Editorial

In the last four editorials importance was given to topics of interest to earth scientists. Since JIGU caters to the needs of earth system scientists I have selected for this issue a topic of importance to Space scientists/ cosmologists and astronomers. In a way this is in continuation of details given in the subsection "Space Science & Technology News" (Pages238-240 of News at a Glance of May, 2017 issue of JIGU). I believe that a time has come for scientists of all the branches of earth system to know more about cosmology and studies on the Universe.

*****Colonization of Planets and Exoplanets**

Man has been endowed with the extraordinary quality of exploring various unknowns, starting from the childhood. This quality can lead him to do knowingly and unknowingly both good and bad deeds that can alter the very evolutionary mechanism and life on earth.

Hardly 200 years back man could not develop a vessel that would help him to fly. Now we not only fly from one corner of the earth to the other in a few hours but also can go to Moon and also Mars in a few days. Significant efforts are made by different countries and especially NASA to colonize Moon followed by Mars overcoming number of hurdles. These efforts may yield in the next 100 years fruitful results. All these achievements by the man make us believe that we can conquer the Universe one day or the other; wild and intriguing imagination. Couple of decades back even many scientists were not familiar with the word Exoplanet (An exoplanet or extrasolar planet is a planet that orbits a star other than the Sun. The first scientific detection of an exoplanet was in 1988. However, the first confirmed detection came in 1992; since then, and as of 1 March 2017, there have been 3,586 exoplanets in 2,691 planetary systems and 603 multiple planetary systems confirmed). The Kepler space telescope really revolutionized the number of exoplanets that we know exist." (Kepler is credited with over 2,300 confirmed exoplanets, using a system to detect them called the transit method.)

But of all those, only a "handful" are potentially habitable, NASA confirmed. NASA also clearly stated that Humanity is not going to be visiting them anytime soon, though. Take, for example, to reach the nearest known exoplanet, Proxima Centauri B, which is about four light years away from here—(a light year being the distance that light can travel in 365 days) would take an astounding amount of time. If we send a probe there (for example Juno space probe, currently orbiting Jupiter at speeds in the neighbourhood of 150,000 miles per hour) to reach Proxima Centauri B, it would take an astounding 18,000 years. "So the technology really isn't there currently". (**Source:** https://en.wikipedia.org/wiki/Exoplanet & http://www.space.com/33844-proxima-b-exoplanet-interstellar-mission.html.).

Where are the exoplanets that have life?

The emergence, evolution, and survivability of extrasolar life, if any exists, involve enormous uncertainties. Despite remarkable progress toward producing life in the lab in recent years, the precise origin of life—the dramatic transformation from chemistry to biology—remains a mystery. Earth is blessed with a relatively large moon that has stabilized the climate. The asteroid belt, on one hand, may have helped to seed life and, on the other, may have been responsible for mass extinctions. Even the location of our solar system—within a minor spur off one of the two main arms of the galaxy, relatively far from the galactic center—has shielded it from the potentially sterilizing effects of gamma-ray bursts.

Given those uncertainties, scientists Mario Livio and Joseph Silk (2017) have reviewed potential life signatures and future plans to find them; to identify the most generic, remotely detectable signatures of an alien life, both simple and intelligent; and to examine the expected effectiveness of various search strategies. They have noted that searches for life focus on Sun-like and smaller stars because the vast majority of stars are smaller than the Sun: M dwarfs comprise some 70% of all stars in the Milky Way, and a large fraction of them harbour planets. Also, more massive stars have shorter lifetimes and emit intense UV radiation. Both factors make them less hospitable as energy sources for biochemical processes that may require billions of years to unfold and take effect. Stars more massive than about three times the mass of the Sun, for instance, will likely burn out before life has time to emerge and evolve. Ideally, therefore, researchers would like to find a star–planet system just like Sun–Earth—Earth 2.0 as it were— because at least we know without a doubt that life emerged here. A program to search for an Earth twin does not guarantee success in finding extrasolar life, but at least it should substantially increase the odds. Nevertheless, a recent comprehensive examination of the habitability of planets orbiting M dwarf stars concluded that some features of their stellar and planetary environments could confer advantages. For example, synchronous rotation could improve habitable conditions on planets orbiting at the inner edge of the habitable zone. Planets orbiting M dwarfs are also predicted to be more resistant to global glaciation. In the search for extra solar life, high priority targets are planets that are numerous and relatively easy to detect. The insistence on the existence of liquid water is again somewhat Earth-centric, but water does have a few special characteristics. It is an excellent solvent; it is less dense as a solid than as a liquid; it is amphoteric, which means it can become an acid or a base by donating or accepting a positive hydrogen ion; and it is abundant across the universe.

Some form of liquid solvent is undoubtedly necessary if chemicals are to be transported into and out of cells and if molecules are to come into contact with one another to form long-chained organic ingredients. A liquid environment would also protect those organic compounds from UV radiation. However, it is not entirely clear whether only water can play that role. To be detectable from a distance, life has to evolve to the point where it so dominates the planetary surface chemistry that it significantly alters the atmosphere. Only then will life give itself away through chemical bio-signatures that can in principle be detected remotely. Earth itself would probably not have been detectable as a life-bearing planet during the first billion or so years of its existence. Oxygen became an important atmospheric constituent due entirely to life processes but it built up slowly. Any oxygen produced by early organisms first went into oxidizing rocks. Only after the oxidizable rocks became saturated did free oxygen start to enrich the atmosphere. An excellent first step in the quest for extra-solar life in the relatively near future would be to search for planets with atmospheric oxygen in abundance. That could be achieved in principle with a next-generation European Extremely Large Telescope or other large, ground-based arrays of relatively low-cost flux collector telescopes.

One would ideally like to go beyond simple bio-signatures and seek the clearest sign of an alien technological civilization. That could be the unambiguous detection of an information-containing, non natural signal, most notably via radio transmission or optical/IR laser beaming. Such detection is the aim of Search for Extra Terrestrial Intelligence (SETI) and other similar programs. One interesting argument to make the search more efficient is that we should concentrate on those directions in which mini-eclipses of the Sun by transiting solar-system planets are detectable. Technological civilizations in those directions, the argument goes, are more likely to discover us and attempt communication.

However, the fraction of the Milky Way that has been reached by radio-communication signals from Earth was recently estimated to be only about 1%. To give ourselves better odds for success, we might want to reach about 50% of the suitable planets before expecting a return signal. That puts the more probable time for a reception of a radio signal from another galactic civilization, assuming it exists, some 1500 years into the future. Other potential signatures of technological civilizations that have been suggested, such as various forms of atmospheric industrial pollution and short-lived radioactive products, are necessarily transitory. Basically, we expect that aliens either learn how to clean up after themselves or they destroy themselves. Infrared emission, on the other hand, seems almost unavoidable. To end on a speculative and perhaps pessimistic note, biologically based intelligence may constitute only a very brief phase in the evolution of complexity. What follows could be what some futurists have dubbed the "singularity": the dominance of artificial, inorganic intelligence. If that is indeed the case, advanced species are likely not bound to a planet's surface, where gravity is helpful for the emergence of biological life but is otherwise a liability, but rather floating in space. Even with that imaginative conjecture, one can still argue that any surviving species must be near an energy supply, namely a star. But if such intelligent machines were to transmit a signal, it may well be unrecognizable and non-decodable to our relatively primitive, organic brains. The detection of potential signs of life with the upcoming generation of space telescopes, followed by the detection of high levels of oxygen from large ground-based telescopes and increasingly reliable detection of bio-signatures with the next generation of 10-m-class telescopes in space. Simultaneously, searches for electromagnetic signals from other galactic civilizations should continue, and searches for unusual IR emissions that could indicate energy consumption by remote species should be intensified.

Are we alone? The answer may affect nothing less than our claim for being special in the cosmos. Its importance cannot be overemphasized. Echoing what Giuseppe Cocconi and Philip Morrison said at the end of their seminal 1959 article on searching for extraterrestrials, **"We shall never know unless we search!"** (**Source:** http://physicstoday.scitation.org/doi/full/10.1063/PT.3.3494).

From the above exposition it is clear, as of now, it is beyond our capability to colonize habitable exoplanets and our focus should at first be confined to precisely identify those exoplanets that are habitable. Colonization follows much later, if at all possible. The following study addresses that in a precise manner.

Exoplanets atmosphere-the basic component to evaluate its habitability

While travelling to the probable habitable exoplanets is beyond our present technological efficiency, one has to first confirm the favourable habitability conditions of an exoplanet. The atmospheres of exoplanets can host bio-signature gases, so the path to finding possible signs of life on exoplanets most likely leads through their atmospheres. Indeed, the atmosphere is the window into all exoplanetary properties beyond mass, radius, and orbital dynamics. Moreover, exoplanetary atmospheres host a wide variety of fascinating physical processes, from intense infrared radiation and exotic chemistry, to super-sonic winds and electric currents. One of our best ways to probe the nature of these alien worlds is to measure the ultraviolet (UV), optical or infrared (IR) spectra of their atmospheres. We have also learned in the recent past that many exoplanets are strikingly different than the planets of our solar system. Most important, we now have dozens of alien atmospheres than are amenable to observations, so that we can measure their properties and begin to conduct comparative studies. The atmospheres of exoplanets reveal all their properties beyond mass, radius, and orbit. Based on bulk densities, we know that exoplanets larger than 1.5 Earth radii must have gaseous envelopes, hence atmospheres. There are contemporary techniques for characterization of exoplanetary atmospheres. The measurements are difficult, because - even in current favourable cases - the signals can be as small as 0.001% of the host star's flux. Consequently, some early results have been illusory, and not confirmed by subsequent investigations. Prominent illusions to date include polarized scattered light, temperature inversions, and the existence of carbon planets. The field moves from the first tentative and often incorrect conclusions, converging to the reality of exoplanetary atmospheres. That reality is revealed using transits for close-in exoplanets, and direct imaging for young or massive exoplanets in distant orbits. Several atomic and molecular constituents have now been robustly detected in exoplanets as small as Neptune. In our current observations, the effects of clouds and haze appear ubiquitous. Topics at the current frontier include the measurement of heavy element abundances in giant planets, detection of carbon-based molecules, measurement of atmospheric temperature profiles, definition of heat circulation efficiencies for tidally-locked planets, and the push to detect and characterize the atmospheres of super-Earths. Future observatories for this quest include the James Webb Space Telescope, and the new generation of Extremely Large Telescopes on the ground. On a more distant horizon, NASA's concepts for the HabEx and LUVOIR missions could extend the study of exoplanetary atmospheres to true twins of Earth. (**Source**: Illusion and Reality in the Atmospheres of Exoplanets; L. Drake Deming and Sara Seager. https://arxiv.org/ftp/arxiv/papers/1701/1701.00493.pdf).

Assuming that there is life on some exoplanets Man started planning to colonize them, an ambitious illusion. Before achieving it Man has to first colonize Space in general. This has become a necessity, as knowledgeable scientists have come to the conclusion that it would be difficult to sustain quality living on earth as we have considerably damaged our environment, polluted our life saving elements of nature and over consumed our non renewable natural resources and unable to ensure future demands of ever increasing population.

Space Colonization

Space colonization is permanent human habitation off the planet Earth. Many arguments have been made for and against space colonization. The two most common in favour of colonization are survival of human civilization and the biosphere in case of a planetary-scale disaster (natural or man-made), and the vast resources in space for expansion of human society. The most common objections to colonization include concerns that the commoditisation of the cosmos may be likely to enhance the interests of the already powerful, including major economic and military institutions, and to exacerbate pre-existing detrimental processes such as wars, economic inequality, and environmental degradation.

No space colonies have been built so far. Currently, the building of a space colony would present a set of huge technological and economic challenges. Space settlements would have to provide for nearly all (or all) the material needs of hundreds or thousands of humans, in an environment out in space that is very hostile to human life. They would involve technologies, such as controlled ecological life support systems, that have yet to be developed in any meaningful way. They would also have to deal with the as-yet unknown issue of how humans would behave and thrive in such places long-term. Because of the present cost of sending anything from the surface of the Earth into orbit a space colony would currently be a massively expensive project. There are yet no solid plans for building space colonies by any large-scale organization, either government or private. However, many proposals, speculations, and designs for space settlements have been made through the years, and a considerable number of space colonization advocates and groups are active. Several famous scientists, such as Freeman Dyson, have come out in favour of space settlement. On the technological front, there is ongoing progress in making access to space cheaper. (**Source:** https://en.wikipedia.org/wiki/Space_colonization).

However, circumstances of the times stimulate the thought that space colonization offers large potential benefits and hopes to an increasingly enclosed and circumscribed humanity. Permanent communities can be built and inhabited off the Earth. Space colonization appears to be technically feasible, while the obstacles to further expansion of human frontiers in this way are principally philosophical, political, and social rather than technological. One of the space colonization systems developed by NASA focuses on a space habitat where 10,000 people work, raise families, and live out normal human lives. The people live in the ring-shaped tube, which is connected by six large access routes (spokes) to a central hub where incoming spacecraft dock. These spokes are 15 m (48 ft) in diameter and provide entry and exit to the living and agricultural areas in the tubular region. To simulate Earth's normal gravity the entire habitat rotates at one revolution per minute about the central hub. Much of the interior of the habitat is illuminated with natural sunshine. The Sun's rays in space are deflected by a large stationary mirror suspended directly over the hub. This mirror is inclined at 45 degrees to the axis of rotation and directs the light onto another set of mirrors which, in turn, reflect it into the interior of the habitat's tube through a set of louvered mirrors designed to admit light to the colony while acting as a baffle to stop cosmic radiation. With the help of abundant natural sunshine and controlled agriculture, the colonists are able to raise enough food for themselves on only 63 ha (156 acres). The large paddle-like structure below the hub is a radiator by which waste heat is carried away from the habitat. Abundant solar energy and large amounts of matter from the **Moon** are keys to successfully establishing a community in space. Not only does the sunshine foster agriculture of unusual productivity, but also it provides energy for industries needed by the colony. Using solar energy to generate electricity and to power solar furnaces the colonists refine aluminum, titanium, and silicon from lunar ores shipped inexpensively into space. With these materials they are able to manufacture satellite solar power stations and new colonies. The power stations are placed in orbit around the Earth to which they deliver copious and valuable electrical energy. The economic value of these power stations will go far to justify the existence of the colony and the construction of more colonies. The **colonization of the Moon** is proposed, as detailed above, by the establishment of permanent human communities or robotic industries on the Moon. Discovery of lunar water at the lunar poles by Chandrayaan-1 has renewed interest in the Moon. Polar colonies could also avoid the problem of long lunar nights – about 354 hours, a little more than two weeks – and take advantage of the Sun continuously, at least during the local summer. Perhaps mankind will make the purpose of the next century in space what Hermann Oberth proposed several decades ago: **"To make available for life every place where life is possible"**. (**Source**: https://settlement.arc.nasa.gov/75SummerStudy/Chapt.1.html&https://en.wikipedia.org/wiki/Colonization_of_the_Moon).

In the details given above, NASA suggested a colonization plan for Moon. Once colonization of moon is achieved earthlings can extend colonization to Mars. As in the case of Moon, Mars's polar regions are of special interest to both atmospheric scientists and geologists. The poles exhibit unique atmospheric processes that periodically spill over into the lower latitudes in the form of storms. The polar ice caps (and their extensions in the form of lower-latitude ground ice deposits) are geological deposits intimately connected to the atmosphere. They are also known records of climate variations. Thus, the polar ice caps, atmosphere, and climate are best interpreted as an ensemble. Scientists have identified a crater on Mars, possibly created by an asteroid that triggered 150 mtrs high tsunami waves when it plunged into an ocean on the red planet three billion years ago. It created a big 75 mile wide crater Lomonosov. Scientists think an ocean might once have filled the vast lowland region that occupied Mars`s northerly latitudes. Tsunami resultant water waves travelling 150 km inland substantiates that Martian surface at that time had a substantial amount of water in residence. This has likely implications for the total inventory of water on Mars, an encouraging component for colonization. (**Sources**: Smith,I.etal(2017),https://eos.org/meeting.../mars-polar-intrigue-spurs-multidisciplinary-collaboration,Eos,98, https://doi.org/10.1029/2017EO069599&http://www.techtimes.com/articles/203105/20170326/impact-crater-linked-to-powerful-tsunamis-on-mars-another-proof-of-an-ancient-ocean.htm).

Such Moon and Mars colonization initiatives are apt and needed but not those plans/ studies focusing on colonization of exoplanets. Irrespective of my predicament and apprehensions I do however continue to enjoy seeing the twinkle - twinkle little stars that glow like celestial angels, and not as distant gaseous hot glowing terrestrial bodies. I am fascinated by the quotation."**Looking at these stars suddenly dwarfed my own troubles and all the gravities of terrestrial life. I thought of their unfathomable distance, and the slow inevitable drift of their movements out of the unknown past into the unknown future**."— H. G. Wells, the Time Machine, 1895.

Search for Extraterrestrial Intelligence (SETI)

While we are trying to weigh our capabilities and limitations, in a realistic way the Search for Extraterrestrial Intelligence (SETI) has assumed a new dimension. This has enthused some and perturbed others. NASA has brought out a significantly important report, giving specifics of the initiatives made by man during the last 100 years, to contact aliens living in habitable exoplanets. Interested can go through the link given below to access this report. (**Source:** https://www.nasa.gov/sites/default/files/files/Archaeology_Anthropology_and_Interstellar_Communication_TAGGED.pdf.).

A team of scientists have revealed new research that seems to indicate intelligent aliens beyond planet Earth exist and are trying to communicate with others. A paper titled "Discovery of peculiar periodic spectral modulations in a small fraction of solar type stars" doesn't necessarily sound like a stunning discovery to most people, but the research paper published in the journal Publications of the Astronomical Society of the Pacific may turn out to be the first step in the quest to establish the presence of intelligent life beyond our solar-system.

An analysis of 2.5 million stars that researchers have been watching has revealed 234 stars giving off "strange modulations" that suggest their origins are likely caused by an alien species, rather than natural causes." The fact that they are only found in a very small fraction of stars within a narrow spectral range centred near the spectral type of the sun is also in agreement with the ETI hypothesis," they add, referring to an "ETI" or "Extra Terrestrial Intelligent" hypothesis. Astronomers from a university in Quebec used a mathematical tool that hasn't really been studied in depth yet to analyze super quick light pulses of about less than a trillionth of a second to reach their conclusion. The scientists explored a series of other potential causes for the modulations, including instrument effects, rotation of molecules, rapid stellar pulsations and chemistry. "Breakthrough Listen", a project backed by Stephen Hawking and Mark Zuckerberg, will begin investigating the 234 star signals as well to see what can be determined. (**Source:** https://www.aol.com/article/news/2016/10/26/astronomers-signals-space-alien-lifeforms-communicate-earth/21592195/)

While many astronomers and cosmologists are fascinated by the above research findings, some highly intelligent and knowledgeable scientists strongly opposed the series of initiatives by NASA and others to contact intelligent aliens.

Stephen Hawking: Intelligent Aliens Could Destroy Humanity, But Let's Search Anyway

Famed astro physicist Stephen Hawking helped launch a major new effort to search for signs of intelligent alien life in the cosmos, even though he thinks it's likely that such creatures would try to destroy humanity. At the media event announcing the new project, he noted that human beings have a terrible history of mistreating, and even massacring, other human cultures that are less technologically advanced — why would an alien civilization be any different? And yet, it seems Hawking's desire to know if there is intelligent life elsewhere in the universe. He was part of a public announcement for a new initiative called "Breakthrough Listen", which organizers said will be the most powerful search ever initiated for signs of intelligent life elsewhere in the universe. Stephen Hawking said that intelligent aliens may be rapacious marauders, roaming the cosmos in search of resources to plunder and planets to conquer and colonize. He reiterates that one day, we might receive a signal from a planet, referring to a potentially habitable alien world known as Gliese 832c. "But we should be wary of answering back. Meeting an advanced civilization could be like Native Americans encountering Columbus. Some scientists believe that Stephen Hawking`s fears have no base as any alien civilization advanced enough to come to Earth would surely already know of humans' existence via the radio and TV signals that humanity has been sending out into space since 1900. (**Source:** http://www.space.com/29999-stephen-hawking-intelligent-alien-life-danger.html & http://www.space.com/34184-stephen-hawking-afraid-alien-civilizations.html).

What should be our immediate priority?

Recently Kasturi Rangan, former chief of ISRO stated that earthlings can colonize Moon. The scientific expeditions that help man to explore the Moon`s or Mars`s surface help us to have better insight into our earth`s origin and varied nature of earth`s atmosphere since 4.5 billion years till date. His prediction is strengthened by the colonization plan proposed by NASA (detailed above). While success of such colonization seems to be possible in about 100 years it needs to be planned meticulously to avoid conflicts in making it successful. I say so because of the following.

Man wishes to live in a normal way, without altering his basic way of living. To live on Moon or Mars that have varied morphology, atmosphere and internal structure and composition it is essential to forego his natural way of living and adapt to a way of life that is akin to that of a robot (as per NASA such a development can be avoided and man can lead a normal life). To ensure no setbacks due to presence of an entirely different environment there is every possibility that colonists will digress from their basic instincts. As man has strong likes and dislikes the migrants to Moon and Mars would slowly but steadily try to bring back their life styles on earth, there by destroying the adapted planets` natural resources and environment and polluting life saving water, air and food, as on Earth. This is evident when we see the way the serene environments of Antarctic and Arctic are degraded beyond limits in a matter of three decades. In spite of these questionable shortcomings it has become a necessity to explore the possibility of migrating and adapting to the local conditions on partly habitable planets like Moon and Mars to ensure survival of human race, amidst irreversible damage to mother Earth due to ever increasing needs of growing human population. Since colonization of large number of human beings is a significantly difficult proposition men belonging to developed and developing countries need to set aside the number of divisive and destructive factors and live like one unique race; as of now a difficult proposition, but not beyond our reach.

As mentioned above colonization of Moon is possible in the next 100 years. Colonization of exoplanets is different and difficult. When we look at the quality of life on Earth and probable deterioration in the next 100 to 200 years, let our scientific studies primarily focus on reduction of pollution and safety of all living creatures on Earth. As a right step let colonization of Moon is first achieved. Let also the exoplanet research continue to protect human race by liens.

Sometimes you have to go up really high in to space to understand how small you really are and then attempt to do such things that are within your reach to benefit the humanity, while curbing our urge to carry out such scientific activities that will unwittingly harm entire human race. I say so as some times intelligence and knowledge of highly capable scientists lead them to create monsters from mole hills due to lack of wisdom (for example creation of nuclear weapons).

*****In this issue**

It has nine research articles, an editorial and News at a glance. We are trying our best to make the journal a SCOPUS journal. Thomson Reuters are in principle happy with the quality of the content and our sincere effort to adhere to publication ethics. If not now it will definitely receive due recognition in the next 8 to 9 months. However, efforts have to be continued to maintain high standards and ensure publication of bi-monthly issues on time. This requires commitment and hard work by all those associated directly or indirectly with JIGU.

I solicit, on behalf of the editorial board, your continued support to JIGU.

P.R.Reddy