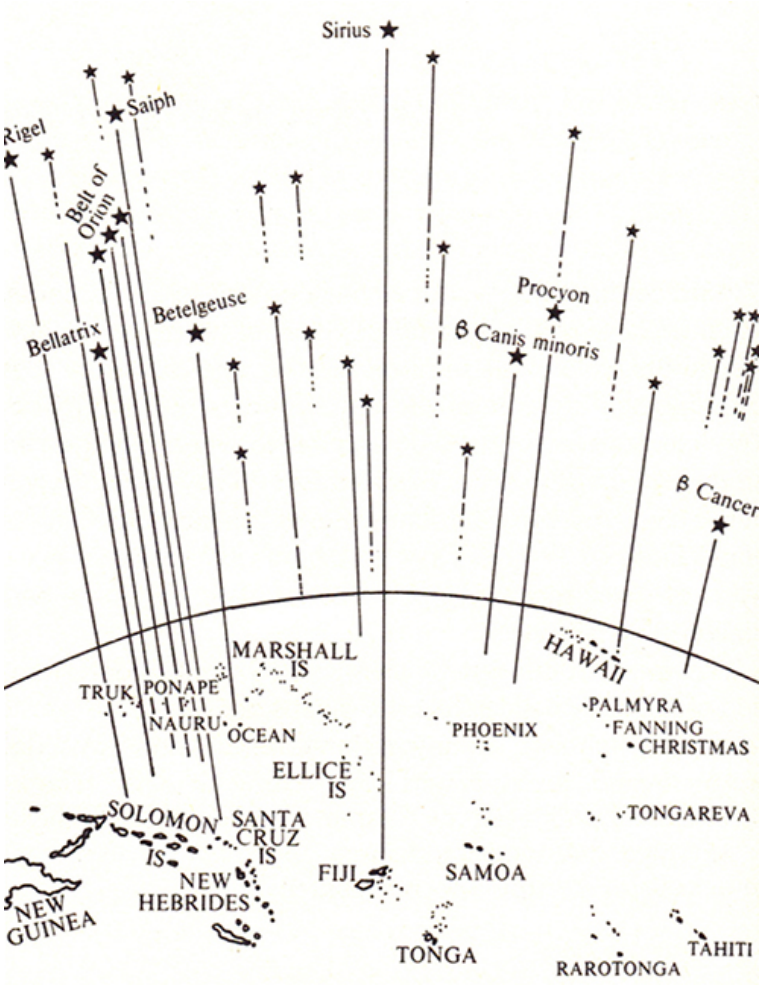
GB: How would such a process of drifting through space influence our evolution as a species?

FD: The point is that it is life as a whole that is moving out—not just humans. Life is of course always changing and every species has a choice: either you go extinct or you diversify, become many species. That has always happened. It doesn't just stay the same. Undoubtedly, as humans spread out in space, either we will become extinct or we will become a hundred species, a million species. That's the way life works.

GB: Could it be that life itself would change in such a drastic way that it would become fully unrecognizable as life?

FD: That is possible if we spread out in space, but on this planet, life has stayed remarkably constant for most of the three or four billion years. The structure of a living cell has changed very little. Most of the essential features were there from the beginning so I don't know whether that will change or not, but certainly what has happened in the last three billion years is that the arrangements of cells of course have changed, but the cells themselves have not changed much. So I would not expect any radical change here, but it could happen.

GB: Recently, you have made some strong critical claims about what you see as the failure of artificial intelligence over the past sixty years of AI research. Your argument is mostly aimed at the inadequacy of the models of intelligence we use in such projects. Following from what you just said, it seems that the type of intelligence you are talking about is an intelligence embedded in a process of ongoing departure and navigation—a migrant intelligence of some sort.



Zenith star passing over Fiji (In We, the Navigators. David Lewis, Australian University Press, 1975)

FD: It is true. As humans we started in Africa and lived in a certain pattern, and after we moved out and came to the North, particularly East-Asia and Europe, the conditions for life were much more harsh. Europe was half covered with ice and humans had to stay alive, learning to keep warm and managing to coexist in caves. That undoubtedly stimulated a different kind of intelligence. Surviving in such conditions required a very high degree of collaboration and the ability to change our habits very quickly. These drastic changes resulted in different kinds of people and societies. This is certainly also true for the future of life in space.

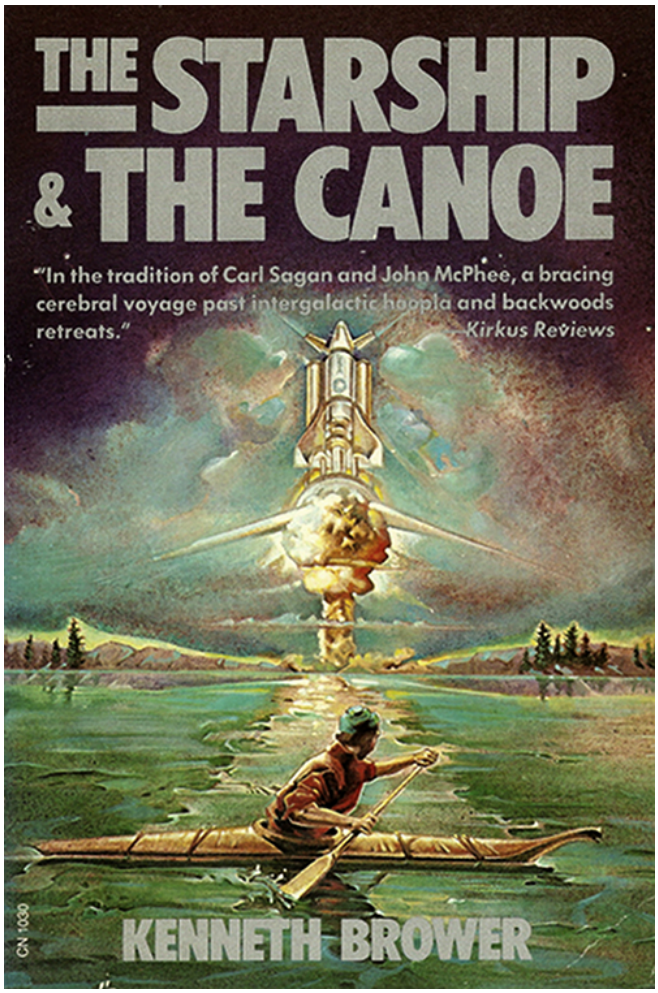
GB: Are you calling for a “Pacific” type of model for intelligence?

FD: What we will certainly learn from the Keppler mission is that there are billions of planets in our own galaxies, many of them not attached to stars. There are billions of planets and even trillions of small objects floating free in the galaxy, so as we move out in space in a “Pacific” way of traveling, we won’t have to go from star to star, as they are many places in between where we can stop. The point is that if we have a billion different

habitats where life can be established, and every place with its own evolution, this will result in a huge variety of ways of living, and most certainly in very different kinds of intelligence.

GB: Regarding the artificial intelligence we are now actually trying to build, can you explain more precisely why you think it is a failure?

FD: Well, merely because we are using digital machines, and these machines are designed for a different purpose. They are good at doing numerical calculations and to do so they have to reduce everything to 0 and 1. That's not the way a brain works. If you look at your own brain, as far as I can tell, you see images, pictures, which come and go very fast. You can immediately recognize a face or a voice. These patterns of sound and light can actually be recognized directly by our brain and I don't believe we are dividing them into 0s and 1s. It certainly works for language because it can be discretized, just as babies have the ability to reduce speech into phonemes. But the human brain doesn't just recognize syllables, it recognizes sentences and ideas. When we are listening to speech we listen to the whole sentence, which is immediately translated into meaning. That's clearly something a digital machine is not good at.



Cover of Kenth Brower's The Starship & The Canoe (Harper & Row. 1978)

GB: Finally, there seems to be a consensus today around preservation of the conditions of life on this planet, some might say a kind of ecological conservatism. I think you are quite opposed to such views, can you explain why?

FD: Well, I think it probably comes from being a child in England in the thirties. If you look at England as it now exists, it is heavily populated and there are all kinds of ugly buildings and ugly disturbances, but somehow it is still a beautiful landscape. It is still a lovely place for humans to walk around, and that's the environment I grew up with. Even though it is all artificial, I feel it has a great beauty to it. Nothing which is there was there ten thousand years ago. Ten thousand years ago, it was nothing but forests, what we now call wilderness, but I think it was much less interesting than the modern landscape, which is of course far more diverse and rich. Modern landscapes have forests, farms, grasslands, in great variety—some of it natural, some of it artificial. In my view, it is

much more beautiful now than it was in its natural state. It is my also my feeling about the whole universe that it is sort of boring the way it is now. If you look at it, all the planets except this one are dead.

GB: So you mean it is our responsibility as humans to transform it?

FD: Yes.

Interview conducted for Glass Bead by Fabien Giraud.

Footnotes

1. Freeman Dyson. “Search for Artificial Stellar Sources of Infrared Radiation” *Science* 131.3414 (June 1960): 1667-1668. Print.

2. Olaf Stapleton. *Star Maker*. London: Methuen Publishing Ltd, 1937. Print.

3. Freeman Dyson. “Interstellar Transport.” *Physics Today* October 1968: 41-45. Print.

4. Kenneth Brower. *With Their Islands Around Them*. New York: Holt, Rinehart and Winston, 1974. Print.

Freeman Dyson’s most useful contribution to science was the unification of the three versions of quantum electrodynamics invented by Feynman, Schwinger and Tomonaga. He subsequently worked on nuclear reactors, solid state physics, ferromagnetism, astrophysics and biology, looking for problems where elegant mathematics could be usefully applied. He has written a number of books about science for the general public.