



SPACE

SCIENCE. TECHNOLOGY. APPLICATION.



VOLUME : 1

ISSUE: 4

OCTOBER 2019

2019 PHYSICS NOBEL PRIZE GOES TO SPACE RESEARCH

It is very interesting and delightful to report that this year Nobel Prize in Physics has gone to three scientists for their outstanding discoveries about the universe. James Peebles from Princeton University is credited with formulation of new theories in physical Cosmology. His research revealed that just 5% of the universe is normal matter and energy, and remaining 95% is invisible dark matter and dark energy. Michel Mayor and Didier Queloz from the University of Geneva are credited with discovery of an exoplanet in another solar system. With simple instrumentation at the Haute-Provence Observatory in southern France, they were able to see 51 Pegasi b, a Jupiter size exoplanet at nearly 50 light years away in 1995 so to say this discovery opened up a revolution in astronomy since then. Today we are aware of existence of nearly 4000 exoplanets in the Milky Way.

INDO-JAPAN JOINT MOON PROGRAMME BY 2023

ISRO, India and JAXA, Japan are working on a joint moon mission programme to be realized by 2023. Japan is planning to bring into the programme technologies like the rocket and the rover. The lander will be provided by India. The programme is expected to last for 6 months with shiny south pole of moon as the location for landing. ISRO and JAXA work for space exploration, the purpose of which is mainly scientific, societal and commercial in nature with very limited defence space

developments such as missile early warning systems. In February 2, 2018 JAXA was successful in putting a ten-pound CubeSat into Earth orbit in its second attempt. The SS-520-5 rocket used for this purpose is the world's smallest orbital launcher developed in Japan. Similarly JAXA space probes such as Hayabusha 1 & 2 launched to explore asteroid material compositions is worthy of mention here. JAXA successfully landed two rovers on asteroid Ryugu in September 2018 and took several high resolution photos of this tiny asteroid.

BLOCK CHAIN ENABLED SPACE SITUATIONAL AWARENESS (SSA)

There are situations when we need to have a secured communication between a satellite and an untrusted ground station. Sometimes we need to have separate channel of communication with a satellite from as many points of contact as possible. The future sees deployment of multi sensor satellite architectures such as constellations and swarms to enhance our earth and space exploration capabilities. One major area of concern is how to establish secure and efficient data and communication channels between ground and space based sources. If we call each information transfer of data as one transaction, and assume that every transaction is stored in a ledger, and imagine that this ledger is stored and updated as well as duplicated on every computer across the server network. This permits every user in the network to have a copy of this distributed ledger which in turn gives the history of events on the network. Creation of such unsusceptible to change distributed ledger containing various



JRD Tata

NATIONAL INSTITUTE OF ADVANCED STUDIES

INDIAN INSTITUTE OF SCIENCE CAMPUS, BENGALURU-12

VISIT US AT : WWW.NIAS.RES.IN

cryptographically stored data structures called blocks is what constitutes block chain technology. In this way, block chain technology enables distributed, accurate, and secure logging and tracking of command and control operations among a network of ground stations without any loss of data integrity.

Block Chain technology provides the ability to control the satellites in a swarm autonomously without satellite-to-satellite communication. Suppose the satellites have limited memory and storage to run a full block chain node, the block chain can still automatically generate information by scanning through any available pathways. To illustrate this point, in a networked ground station no sooner information is sent to the block chain, every ground station will have automatically that data stored in the ledger which will enable required station to communicate with any other satellite.

Very interesting work has been reported using block chain technologies for enhancing SSA. Among others, SSA includes tracking of active and inactive space objects while monitoring the space environment using sensor data processing. One way to enhance SSA is to couple online data with offline models through proper feedback control, sensor management, and communications reliability. Since SSA systems are decentralised and heterogeneous in nature, building a centralized efficient scalable lightweight access control system becomes a challenge. It is possible to introduce block chain enabled decentralised access control system as well as decentralised authentication system with secured protective system for devices, services and information.

There are other situations also. While lot of work has been done in ensuring security of software running on many electronic systems, the similar trustworthiness cannot be assumed about the security of hardware used in satellite communication systems without studying the vulnerabilities that creep into the globalized electronic supply chain. Security experts are proposing a decentralised block chain based certification system in place to protect supply chain integrity.

ARTIFICIAL MEAT IN SPACE

Food is the most important part of living. Availability of right food decides the habitat for human beings. Provision of nutritious food to astronauts is a challenge for space programme authorities. More so if it is a long distance travel like Mars mission where the astronauts have to spend months. It is impossible to carry food for months in space. The spacecraft design will become so challenging that they have to maximize space when stowing or disposing of food containers.

The first astronauts had tough time in space as their meals were squeezed from toothpaste tube. Today's astronauts are a shade better. Now, astronauts have a choice of foods like beef, chicken, seafood, candy, ice cream, brownies, fruits, nuts, etc. Choice of drinks include tea, coffee, lemonade, orange juice, fruit punches etc. NASA has raised a "space garden" where carrots, potatoes, lettuce, and strawberries can be grown on the Gateway, a proposed space station for orbiting the Moon.

Now the good news is some breakthrough has come through a tech company in Israel last September. A start up Aleph Farms could grow meat in space for the first time using a 3D bio printer. The start-up extracted cells from a cow through a small biopsy and grown in a "broth" of nutrients which provides the environment akin to a cow's body. Then, they placed the cow cells and nutrient broth in closed vials. The vials were loaded onto the Soyuz MS-15 spacecraft in Kazakhstan. On September 25, the spacecraft took off for the International Space Station, orbiting about 400 kilometres. When the vials arrived at the station, Russian cosmonauts – inserted them into a magnetic printer from the Russian company 3D Bio printing Solutions and came out with a thin piece of steak produced in microgravity. For information, a 3-D bio printer deposits bio inks layer by layer and produce tissue like structures and even organs for medical research.

HYGEIA IS NOT AN ASTEROID BUT A DWARF PLANET IN OUR SOLAR SYSTEM

Using data from the Spectro-Polarimetric High-contrast Exoplanet REsearch (SPHERE) instrument at the Very Large Telescope (VLT) in Chile in October 2019, an international team of astronomers realised that Hygeia is actually round in shape making it a dwarf planet like Pluto in the Solar System. Hitherto, Hygeia was considered as an asteroid. International Astronomical Union (IAU) in 2006 explained a dwarf planet as a celestial non-satellite body orbiting a star and is massive enough to be rounded by its own gravity but has not cleared the neighbourhood around its orbit of other material. It means it is massive enough to be plastic – for its gravity to maintain it in a hydrostatically equilibrium shape. Using the same criteria, IAU has defined the well-known planet Pluto as a dwarf planet in 2006 and astronomers stopped referring Pluto as a planet since then. Today, Pluto is the largest dwarf planet with diameter 2377 km while Hygeia is smallest with 430 km.

HONEYBEE ROBOTICS - A COMPANY TO BE ACKNOWLEDGED FOR THEIR INNOVATIVE WORK:

It is a New York based company with innovative and critical problem solving skills, founded in 1983 by Steve Gorevan & Chris Chapman and has so far completed more than 300 projects for NASA, Darpa, Lockheed Martin, JPL, IBM etc. They have developed systems for drilling, coring, and physical sampling of Mars, the moon, and asteroids required for scientific exploration. Honeybee Robotics has been building planetary drills and sampling systems for over 20 years, and have built and tested 10 different core drilling systems. They have finest engineering talent and expertise into making high-performance, autonomous, reliable drilling and sampling systems for space application.

Today, one of the most daunting tasks is how to excavate the Moon surface. The following information is reproduced from the company website. " Lunar Sampling and Resource Utilization: The space exploration community is steadily moving

towards establishing a semi-permanent base on the Moon. Excavation of the lunar regolith (loose, heterogeneous superficial deposits covering solid rock) will be a key aspect of achieving this goal, both for the construction of base structures and for the mining of oxygen-rich material for in-situ resource utilization (ISRU). Honeybee has been working on the challenge of mining on the moon. Low gravity means that unmanned systems can't rely on traditional downforce for excavation. The fine lunar dust abrades surfaces and destroys mechanical components. And with no atmosphere, traditional wet lubrication does not work. Honeybee Robotics has several technologies under development to address the challenges of Lunar ISRU: eg Percussive digger. The percussive digger uses vibration or hammer action to reduce required digging forces by a factor of 40. This in turn reduces the mass requirement of the lunar excavator. Because every kilogram of Lunar mission payload adds approximately \$100,000 to mission cost, this technology offers billions of dollars in savings.

Pneumatic Mining and Transfer

Pneumatic excavation is an emerging technology which uses gas to mine and transport regolith. Initial test results have shown that one gram of pressurized gas can loft almost 6,000 grams of soil under lunar-like conditions (gravity and vacuum). The excavation gas can be carried in liquid form in a designated tank, generated on-site by burning residual propellant in the lander, or even generated as a by-product of the ISRU reaction process. Because the pneumatic system has no moving parts it is ideally suited to the abrasive lunar environment"

DOES EARTH LIKE PLANETS EXIST?

Going by recent UCLA study (Oct 2019), it appears existence of Earth-like planets are common in the universe. This is a result of a geochemical analysis of rocky planet fragments orbiting around distant white dwarf stars 200 to 665 light years outside our solar system. One of the researcher said "Observing a white dwarf is doing an autopsy on the contents of what it has gobbled in its solar system" The telescopic data analysed from Hawaii observatory clearly showed presence of Hydrogen, helium, silicon, magnesium,

carbon, oxygen, oxidised iron etc. that got into the dwarf star from bodies orbiting them.

The fact is similar chemical composition along with large amounts of oxidised iron has been seen from rock samples of the Earth, Mars and elsewhere in our solar system. Due to presence of abundant hydrogen, no oxidation is possible on stars. Another researcher said: "The fact that we have oceans and all the ingredients necessary for life can be traced back to the planet being oxidized as it is. The rocks control the chemistry. A question was whether this would also be true around other stars. Our study says yes. That bodes really well for looking for Earth-like planets in the universe.". Another researcher continued: "If extra-terrestrial rocks have a similar quantity of oxidation as the Earth has, then you can conclude the planet has similar plate tectonics and similar potential for magnetic fields as the Earth, which are widely believed to be key ingredients for life. This study is a leap forward in being able to make these inferences for bodies outside our own solar system and indicates it's very likely there are truly Earth analogues. "(Ref: Alexandra E. Doyle, Edward D. Young, Beth Klein, Ben Zuckerman, Hilke E. Schlichting. Oxygen fugacities of extrasolar rocks: Evidence for an Earth-like geochemistry of exoplanets. Science, 2019 DOI: 10.1126/science.aax3901)

SATELLITE STUDY REVEALS THAT AREA IN AFRICA EMITS ONE BILLION TONNES OF CARBON

In an important study, two NASA satellite missions -- Japanese Greenhouse Gases Observing SATellite (GOSAT) and the Orbiting Carbon Observatory (OCO-2) have shown carbon emissions of 1 to 1.5 billion tons from northern tropical regions of Africa per annum. The report says: "The data suggest stored carbon has been released from degraded soils -- those subject to prolonged or repeated drought or land use change -- in western Ethiopia and western tropical Africa, but scientists say further study is needed to provide a definitive explanation for the emissions." The carbon source might have gone undiscovered with land-based surveys alone, according to a team led by researchers from the University of Edinburgh. (Ref:

University of Edinburgh. "Satellite study reveals that area in Africa emits one billion tonnes of carbon." Science Daily, 13August2019. www.sciencedaily.com/releases/2019/08/190813112213.htm)

"A blade of grass is a commonplace on Earth; it would be a miracle on Mars. Our descendants on Mars will know the value of a patch of green. And if a blade of grass is priceless, what is the value of a human being?"

— **Carl Sagan, Pale Blue Dot:
A Vision of the Human Future in Space**

ABOUT THIS NEWSLETTER

This quarterly News Letter from NIAS, IISc Campus is to bring out various latest and important S&T developments likely to find place in future space programs. The future programs include Man in space, Exploitation of extra-terrestrial resources, space based services, space exploration, science of microgravity, space for national security etc.,. The intention is to provide brief information to researchers, academicians, R&D personnel, space industry to generate S&T leads in the minds of people. It is our endeavour to keep this newsletter fresh and engaging with well researched content. Any suggestion(s) for improvement of this newsletter shall be highly appreciated. - Editor

ACKNOWLEDGEMENT

Acknowledgement with thanks is due to Dr Shailesh Nayak, Director, NIAS, Dr P S Goel, NIAS and Prof PM Sounder Rajan, NIAS for their many helpful suggestions.



Editor: Dr V Bhujanga Rao, ISRO Chair Professor, NIAS
spacenewsletter@nias.res.in