The 64 m radio telescope in Parkes, New South Wales. Pic courtesy Daniel John Reardon

Intelligent life in the cosmos

Is someone out there sending a message to us?

S ANANTHANARAYANAN

The Guardian, UK, reported on 18 December 2020, that extra-terrestrial signals appear to have been detected. The findings are to be published early this year, but the news leak has brought the subject of ET back into focus.

The report is that while monitoring radio-frequency emissions from *Proxima Centauri*, a red dwarf star – the nearest, at 4.2 light years, from the solar system –, scientists at the Parkes Observatory in Australia recorded a persistent signal, at a fixed frequency, repeated many times over a period of a week. Checks and cross checks to eliminate errors or identify sources have led to a suspicion that this may just be what a campaign that was set into motion over 60 years ago has been waiting for!

Speculation about intelligent life in the cosmos was given shape in 1959, in a seminal paper by Giuseppe Cocconi and Philip Morrison, published in the journal, *Nature*. Assuming there was an intelligent community somewhere in the universe interested in communicating with another one, the paper said, the signal it sent out would need to be one that could cover long distances. The writers argued that it must be a radio wave, in the range of one to 10,000 MHz. Within this range, the best place to look would be in the region of the prominent emission of hydrogen, at 1,420 MHz (or a wavelength of 21 cm). And further, to stay clear of background emissions, we should look in directions away from the galactic plane, in spells of observation from minutes to hours, and to look out for streams of pulses that may continue for years before they are repeated.

The very next year, the scheme was taken up by American astronomer, Frank Drake, and he set up a facility with the 26-metre radio telescope in Green Banks, West Virginia. Many others joined and Drake later set up a radio telescope in Puerto Rico. It became the start of the Search for Extra Terrestrial Intelligence or SETI, an international effort, mostly privately funded and including individual exo-planet hunters. And then, in 2015, in a function that celebrities, like Stephen Hawking attended, Russia-born, Silicon Valley billionaire, Yuri Milner launched Milner's Breakthrough Listen, a US$ 100 million, 10-year programme to push the limits of the search of SETI. "If we do not find something in these 10 years, we will just extend for another 10, and then another 10, "Milner said.

The programme purchases stellar observation time in facilities and funds investigation, worldwide, major work being by two of the largest radio telescopes in the world, the Green Banks Telescope in West Virginia and the Parkes Telescope in Australia. Perched, as these two are, on opposite sides of the Earth, they can cover most of the visible sky. And in addition to radio signals, the project has tied up with the Link observatory in Berkeley. It is both for data analysis, and to watch, using the ultra-sensitive equipment of the Link, for feeble signals sent through optical lasers.

The facilities at hand could thus monitor millions of stars and galaxies. The major thrust, however, has been with red dwarves, which are the most ancient stars, at later stages in their course of evolution. The choice was first of "Sun-like" stars, as being the most likely to host "Earth-like" planets. But then, it was found that conditions could be suitable with near planets of the cooler red dwarves too. And there are a great many more such red dwarves than "Sun-like" stars.

Proxima Centauri, which holds centre stage at the moment, is a red dwarf, and it has two main planets in orbit. The one that is farther away is surely too cold to be of interest. The nearer planet, however, is about the size of Earth and in the so-called "habitable zone", where it is possible for water to exist in the liquid form. *Proxima Centauri*, however, exhibits peaks in magnetic activity, with rise in brightness and X-ray emission. Because of this feature and the fact that the planet is close to the star, *Proxima Centauri* was not of serious interest for SETI. The data that is now of interest got collected because of a team that used the facility to study the effect the star's periodic "flares" had on its planets.

The way the Milner's Breakthrough Listen programme functions is that massive data collected by radio telescopes around the world is analysed, through automation, and manually, during months after collection. The data is first filtered, to throw out what is clearly terrestrial or other forms of "noise", that have nothing to do with ET. What is left is then analysed in detail, to keep only a part whose origin cannot be explained – for further study.

The data from *Proxima Centauri*, collected in April 2019, was also routinely kept aside for examination. And in October 2019, Shane Smith, undergraduate student and intern at the SETI programme at Berkeley, noticed the curious feature – emissions in a narrow frequency band, 982.002 MHz. It was outside the range of known artificial sources. None of the filters had blocked the signal and it was screaming for a reason of why it was there!

All the data was reviewed, and it was seen that the emission had been in focus several times in the course of a week of observation. The procedure is that after each 30-minute spell of observation, the telescope shifts to a different part of the sky, to make sure that data pertaining to the part observed is unique to that part. The emission at 982 MHz qualified, and was found to be coming from precisely the direction of Proxima Centauri.

The effort is on to find an explanation for the signal, some source of radiation, maybe from a man-made satellite, some atmospheric disturbance, some identified cosmic event. Everybody involved agrees that the chance of the reason being anything else is exceedingly remote. The signal also does not present features of being anything else. It does not have a pattern, for instance – it is just a drone. There is a small change in frequency, but contrary to what could be explained by the motion of the planet – which raises questions.

Now what observers are waiting for is a repeat of the signal, for if it is indeed a message, the sender would send it again. "If an independent team at an independent observatory can recover the same signal, then hell, yes! I would bet money that they won't, but I would love to be wrong," says Shami Chatterjee, a radio astronomer from Cornell University in New York.

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ARE WE ALONE IN THE UNIVERSE?

'Mankind has a deep need to explore, to learn, to know. We also happen to be sociable creatures. It is important for us to know if we are alone in the dark," said Stephen Hawking, when Milner's Breakthrough Listen was inaugurated.

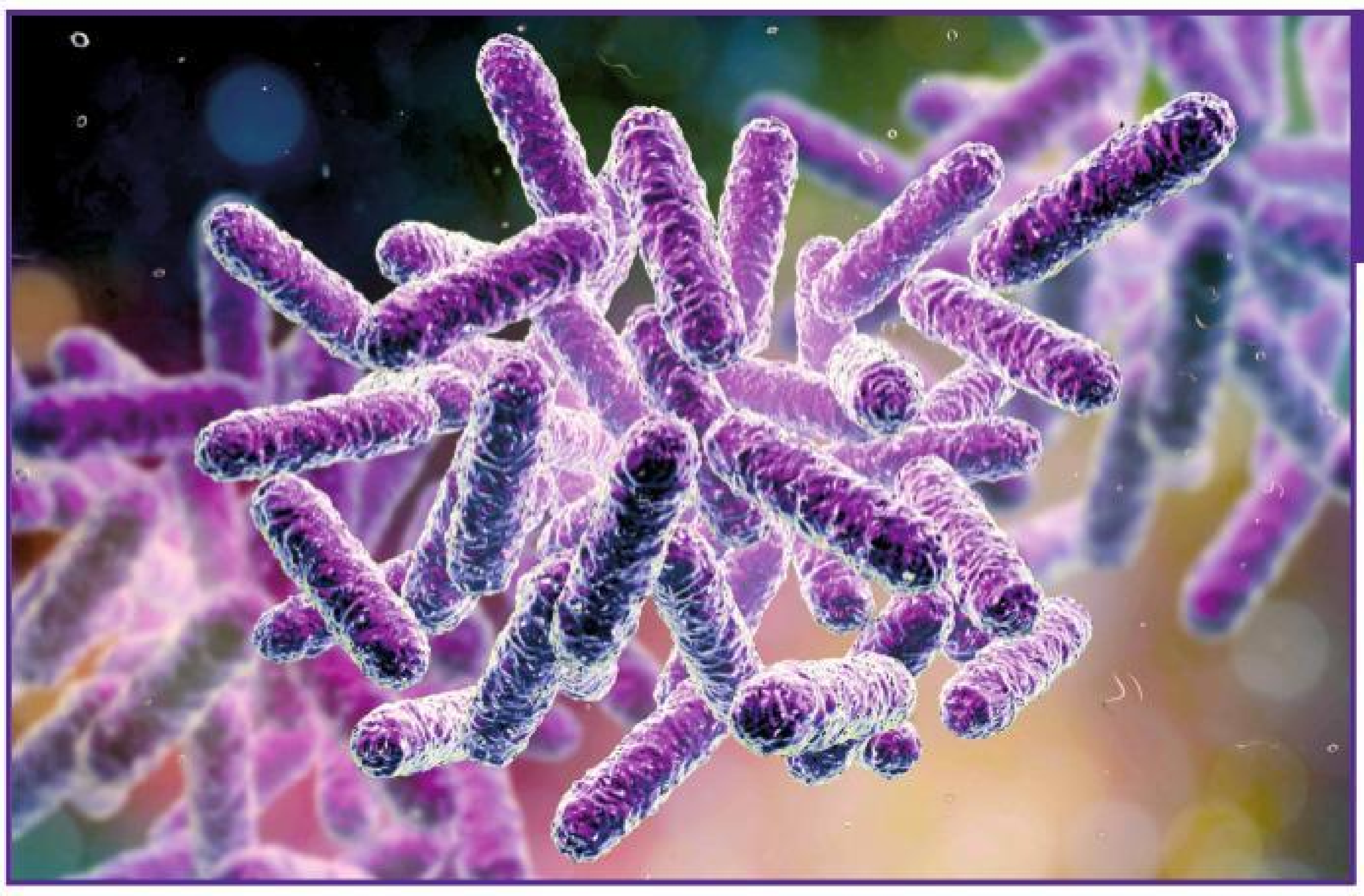
Hawking, however, also cautioned that contact with an alien civilisation may not be all good for Earth. The aliens may have the capability to wipe out the human race. They may not be more considerate to humans than humans often were to creatures or people less capable than themselves, Hawking said.

There have been other studies of technologically superior humans making contact with greatly different civilisations. In the contact of Europe with the Americas, after Christopher Columbus, humans, ideas, animals, plants, microbes, and diseases were transferred, to the advantage of the Europeans and effective elimination of the original Americans.

ET initiatives, however, are limited. The only possible contact, as of now, may be the decoding of a radio message, from light years away. And visits by aliens or alien spacecraft are quite out of sight.

THE MOTIVATION

"The probability of success is difficult to estimate, but if we never search, the chance of success is zero." – Cocconi and Morrison



GENE REGULATION

Both expression and repression mark the life of a cell and its various processes

TAPAN KUMAR MAITRA

Regulation is an important part of almost every process in nature. Rarely, if ever, is it adequate simply to describe the steps of a process. Instead, it must also ask what turns it on, what turns it off, and what determines its rate.

That is especially true of gene expression. Most genes are not expressed all the time. In some cases, selective gene expression enables cells to be metabolically thrifty, synthesising only those gene products that are of immediate use under the prevailing environmental conditions; this is often the situation with bacteria. In other cases, such as in multicellular organisms, selective gene expression allows cells to fulfill specialised roles.

As one might expect, the first knowledge about the regulation of gene expression came from investigations of prokaryotes. Bacteria are far more amenable to the kinds of genetic and biochemical manipulations that marked the early studies of gene control mechanisms.

Of the several thousand genes present in a typical bacterial cell, some are so important to the life of the cell that they are active at all times; their expression is not regulated. Such constitutive genes include, for example, the genes encoding the enzymes of glycolysis. For many other genes, however, expression is regulated so that the amount of the final gene product – protein or RNA – is carefully tuned to the cell's need for that product. A number of these regulated genes encode enzymes for metabolic processes that, unlike glycolysis, are not constantly required.

One way of regulating the intracellular concentrations of such enzymes is by starting and stopping gene transcription in response to cellular needs. Because this control of enzyme-coding genes helps bacterial cells adapt to their environment, it is commonly referred to as adaptive enzyme synthesis.

Bacteria use somewhat different approaches for regulating enzyme synthesis, depending on whether a given enzyme is involved in a catabolic (degradative) or anabolic (synthetic) pathway. The enzymes that catalyse such pathways are often regulated coordinately; that is, the synthesis of all the enzymes involved in a particular pathway is turned on and off together. Here are two well-understood pathways – one catabolic and another anabolic.

Catabolic enzymes exist for the primary purpose of degrading specific substrates, often as a means of obtaining energy. The central step in this pathway is the hydrolysis of lactose into the monosaccharides glucose and galactose, a reaction catalysed by the enzyme beta-galactosidase. However, before lactose can be hydrolysed, it must first be transported into the cell. A protein called galactoside permease is responsible for this transport, and its synthesis is regulated coordinately with beta-galactosidase.

Since the function of a catabolic enzyme is to degrade a specific substrate, such enzymes are needed only when the cell is confronted by the relevant substrate. The enzyme beta-galactosidase, for example, is useful only when cells have access to lactose; in the absence of lactose, the enzyme is superfluous. Accordingly, it makes sense in terms of the cellular economy for the synthesis of beta-galactosidase to be turned on, or induced, in the presence of lactose, but to be turned off in its absence. This turning on of enzyme synthesis is called substrate induction, and enzymes whose synthesis is regulated in this way are referred to as inducible enzymes. Most catabolic pathways in bacterial cells are subject to substrate induction of their enzymes.

The regulation of anabolic pathways is in a sense just the opposite of that for catabolic pathways. For anabolic pathways, the amount of enzyme produced by a cell usually correlates inversely with the intra-cellular concentration of the end-product of the pathway. Such a relationship makes sense. For example, as the concentration of tryptophan rises, it is advantageous for the cell to economise on its metabolic resources by reducing its production of the enzymes involved in synthesising tryptophan. But it is equally important that the cell be able to turn the production of these enzymes back on when the level of tryptophan decreases again.

This kind of control is made possible by the ability of the end-product of an anabolic pathway – for example, tryptophan – to somehow repress the further production of the enzymes involved in its formation. Such reduction in the expression of the enzyme-coding genes is called end-product repression. Most biosynthetic pathways in bacterial cells are regulated in this way. Repression is a general term in molecular genetics, referring to the reduction in expression of any regulated gene.

True genetic repression always has an effect on pro-tein synthesis, and not just on protein activity. The end-products of biosynthetic pathways often have an inhibitory effect on enzyme activity as well. This feedback inhibition differs from repression in both mechanism and result. In feedback inhibition, molecules of enzyme are still present, but their catalytic activity is inhibited; in end-product repression, the enzyme molecules are not even made.

One feature common to both induction and repression of enzyme synthesis is that control is exerted at the gene level in both cases. Another shared feature is that control is triggered by small organic molecules present within the cell or in the cell's surroundings.

Geneticists call small organic molecules that function in this way, effectors. For catabolic pathways, effectors are almost always substrates (lactose for example), and they function as inducers of gene expression and, thus, of enzyme synthesis. For anabolic pathways, effectors are usually end-products (tryptophan for example), and they usually lead to the repression of gene expression and thus repression of enzyme synthesis.

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PLUS POINTS

Microplastics in placenta

Scientists have described the discovery of microplastics in the placentas of new mothers as "a matter of great concern", after new research identified a range of synthetic substances from relatively small tissue samples.

The women who took part in the study in Italy had no complications with the births of their children, and the effect of the tiny plastic particles is unknown, however, experts have suggested plastics could provide a means for harmful chemicals to damage a developing foetus's immune system.

The researchers from Rome's Fatebenefratelli Hospital, which specialises in paediatrics, and the Politecnica delle Marche University said, "With the presence of plastic in the body, the immune system that self-recognises is disturbed, even what is not organic. It's like having a cyborg baby, no longer composed only of human cells, but a mixture of a biological entity and inorganic entities." Lead author of the study Antonio Ragusa, head of Fatebenefratelli's obstetrics and gynaecology department, said "the mothers were shocked".

The research team found 12 microplastic fragments in four placentas out of six donated by women after the birth of their children. Only three per cent of the tissue from each placenta was sampled, suggesting the total number of microplastic pieces could be much higher. Dr Ragusa, said, "When I saw for the first time microplastics in the placenta, I was astonished."

The research paper said all the plastics were pigmented. "Three were identified as stained polypropylene a thermoplastic polymer, while for the other nine it was possible to identify only the pigments, which were all used for man-made coatings, paints, adhesives, plasters, finger paints, polymers, cosmetics and personal care products."

Inside human cells, microplastics are treated as foreign bodies by the host organism and this can trigger localised immune responses. Microplastics can also act as carriers for other chemicals, including environmental pollutants and plastic additives, which may be released and are known for their harmful effects, the authors said.

In order to ensure the placentas the scientists were studying were not contaminated with plastics after they had left the body, a plastic-free environment was maintained during the entire experiment. Obstetricians and midwives used cotton gloves to assist women in labour. In the delivery room, only cotton towels were used to cover patients' beds, and the umbilical cord was clamped and cut with metal clippers, to avoid contact with plastic material. Pathologists also wore cotton gloves and used metal scalpels.

The authors said, "Due to the crucial role of placenta in supporting the foetus development and in acting as an interface between the latter and the external environment, the presence of exogenous and potentially harmful (plastic) particles is a matter of great concern."

The research is published in the *Environment International* journal.

–THE INDEPENDENT

Underwater bullies

The first time that Eduardo Sampaio saw an octopus wind up and punch a fish, "I burst out laughing," he said. That was a problem because he was scuba diving in the Red Sea and nearly choked on his diving regulator.

While an octopus curling one of its arms and explosively releasing it into a fish that gets too close has been seen before, the context was new. The octopus that Sampaio observed was hunting for food alongside other marine creatures, and this was the first time anyone had seen an octopus haymaker thrown during such behaviour.

Sampaio and his co-authors published their observations of several octopus bullies in the journal *Ecology*. They hope their research will help reveal the dynamics among these animal groups, which may balance their competing interests through subtle – and less subtle – negotiations.

–THE STRAITS TIMES/ANN