Are we alone in this universe?



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IS OUR planet the only habitat of living systems? Or, are there other locations far beyond the Earth that also support life? These questions have stirred human imagination in all epochs past and present. Old folk tales from various cultures talk about extraterrestrials (ETs in brief), with considerable glamour attached to them. With the advent of science fiction, the ETs provided a staple diet to the emerging genre. But what does hard science think of the above questions?

For a long time serious science kept aloof from these issues because there were no examples of "hard" evidence for making one believe in the existence of ETs. Astronomers of course have been diehard optimists, arguing that with some thousand billion stars present within the observable universe, surely some stars would have planets around them hosting life? But the number game apart, what one would like is some concrete evidence to support the hypothesis of ET.

Thanks to two developments there is now evidence of that kind. The first development came in the 1960s when millimetre wave astronomy began to produce evidence for clouds in the interstellar space containing molecules. The discovery started in a modest fashion with small molecules like the hydroxyl, carbon monoxide, cyanogens, etc. but soon blossomed out leading to complex organic molecules of the kind found in the basic structure of life on Earth. So the tantalising question emerged as to whether these "jigsaw pieces" have combined together to form life somewhere.

That "somewhere" is expected to be a planet with an eco-friendly atmosphere, going round a star from which the life forms derive energy for their survival and progress. The evidence for planets around stars other than our Sun was missing for a long time. The wait was, however, over in the early 1990s when new optical techniques began to reveal evidence of extra-solar planets. Today more than 400 of them are known and some of them may well be eco-friendly. Thus the stage has been set in the 21st century to make a scientific search for extraterrestrial life.

Enthusiasts, however, have not waited for these developments. Believing that the most effective way of discovering technologically advanced ETs is through radio messages, the programme known as Search for Extra-Terrestrial Intelligence (SETI) has been in operation for more than four decades. The SETI programme relies on our receiving replies to messages sent, usually on the 21 centimetre waveband. Coded messages describing basic scientific information and facts about our existence on the Earth have been sent to likely locations usually within a few tens of light years. The messages are not in any earthly language but try to incorporate binary arithmetic and fundamental scientific facts.

If "they" get our message and do think it worthwhile to reply on the same system, then their presence will be known to us and that will no doubt be the most important discovery in the history of human civilisation on this planet. But this method requires patience. If you send a signal towards a star 15 light years away, it means that travelling with the speed of light the signal will reach its destination in 15 years. Add another 15 for the reply to arrive and we have a full 30 years to wait for the response. That is, assuming that "they" are there and they deem it worthwhile replying to us. In short, success is not guaranteed and even if it does materialise, the entire project will have taken up a significant part of the typical human lifespan.

A second approach, not as glamorous as SETI, involves searching for life in a microbial form and that too right at our doorstep. Do cells, bacteria and viruses exist at heights of 40-50 km above the Earth's surface? A theory suggesting a positive answer to this question was put forward by two British astrophysicists Fred Hoyle and Chandra Wickramasinghe. They argued that micro-organisms ride on comets in their frozen form, thus coming from vast interstellar distances. When the comet approaches the Sun its outer layers evaporate and form a long tail. The micro-organisms then spread out and some get shifted to the tail. If the tail brushes the Earth's atmosphere, the micro-organisms get transferred to it and then over the next six to 12 weeks they descend to the *terra ferma.* Given that there are many cometary visits during the year, we expect a flux of infalling bacteria, viruses, etc. at considerable heights above the sea-level.

Keeping this picture in view, but out of a wider interest, some of us decided to look for these micro-organisms at heights of around 30-40 km. At lower heights there is danger of terrestrial contamination, say by micro-organisms tossed up by aircrafts, volcanoes, cyclones, etc. At heights far in excess of the above range, the probability of finding anything in the extremely rarefied atmosphere prevailing there is very low. As it happened we could get a balloon capable of carrying our payload up to 41 km height. It was launched from the National Balloon Facility managed by the Tata Institute of Fundamental Research, at Hyderabad.

The Indian Space Research Organisation sponsored two balloon flights, one in 2001 and the other in 2005. Both involved collecting air samples from specified height bands and examining them under aseptic conditions in biology labs. For example, the 2005 samples were examined at the Centre for Cellular and Molecular Laboratory, Hyderabad, and the National Centre for Cell Sciences, Pune. In both cases we got evidence for live bacteria at a height of around 41 km. Moreover, some bacteria showed survival ability against ultraviolet radiation. The possibility therefore emerges as to how long have those bacteria remained in high UV environment. Could they have come from far away as Hoyle and Wickramasinghe suggested?

Further studies are needed to settle the issue. If we can find out the nuclear isotope composition of the bacteria collected and verify that it differs from terrestrial composition, then we will have established their extraterrestrial origin. The outcome is important; for if the bacteria turn out to be extraterrestrial, then it becomes possible to argue that life on Earth itself may have been seeded by such showering micro-organisms. That would make us all extraterrestrial!

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