Anyone out there?

The search for an intelligent life form elsewhere in the universe has been a 50-year saga, writes **S Ananthanarayan**

WHETHER humankind is alone as an intelligent life form in the universe has been an oft-asked question through the ages. It has intrigued thinkers, dreamers, even scamsters and for 50 years down the line there has been a scientific and systematic search for evidence. The Search for Extra-Terrestrial Intelligence (Seti) is the collective name for the many programmes undertaken by institutions, groups and individual amateurs looking for evidence — through electromagnetic radiation — of inhabitants of other worlds. Noted British physicist Paul Davies, writer and broadcaster who is currently with Arizona State University, in his recent book *The eerie silence, are we alone in the Universe?* talks about the history, the different approaches, the issues, and every other aspect of this haunting quest.

Frank Drake began the search in 1960, something that Paul Davies (left) describes as a "haunting quest".

The start

It has been clear that with the distances in the universe, the only way to look for traces of other intelligent beings must be through radio signals that came from outer space. In 1959, Guiseppe Cocconi and Philip Morrison published a landmark paper (in *Nature*) in which they analysed the kind of radio signals that we need to look for.

The authors reasoned that assuming there was another intelligent community in the universe interested in communicating with a similar, technologically advanced life form, the radio signals they would use must be such that could reach far off worlds and were likely to be detected. Very low frequencies, like one megacycle/sec, as well as frequencies higher than those corresponding to molecular absorption, about 30,000 megacycles/sec, would get absorbed in atmospheres and would not be suitable. In fact, in keeping with economical generation methods, it is the range from one megacycle/sec to 1,000 megacycle/sec that seems feasible.

Even so, searching for a weak signal of unknown frequency in such a range can be challenging. The 1959 authors then reasoned that the intelligent extraterrestrial source would choose a convenient standard frequency, and one that is well known to intelligent listeners in the universe, within this permitted range. A candidate is the outstanding radio frequency emission line of neutral hydrogen, at 1,420 megacycles/second or a wavelength of 21 cm. The authors thus recommended that we look for radio signals at this frequency for evidence of intelligent transmissions!

In the matter of the power that the source may have, the authors noted that in the "galactic plane" (of the Milky Way), there was 40 times the background noise in the range of 21 cm wavelength, than off the galactic plane. Hence, a weak signal would be difficult to identify in the galactic plane and the right place to look would be towards the nearest stars *off* the galactic plane.

And then the detector would need to search sufficiently above and below the target frequency to account for the rise or drop in frequency of radiation emitted from sources moving towards or away from the solar system.

What kind of signals?

In this matter, the recommendations were purely speculative. The signals, it was argued, would be in pulses not far off from once a second to suit band width and rotating devices. As the distances were in tens of light years, for the signal as well as the response, each signal would perhaps last a few years and then to repeat. The content may be a series of pulses numbering prime numbers or simple arithmetic sums (or differences).

The nearest stars, and of this kind there were a few hundreds within, say, 50 light years, were the first towards which attention should be devoted.

The search begins

Almost immediately, in April 1960, American astronomer Frank Drake started a systematic search for extraterrestrial radio signals with a 26-metre dish at Green Bank in West Virginia. Many others joined in and Drake later set up the radio telescope at Arecibo in Puerto Rico. This was the start of Seti, now grown to an international effort, mostly privately funded, of scientific institutions and even individuals in several countries. While amateurs often work with just telescopes to look for visible signs, the main apparatus for Seti is the radio telescope, an array of dish antennas spread out over several kilometres, with the signals received being brought together and processed by computers to mimic a receiving mirror so many kilometres in diameter.

The important centre of activity is now the Allen Telescope Array, a system of 350 networked dishes (42 are operational so far), being set up in northern California. The name, Allen, is in honour of its main sponsor, Paul Allen, co-founder of Microsoft.

Eerie silence

The trouble is that through all these 50 years, no acceptable extra-terrestrial radio activity has been detected. This is not by itself surprising as the best supporters of Seti do not hold out great hope of detecting signals in real time. Noted scientist and science fiction author, Carl Sagan, suggested that there may be an altruistic civilisation trying to make contact with earth. Even if there were one such, 500 light years away, for instance, says Davies in his book, the civilisation, if it were to beam a signal towards the earth, would be addressing an earth in the 16th century. This is before the industrial revolution and all the alien civilisation would see on earth is agriculture and maybe the Great Wall of China. If they were to wait till we also learnt about radio signals, this would be 400 years later, and then the signals would take 500 years in transit! The late Sagan's dream may not be realised for a millennium.

When Frank Drake started out in 1960, he devised a formula which, even if it did not calculate anything, did show how far we are from understanding what we are about. The formula: $N=Rxf_p n_e f_L f_I f_c L$, where R is the rate of formation of sun-like stars in the galaxy, f_p is the fraction of those stars with planets, n_e is the average number of earthlike planets in each planetary system, f_L is the fraction of those planets on which life emerges, f_I is the fraction of planets with life on which intelligence evolves, f_c is the fraction of those planets on which technological civilisation and the ability to communicate emerges, and L is the average lifetime of a communicating civilisation.

We can see that the formula is dominated by f_L and f_I, the probability of life emerging and then of intelligent life which are completely unknown. The probability of life emerging has long been considered to be exceedingly low, what has happened on earth being regarded as an astronomical fluke. And yet, now there is a counter view that emergence of life is fairly likely to happen if the conditions are "earth-like".

For this hypothesis, while we have no evidence in other worlds, it may make sense to look for repeated instances of life arising on our earth itself. This is the search, as part of Seti, that has now caught on, not life as we know it but at the microbial level, a population of organisms of a radically different biochemistry. If we should find anything like it on earth, it would be a powerful reason to expect the same in other worlds, too.

Technology footprint

Davies suggests that we look for indirect evidence of intelligent life. That is to say, not for signals beamed at us by an alien race but other signs that they are there. For instance, humans have significantly modified earth over the last so many centuries. Is it not conceivable that another civilisation may have done the same thing on their world?

Physicist Freeman Dyson had suggested that an energy-hungry civilisation might create a shell of material around its host star to trap most of the radiation. If such a "Dyson sphere" existed, it would leave a radiate in the infrared, which could be detected.

Other largescale projects on the alien world may also produce detectable effects in its spectral or thermal characteristics. There may even be physical features that could be detected and beamed back by unmanned spacecraft.

In 1950, physicist Enrico Fermi had suggested that an intelligent alien race would be able to spread across the galaxy in far less time than the age of the galaxy. Hence, if there were any such in the Milky Way they would have reached earth by now! This is called the Fermi Paradox and there are many resolutions to say why this has not happened!

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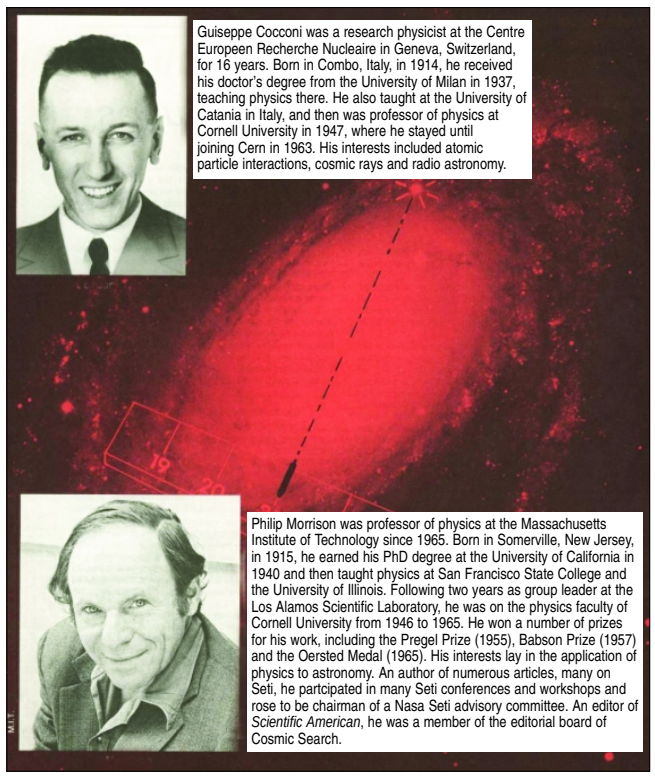

Guiseppe Cocconi was a research physicist at the Centre Europeen Recherche Nucleaire in Geneva, Switzerland, for 16 years. Born in Combo, Italy, in 1914, he received his doctor's degree from the University of Milan in 1937, teaching physics there. He also taught at the University of Catania in Italy, and then was professor of physics at Cornell University in 1947, where he stayed until joining Cern in 1963. His interests included atomic particle interactions, cosmic rays and radio astronomy.

Philip Morrison was professor of physics at the Massachusetts Institute of Technology since 1965. Born in Somerville, New Jersey, in 1915, he earned his PhD degree at the University of California in 1940 and then taught physics at San Francisco State College and the University of Illinois. Following two years as group leader at the Los Alamos Scientific Laboratory, he was on the physics faculty of Cornell University from 1946 to 1965. He won a number of prizes for his work, including the Pregel Prize (1955), Babson Prize (1957) and the Oersted Medal (1965). His interests lay in the application of physics to astronomy. An author of numerous articles, many on Seti, he partcipated in many Seti conferences and workshops and rose to be chairman of a Nasa Seti advisory committee. An editor of *Scientific American*, he was a member of the editorial board of Cosmic Search.

We look where we can

A drunk was searching under a streetlight.
A passerby asks, "What you lookin' for, mate?"
"Ma keys."
"Drop them near here?"
"Naw, down there, in the dark corner."
"Why you lookin' here then?"
"Because there is a light."

Antibodies in action

What are antitoxins and how do they interact with toxins and neutralise them? **Tapan Kumar Maitra** explains some of the occult properties of micro-organisms

ANTITOXINS are antibodies capable of interacting with the corresponding toxins and neutralising them. It has already been established that some micro-organisms are capable of producing exotoxins.

In the reaction of neutralisation of the toxin by the antitoxin, certain conditions are required — quantitative proportions, time necessary for interaction and optimal temperature. A physicochemical reaction lies at the basis of this phenomenon. The outer manifestation of the binding of toxin with antitoxin in vitro is a flocculation — turbidity in the test tube containing a mixture of toxin and antitoxin. Flocculation is a specific reaction, and is employed in the manufacture of sera for the determination of the degree of activity or strength of the action of antitoxic sera.

The International Unit is accepted as the unit in measuring the potency of the antitoxic serum. It is the dose of the antitoxic serum which neutralises a definite amount of Dlm of toxin. In accordance with the recommendation of the World Health Organisation Expert Committee on the Standardisation of Biological Preparations, the International Unit (IV) is a definite number of milligrams of dry hyperimmune horse serum in physiological saline solution with 66 per cent glycerin by volume. The standard preparations of such sera are stored at the International Laboratory of Biological Standards of the State Institute of Sera in Copenhagen, Denmark.

The reaction between the toxin and antitoxin takes place according to the type of complex proportions calculated by special equations of adsorption isotherms. Experiments have confirmed that the free amino groups of toxins take part in rendering a toxin harmless and their binding is accompanied by the loss of toxicity.

Therapeutic action of antitoxic sera depends not only on the strength and amount of IU in one millilitre but also on the avidity (eagerness), rapidity, completeness and stability of the bond between the toxin and antitoxin.

The methods of obtaining and titrating sera are many. Antitoxic sera are obtained by hyperimmunisation of animals (horses). After a complete course of immunisation a large amount of antitoxin accumulates in the blood of the animals, after which partial or complete bleeding is carded out. The blood is collected in bottles where it clots, and a transparent yellowish liquid (serum) separates out above the clot.

The serum thus obtained is checked for sterility, pyrogenicity — the ability to cause an elevation of temperature in animals during parenteral injection — and the titre is established, that is, the amount of IU in a millilitre is determined.

Titration of antitoxic sera is performed with the aid of certain standard toxins on animals — guinea pigs, white mice and rabbits by injecting the mixture of a definite dose of a standard toxin and different doses of the serum under test. Titration, for example, of the antitoxic antidiphtheritic serum is performed on animals — in vivo — according to the methods of Ehrlich and Romer, and by the method of flocculation — in vitro — according to Ramon.

For titration of the antitoxin by the method of flocculation an Lf toxin is used — limes flocculation is the amount of toxin that in one IU brings about the most rapid flocculation. The test tubes are placed in a water bath at 45° Celsius.

Pyrogenicity is determined by injecting into rabbits 0.1 ml of serum per kilogram of body weight. The temperature is measured every five, 30 and 120 minutes. If the temperature rises more than one degree Celsius, then the serum is considered to be pyrogenic.

At present the method of determination of the toxigenicity of diphtheria cultures on solid nutrient media is employed for diagnostic purposes. It is based on the interaction of the antitoxic serum and toxin produced by the diphtheria bacteria during growth. For this purpose, a sterile strip of filter paper soaked in antitoxic antidiphtheritic serum is placed in the centre of a petri dish and covered with a nutrient medium, after which streaks are made perpendicular to the strip of filter paper. If the culture produces exotoxin, it diffuses into the nutrient medium and the reaction of precipitation with antitoxin occurs. The precipitate thus produced can be observed as fine arrow-whiskers on both sides of the streaked culture.

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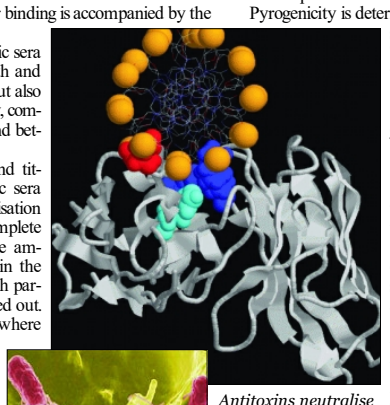


Antitoxins neutralise the toxin released by pathogenic microorganisms. (above), even as they neutralise the toxin released by pathogenic micro-organisms (left).

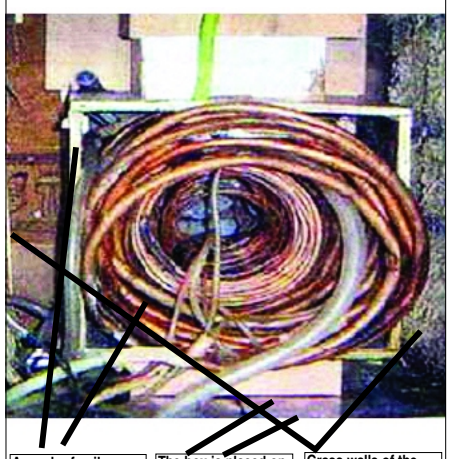
Beat the heat

Three years since an elderly journalist came up with the 'common man's airconditioner', his Snowbreeze variants have acquired government support and a 'green' guarantee

WAY back on 2 March 2008, *The Statesman*, in its Sunday supplement, carried a richly illustrated article on "the common man's airconditioner" designed and created by the elderly MB Lal, a former journalist with this newspaper. Of the several models of this marvellous concept, Snowbreeze 4 has turned out to be the cheapest, most efficient and easiest to make. You can convert your desert cooler into a dual-purpose machine to function both as a desert cooler and an airconditioner at a mere additional cost of Rs 2,500. The cost of the whole unit is less than Rs 5,000. When used as an airconditioner it can bring down the temperature of a room by 10° Celsius and dehumidify it proportionately.

Lal's unique project last year attracted financial support – Rs 1.10 lakh – from the Union science and technology ministry under its Technopreneur Promotion Programme (TePP). Technical support was provided by its Foundation for Innovation and Technology transfer through Dr Anil Wali, its managing director, and Dr Sanjeev Jain, an IIT professor specializing in refrigeration.

Inside view of the 90 per cent energy-saving airconditioner-cum-desert cooler



MB Lal

Born of sheer necessity to cope with long and frequent power breakdowns, Lal made his first crude model, run on ice and a 25-watt fan, in the summer of 2007. It attracted wide attention and, finally, after a year's reviews by various expert bodies, the project was adopted by the ministry.

Explaining his invention, Lal says, "The project leads us to the conclusion that airconditioning and refrigeration experts should take a serious look at ice and chilled water as a room-cooling option. Snowbreeze is just the beginning. Airconditioning has emerged as one of our biggest power guzzlers and environmental hazards. At the same time, with massive urbanisation our cities are becoming concrete furnaces during summer and there is an urgent need for cooling devices that are cheap, easily affordable, 100 per cent green and less dependent on electricity."

He points out that a 1.5-ton wall airconditioner consumes two units of power in an hour, which is enough to run Snowbreeze for 10 hours. One unit can produce 20 kg of ice in an ice factory and 10-12 kg in the family refrigerator, he says.

Lal discovered that in the matter of moderating airflow to the right measure – by first compressing the air and then amplifying it before ejecting it into a room – the design of the desert cooler was unbeatable. But one with a desert cooler could make it a dual purpose appliance by merely placing in it a thick mesh of copper coil around the fan, an additional Tullu pump in the tank and a metal sheet to seal off the water tank from the air.

The water tank is common to both systems. When used as an AC (inside the window) the Tullu pump circulates chilled water in the copper coil while the grass walls (on either side of the tank) are kept dry. When used as a desert cooler (outside the window) another Tullu pump provides normal water from the same tank. This tank is separated from the air chamber by a thick metal sheet. The changeover to AC merely means rolling it a few inches inside the room on the same angle iron frame and shutting the window behind it.

It can run on an inverter since it is powered by a 12-inch exhaust fan of 70 watt and can be rolled from room to room as a standalone or connected to a refrigerator or chilling machine in an instant. It has been created for the common good and has not been patented. For more information, visit: www.greenairconditioner.org.