Search for Extra-Terrestrial Intelligence

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Introduction

Does life exist beyond the confines of our planet? Do we have extra-terrestrial creatures out there in the interstellar space, which are advanced to levels of intelligence, technology and living styles far higher than what we possess here on Earth? If so, how do we search for them?

No doubt the young and the old in our present society wonder about these questions from time to time. And our society would not be the first to undertake such an exercise! If we look at the records of ancient cultures, we find them replete with tales of superior species coming from outside and dominating human life on the Earth. Indian *puranas* contain stories of *yakshas, gandharvas, kinnaras,...*as well as the battles between *devas* and *asuras.* Indeed modern science fiction stories could very well take a cue from those ancient myths.

Since the times of Jules Verne and H. G. Wells, we have had several generations of science fiction writers who have given expression to the human curiosity about extra-terrestrials (*ET's*). The films and TV serials like *Star Wars* and *Star Trek* have added to these speculations. But one may ask: *What has been the attitude of the scientists to these questions?*

This question may be answered reasonably simply: *Till around 1960, the scientific community had dismissed these questions as largely speculative; but their attitude began to change and they started to take these questions seriously since that time.* So much so, that towards the late 1960s, scientists from both the United States and the (erstwhile) Soviet Union met to discuss how one may tackle these issues in a scientific framework. Today the subject of *exobiology* looks at the question of extra-terrestrial life within a purely scientific framework.

What was the reason for this change of attitude?

Life on Earth and Life in Space

One important development was the important discovery of the basic structure of the DNA-molecule by James Watson and Francis Crick in 1953. This molecule is the basic building block of life in all forms on the Earth. It has the structure of a spiral staircase, with the spiraling edges in the form of chains of sugar and phosphate molecules, connected by rungs of bases of four types, commonly known by their initial letters A,C,T,G. This was a breakthrough for our understanding of *life on Earth.*

The link of life with space came in the early 1960s when observations carried out with millimetre wave antennas began to reveal the existence of molecules in space. Atomic and molecular physics tells us that a typical molecule has internal motions of its constituent atoms, in the form of rotations and vibrations. Molecules may exist in states of different energies, corresponding to how energetic these internal motions are. It is possible for a molecule of higher energy to spontaneously change over to a state of lower energy, thereby releasing the extra energy. This energy comes out in an electromagnetic wave of wavelength of the order of a millimetre. The precise wavelength can be

linked with a specific molecule, thus enabling the astronomer to identify the molecule from the waves received.

The astronomer Fred Hoyle had been pioneer in suggesting the possible existence of giant clouds of molecules in the vast space between stars. [It may be mentioned that his suggestion was initially found to be so bizarre as to be unacceptable by his fellow-astronomers. Whereupon in mid-1950s, he wrote a science fiction novel called *The Black Cloud* [1]around his idea!] The 1960s saw the existence of molecular clouds confirmed and as time advanced astronomers began to detect complex organic molecules also in space. Thus it was possible to say that the constituents of the DNA molecule are now available in the interstellar space. If these building blocks of life are present can we expect the complete living system to be present too?

Thus scientists had what may be regarded as prima-facie evidence for extra-terrestrial life, evidence suggestive enough for them to take up the idea for a serious scientific scrutiny. Given that our Sun is only one of over a hundred billion stars in our Milky Way Galaxy, what are the chances of life existing elsewhere?

Physical and Biological Constraints

Of course, science fiction can imagine life in various forms, bizarre and weird. Let us leave these presently from our considerations and think of life as we are used to here. Can we expect to find it anywhere in the Galaxy? The answer is 'No'. There are several restrictions which we may have to bear in mind when exploring the existence of life elsewhere. I give a few below.

Life requires energy for growth and sustenance. In our case it is the Sun that provides the energy. We therefore expect that life would concentrate in the vicinity of a star. While it cannot obviously exist on the surface of a star, because of its extreme temperature, it will need a cooler planetary surface for habitation. Thus we need planets around the star. Till 1991, the Sun was the only known star with planets. Later astronomers began to find many stars with planets. How they succeeded in detecting non-luminous planets at such large distrances as several light years, is an exciting story that needs to be told separately[2]. Today, we can say that at the time of writing this article, the number of *extra-solar* planets is reaching the century mark.

It is not sufficient to have planets around stars. A 'habitable' planet should lie within a specified *ecosphere*. This is the shell around the star wherein the temperature and other conditions are not too extreme for life. If we are too near the star, the ambient temperature may be too high; if we are too far, it may be too low. Likewise, the planet should not move too far or too near the star during its orbit; that is, its orbit should not be too eccentric. It is significant that among the extra-solar planets, a small fraction have been found to have nearly circular orbits.

But it is not sufficient to have such habitable planets. The star itself must be located in a reasonable part of the Galaxy. For, the Galaxy is known to have a rather turbulent centre, where considerable dynamical and radiant activity is going on. It is desirable to be away from this region, as our Sun is [– the Sun is located at around 30,000 light years from the centre of the Galaxy].

There are also restrictions on what type of star we are talking about. Stars come in all different sizes and have varying physical properties. Studies of stellar evolution tell us how stars change in their brightness, surface temperature, chemical composition, etc., as they evolve with time[2]. We will not go into these details but simply say that no more than ten percent of all stars may be like the Sun, thus reducing the choice of habitats for life.

These are some physical considerations. What about biological ones? When all is said and done, we still do not know how life on this planet started. The commonly accepted viewpoint is

that of Alexander Oparin and J.B.S. Haldane, who argued that in the primitive Earth, lightning and thunderstorms provided the energetic conditions for synthesis of amino acids from atmospheric methane and ammonia.

In 1953, Stanley Miller working under his thesis adviser Harold Urey produced such a synthesis under laboratory conditions by passing electrical discharge through a mixture of methane, ammonia, water vapour and hydrogen. The Miller-Urey experiment shows how in the primitive conditions on the Earth, formation of amino acids might have taken place. But it still leaves the main problem unanswered, viz., what chain of events might have led to the DNA, cells and microbial form of life. (Once primitive life is in existence, it would evolve to more complex forms by natural selection.)

Indeed, as we shall see towards the end of this article there may well have been an alternative scenario that brought primitive life to the Earth.

Contacting the ETs

Setting aside our present ignorance about how life began here, let us ask how can we detect the existence of advanced ETs elsewhere in the Galaxy. The age old method of sailing forth in a spaceship, like Columbus and Magellan did in their terrestrial explorations, will not work as the following simple example will show.

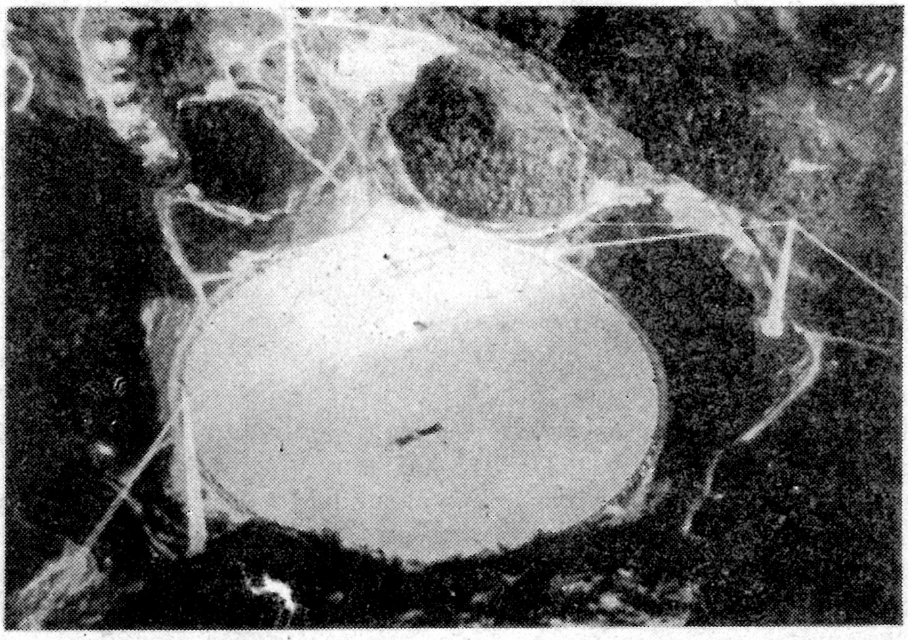
The only manned extraterrestrial visit has been to the Moon. The Apollo 11 technology can take man from the Earth to the Moon in about two days. How far is the Moon? We can estimate its distance by stating that light takes only one and a quarter (1.25) second to go from the Earth to the Moon. Now the nearest star from here is around four and a quarter light years away. If light takes 1.25 second to reach, man takes two days; how long will man take to reach where light requires 4.25 *years* ? Try to work out the answer and you will realize the impossibly long time durations needed for inter-stellar space travel with our present technology.

The way out is to use light speed for transmission of information, since light is the fastest agent we have. Light, as you know, comes in several forms, in radio, microwaves, infrared, visible light, ultraviolet, X-rays, gamma-rays...etc., depending on the wavelength of the radiation. What is the best waveband for interstellar communication?

Experts suggest the 21 cm waveband, which corresponds to the radiation emitted by hydrogen atoms when their internal electrons change their spin directions. There are three reasons for the choice of this waveband for communication. Firstly, it is capable of travelling vast interstellar distances in the Galaxy without much absorption, and so sending messages will require relatively less energy. Secondly, there is less noise in this waveband around the Earth, so that we can 'hear' outside signals relatively easily. Finally, since hydrogen in predominant in the Galaxy, the ET will be familiar with it and if he/she is advanced (at least to our level), would be aware of this wavelength.

It may well be that interstellar communication is going on between advanced ETs and we are yet to know about it! To intercept any such exchanges, we can use large antennas tuned to 21 cm radiation. Such antennas do exist in various radio observatories round the globe. Indeed to ensure that we do not miss out a signal, multi-channel analyzers which can probe up to a million channels simultaneously, are used. Computers can routinely scan the radiation received from any given direction, and use software to pick out any possible real signal out of the maze of noise.

The biggest radio dish with a diameter of 1000 ft, at the Arecibo Observatory in Puerto Rico has been amongst those used for looking for such ET-signals from plausible sources (e.g., stars that might have planets around them). A large community of amateurs has been roped in to do the space watch. The programme is called SETI, i.e., search for extra-terrestrial intelligence.



The 1000-ft dish at Arecibo, which has been used for SET I

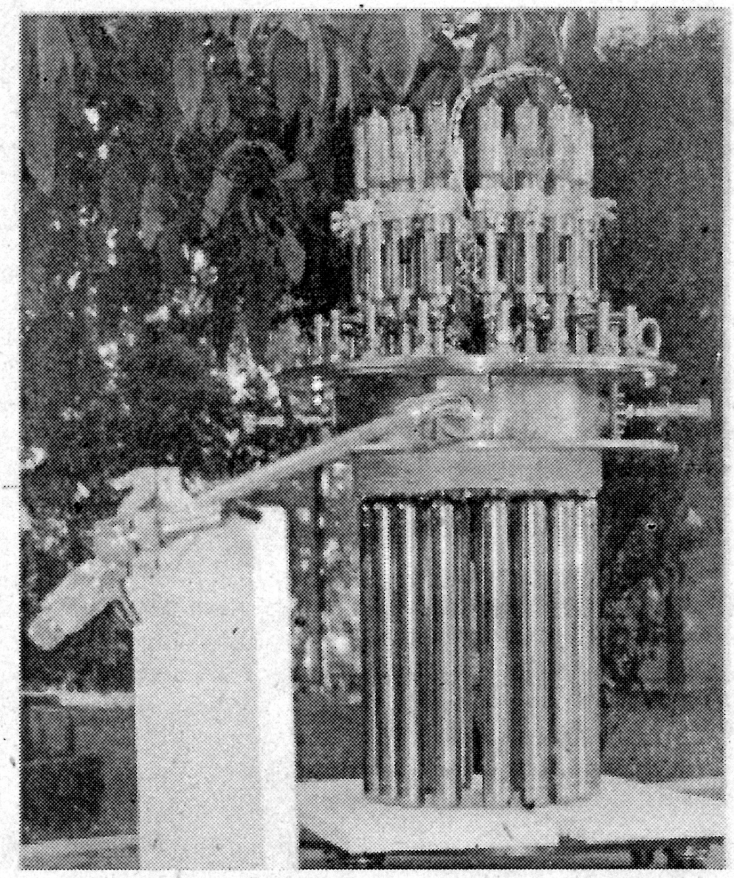
So far we do not have any positive identification. Since the mid-1960s we too have sent signals outwards on this wavelength, giving codified information about the Earth, its location and its occupants. If an ET receives them and chooses to respond we would have scored a 'hit'. But it is not going to be a fast operation. If the ET is ten light years away, we won't hear the response for twenty years! So an interstellar telephone conversation is out.

Nevertheless, as and when we do get a signal, it will signify a quantum jump in the cultural history of the entire humankind...for it will be a signal that we are not alone in the universe.

Local ETs ?

Let us end with a more modest goal which might be more easily attainable if certain ideas on the origin of life on the Earth are correct. In the mid-1970s, two British astrophysicists, Fred Hoyle and Chandra Wickramasinghe had proposed the idea that life on the Earth was started by micro-organisms, bacteria and viruses being deposited on the Earth's surface by comets that occasionally brush past the earth's atmosphere. In this hypothesis, these microorganisms are picked up from the interstellar space by comets which come from as far a distance as 50,000 times the Earth-Sun distance. These lie frozen in comets, but as they approach the Sun, the cometary tails develop and the bacteria, say, are carried by the tails. In some cases the tails brush the Earth's atmosphere and the bacteria are transferred to it. There they descend to the Earth's surface under gravity. It is through such impacts of extra-terrestrial microorganisms that, according to Hoyle and Wickramasinghe, the life was seeded on Earth.

To check this hypothesis some of us have carried out an experiment along the following lines. By attaching evacuated cylinders as payload to a balloon, air samples are collected at different heights in the atmosphere. These samples are examined for microorganisms in biology labs. The first such experiment was performed in January this year (2001) under the sponsorship of the Indian Space Research Organization. Samples were collected at heights ranging from 20 to 41 km. At such heights the chances of terrestrial particles or microorganisms being lifted is negligible. Scientists from IUCAA, Tata Institute of Fundamental Research, the Centre for Cellular



The cryo sampler used in the ISRO experiment to detect microorganisms in the Earth's atmosphere at heights 20-41 km.

and Molecular Biology and ISRO in India as well as the Astrobiology Laboratory in Cardiff, UK are collaborating in this exercise. Preliminary findings reveal the existence of living cells and DNA at these heights in numbers consistent with their being showered from above.

We hope that this and further experiments will tell us about the viability of the Hoyle-Wickramasinghe hypothesis and in turn add to the ongoing research on how life began on the Earth. If they are right then we ourselves are ETs !

[1]Hoyle, Fred, The Black Cloud , Penguin, U.K.
[2]Narlikar, Jayant V.; A Cosmic Adventure, Rajahans Prakashan, Pune (Translated from Marathi by Mangala J. Narlikar)

Professor Jayant V. Narlikar is a cosmologist. His contributions to the theory of evolution of the universe are well known. He is the Director of the Inter University Centre for Astronomy and Astrophysics (IUCAA), Pune. His science and science fiction writings in print, radio and television media are popular.