Extra-terrestrial Life
Are We Alone in the Universe?

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IS our planet the sole habitat of life? In a universe that contains billions of galaxies, each galaxy containing the order of hundred billion stars like our Sun, is there any possibility of the existence of extra-terrestrial intelligence? This latter question, of course, presumes that we humans on the Earth are intelligent. Our ancient mythologies, as indeed those of most ancient cultures, routinely talk of the extra-terrestrials, like the *yakshas, kinnaras* and *gandharvas.* So, does modern science fiction with its high-profile versions in *Star Trek* or *Star Wars.*

What are the ground (or, rather, space) realities for modern technology to carry out a *Star Trek* type interstellar exploration? Till the late fifties scientists were cautious about talking of SETI, that is the search for extra-terrestrial intelligence. But today it is a respectable discipline attracting support even from a conservative funding agency like NASA. What has been the key factor in bringing about this change of perception?

Radical Idea

In the mid-fifties the astrophysicist Fred Hoyle proposed that gigantic clouds containing molecules might exist in space. But his idea was considered so radical that he could not get his paper published. So he put it all as part of a science fiction novel called *The Black Cloud* which was a great success.

Within a few years, however, special dish antennas equipped to receive radiation of a few millimetres wavelength began to detect molecules in space. What is more, these molecules were organic as well as inorganic, with the organic ones being not only large and complex but recognisable as sub-structures of the DNA molecule known to be basic to all living systems on the Earth. Today we know of gigantic molecular clouds filling the vast spaces between stars, and extending to several tens to hundreds of light years. So, circumstantial evidence suggests that if the basic building blocks of life are seen scattered in space, why not life itself?

Thus in the sixties there started inter-disciplinary discussions about extra-terrestrial life. The astronomers can tell what are the likely sites for life and how many of them are there in our Milky Way Galaxy of stars. Biologists have to decide what is it that triggers the life-mechanism and where among the various astronomical sites it is likely to occur. Then the evolutionists have to say how a simple living system can develop over what time span into a complex intelligent species. Experts in artificial intelligence, communications and information transfer are needed to resolve the problem of contacting such species if they exist. And the social scientists need to assess the lifetime of an advanced civilisation.

In the sixties, Frank Drake, an astronomer from Cornell University, quantified these issues into what has come to be known as the Drake's equation. Simply put, it is a series of factors which, when multiplied together, would give us the total number, N, of extraterrestrial civilisations in our Milky Way, which have progressed beyond us on the technological ladder.

Drake's Equation

The assumptions behind Drake's equation are fairly conservative. They suppose that such a civilisation would exist on a planet moving around a star from which it gets energy for survival. The planet would have to be at an optimum distance from the star, not too near or it will be too hot for survival, and not too far; otherwise, there will be hardly any energy available for sustaining life. The nature of life is also assumed to be not very radically different from the way we perceive it here. It is for the experts from the various disciplines to estimate these factors and thereby arrive at a realistic value of N. If calculations give N=1 then we are the only advanced civilisation in our Galaxy enjoying a unique, if lonely, status. If N turns out to be large, say, a million or so; then we do lose our uniqueness but can aspire to a social intercourse in the Galaxy.

The current state of our knowledge is such that we cannot estimate this number. But when you start asking experts, their guesses are many. There are the pessimists who think that we are alone. These are largely the biologists who think that the appearance of life on Earth is a combination of such rare events that not even the astronomical numbers I quoted in the beginning can compensate for it. The optimists, and among these are the astronomers who are impressed by the vastness of the Universe, think otherwise. For them, it is the belief that once we know how life originates we will find it not such a rare phenomenon. One argument the pessimists put forward is: If life is so common, why has no one visited us from an alien habitat? At this stage, a UFO-buff will say that we have been visited, that we are being visited. There is, however, no scientifically valid evidence for this assumption. Visiting even the nearby planetary systems is not so simple. With our present technology, let us suppose we can reach the Moon in 50 hours. How far is the Moon? Rather than quote a distance in kilometres, let me say that light would take approximately a second and a quarter to cover the distance. How long will it take for such a spaceship to come from the nearest star Proxima Centauri to the Earth? Light takes four and a quarter years to make the journey.

Well, I will spare you the arithmetic and give the answer, it will take about six lakh years! No doubt, aliens will have better technology and can reduce the travel time but it shows the enormity of the problem.

Many optimists answer the above question in a different way. They invoke the so-called "zoo hypothesis". We humans have zoos and sanctuaries in which wild animals enjoy a protected life. Animals or birds are remotely observed and their behavioural patterns studied, but there is no interference with their life. Likewise, we on the Earth are being remotely observed and studied by the extra-terrestrials and on purpose they do not interfere with our life-system which they want to study!

Scientists' Plan

Leaving speculations aside how can we look for alien ETs? As seen earlier, with our present technology, space explorations with humans or without them are out. The only practical way is the one proposed by two scientists Giuseppe Cocconi and Philip Morrison in 1959. The method involves using the radio wavelength of 21 centimetres for interstellar communications. Radiation of this wavelength is naturally emitted by the atom of hydrogen, the most common element in the Galaxy. Thus it will be known to the ET as it is to us. Moreover, it requires less energy per quantum to send out and is less likely to be absorbed en route, compared to other waves. Our atmosphere is also relatively less noisy at this wavelength.

Given these advantages, the best strategy is to erect huge antennas and try to intercept any communication that may be going on between two ET groups. If we can detect and decode intelligent messages, we will be able to locate the sender and the receiver. This wire-tapping on a cosmic scale may have doubtful morality, but the success of the experiment will justify the means. SETI enthusiasts are trying this out as well as the more honest method of sending our own messages to likely sites of ETs and hoping for a reply. But enormous patience is needed in carrying out any conversation of this kind. For, if you say "hi" to your ET neighbour going around Proxima Centauri, you will have to wait for eight and a half years for a reply!

Astronomical Spectroscopy

The discovery of helium described in the previous parsecstone was a major step in a quiet but significant revolution that was taking place in astronomy in the nineteenth century, a revolution that was to lead to major advances in physics in the early years of the twentieth century. This astronomical revolution was in spectroscopy and some important developments in it were as follows.

1814-15 J. von Fraunhofer measured the relative positions of darkness in the solar spectrum.

1822 John Herschel discovered the bright spectra of volatilized metallic salts and suggested in the following year that such lines might be used to detect these elements.

1849 J. Foucault pointed out the exact correspondence between the bright and dark lines.

1850 George Stokes showed that atoms which emit bright emission lines when hot, absorb lines of the same wavelength when in cold vapour form. Thus, he explained that the dark Fraunhofer lines represent absorption by metallic vapours.

1860 The first spectroscopic examination of stars began.

1867 Angelo Secchi classified stars in four classes according to their spectra.

1900 Around this time E. Pickering introduced the Harvard spectral classes O, B, A, F, G, K, M, R, N,... that are now commonly used.