Notes and News

Presentation of 150th Birth Anniversary Commemorative Book on Acharya P.C. Ray Published by ISNA to Dr. Harsh Vardhan

A book entitled "**Sir P.C. Ray: The Father of Chemistry Teaching and Research in India, a Philanthropist, and an Entrepreneur**" published by the Indian Science News Association (ISNA) in commemoration of 150th birth anniversary of Sir Prafulla Chandra Ray was presented to **Dr. Harsh Vardhan**, Union Minister, Ministry of Science & Technology, Ministry of Environment, Forest and Climate Change and Ministry of Earth Sciences Environment by Professor Suprakash Chandra Roy, Member of the National Commission of History of Science, INSA, and Editor-in Chief of the journal *Science and Culture*. Incidentally, *Science and Culture* is published by ISNA, an organization established in 1935, of which Acharya Ray was the Founder President. The event took place in the CSIR-Central Glass and Ceramic Research Institute (CGCRI), Kolkata on 14th September 2018 where Dr. Harsh Vardhan was present for the Curtain Raiser of the International Science Festival-2018 to be held in Lucknow and Professor Roy was present as a moderator of a panel discussion.

Acharya Prafulla Chandra Ray was a multifaceted genius. He was a chemist by profession, but his contribution was not only limited to chemistry teaching and research in India but also in many other areas like history of science, science communication, literature etc. including socio-political movement for the welfare of the masses. His pioneering role in establishing the journal *Science and Culture* and the Journal of the Indian Chemical Society have been narrated in this book.

Professor S.C. Roy, Editor-in-Chief, Science and Culture and Member, National Commission of History of Science, INSA presenting the book "Sir P.C. Ray: The Father of Chemistry Teaching and Research in India, a Philanthropist and an Entrepreneur" to Dr. HarshVardhan, Union Minister, Ministry of Science & Technology, Ministry of Environment, Forest and Climate Change and Ministry of Earth Sciences Environment at CSIR-CGCRI, Kolkata during the curtain raiser event of International Science Festival-2018 on 14th September, 2018. Present in the picture are (from rigt): Dr. Indranil Chattoraj, Director, CSIR-CGCRI, Dr. Harsh Vardhan, Prof. S.C. Roy, Dr. Sitendu Mandal, Principal Scientist, CSIR-CGCRI.

This book, edited by Profs. Sunil Kumar Talapatra and Biswapati Mukherjee, is a collection of articles written by eminent authors focusing on Acharya Ray's contributions as a pioneer in teaching and research in chemistry in India, his effort in establishing the Bengal Chemical and Pharmaceutical Works and other industries, his knowledge in critical evaluation of Shakespearean literature, his patriotic role as the President of National Council of Education etc.

The book has been published from the generous grant received from the CSIR. The minister appreciated this endeavor of ISNA to pay tribute to their Founder President on his 150th birth anniversary. ❐

STEVE, Aurora's Newfound Cousin: A New Celestian Phenomenon

We are all familiar with 'aurora' - aurora borealis in the northern horizon and aurora australis in the southern horizon - bright waves of mostly green (sometimes red or blue) light observed in high latitude sky at night. But several years ago, citizen scientists from New Zealand, Canada, the U.S.A. and the U.K. started reporting in social media the appearance of an unusual sight in the night sky: an extremely narrow ribbon of dazzling purple and white colours (that do not diffuse) travelling across the sky for about an hour at a time and visible at lower latitudes than where a classical aurora is observed, mostly in the spring and the fall. The citizen scientists did not have a scientific explanation for this phenomenon. But one of them from Alberta, Canada playfully named this subauroral spectacle 'Steve', a joke alluding to a mysterious hedge in the 2006 children's film *Over the Hedge,* which frightens some woodland creatures when they come upon it suddenly in their environment.

A Facebook group of amateur auroral photographers, called the Alberta Aurora Chasers, had noticed the appearance of Steve running east to west in the Canadian night sky and visible only a few times each year. It was also showing up closer to the equator than the aurorae are, as stated above. They brought the attention of the scientists to this observation in 2016. When the data about these unusual light ribbons were presented by the researchers at a scientific conference in 2016, a space physicist suggested, to pay respect to the citizen scientists, the revised acronym 'STEVE', i.e. Strong Thermal Emission Velocity Enhancement, which was accepted by all.

At this stage it is necessary to understand how an aurora is produced. Put simply, the interaction of solar wind generates strong electrical currents in earth's magnetosphere, the region around earth dominated by earth's magnetic field. These currents accelerate and precipitate electrons and protons from earth's magnetosphere along the magnetic field lines to earth's ionosphere, the region of charged particles in the upper atmosphere. The precipitating charged particles collide with and energise the constituent particles in the ionosphere that, in turn, emit photons producing what is known as aurora. An aurora forms a large oval around a magnetic pole and is located at high latitudes, ~65°-80° magnetic latitude (MLAT). It is generally less than 10° in latitudinal width. When the energy input from the solar wind is increased, the auroral oval broadens and moves towards the equator.

Recently a multinational research group comprising, *inter alia*, Bea Gallardo-Lacourt, a space physicist at the Department of Physics and Astronomy, University of Calgary, Alberta, Canada and Elizabeth A. MacDonald, a space physicist at NASA Goddard Space Flight Centre in Greenbelt, Maryland and the founder of the Aurorasaurus citizen science project in 2013 with financial support from the National Science Foundation studied a STEVE event that was observed over eastern Canada on March 28, 2008. This STEVE first appeared as a very narrow structure in the eastern region and later propagated from east to west, across the entire longitudinal FOV of the camera covering more than 1,000 km in longitudinal extent with only about half a degree in latitudinal width (~tens of kilometers).They mainly addressed the fundamental question: is STEVE caused by particle precipitation like aurora or is it produced by a new ionospheric phenomenon? For this investigation, they used a network of ground-based All-Sky Imagers across North America and Canada and energetic particle detectors on a Polar Orbiting Environmental Satellite (POES-17) that happened to pass directly over the ground-based cameras during the STEVE event. The satellite is equipped with an instrument that can measure charged particles precipitating into the ionosphere. Using data from a European satellite (Swarm-A), they studied STEVE in its native environment, about 200 km up in the atmosphere. The observed luminosity was collocated with very hot (*ca.* 6,000°C) fast moving (*ca.* 6 km/s) ions flowing east to west, propelled by the electric and magnetic fields in the atmosphere and moving less than 50 km in north-south extent. All of these heating and motion probably contributes to STEVE's purplish appearance, said E. MacDonald. Analysing their results they concluded that 'STEVE' is clearly distinct from an aurora and is an entirely new celestial phenomenon.

The results have been published by E.A. MacDonald *et al.* in *Science Advances* (14 Mar 2018: Vol. 4, no. 3, eaaq0030; DOI: 10.1126/sciadv.aaq0030) and by B. Gallardo-Lacourt *et al.* in *Geophysical Research Letters* (first published: 20 August 2018; https://doi.org/10.1029/2018GL078509). The investigators could not, however, rule out the possibility that STEVE's skyglow might be associated with low energy (<50 eV) proton precipitation. Also, they could not conclude for certain whether or not STEVE originates by a fundamentally different mechanism in the ionosphere or the magnetosphere.

MacDonald hopes that "*this example can help change the nature of scientific engagement between the scientific community and citizen scientists and move communication from one way to two way, with curiosity transitioning to participation and finally to stewardship*." In the words of another physicist, John Bonnell, at the University of California, Barkley, this investigation is a "*great example of what can happen when a critical mass of motivated amateur observers, professional space physicists, and space-based and ground-based instrumentation come together*." ❐

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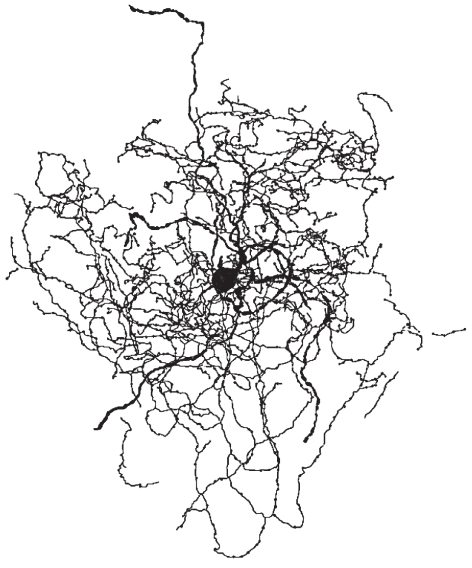
Rosehip Neurons – A New Type of Brain Cells Found in Human Beings

Human beings are admittedly the most intelligent species on earth. But the question is: what makes the human brain so special? It is one of the most intriguing questions that even the neuroscientists find difficult to answer. Nevertheless, a collaborative group of thirty four scientists led by Ed Lein from the Allen Institute for Brain Science, Seattle, USA and Gábor Tamás from the University of Szeged, Szeged, Hungary have just reported in *Nature Neuroscience* the isolation of a new type of neurons from the human cortex. This type of brain cell has not earlier been found in mice or other well studied laboratory animals. Tamás and Eszter Boldog, another member of his research team, dubbed these new cells 'rosehip neurons' since the dense bundle, that each brain cell's axon forms around the cell's centre, looks just like a rose after it has shed its petals.

The cortex, the outermost region of the brain, is responsible for human consciousness and many other functions that make the human beings so different from other species. As Lein said, "*It's the most complex part of the brain, and generally accepted to be the most complex structure in nature*." The Tamás' group was studying the human brain using a classical approach, viz. examination of the shapes and electrical properties of the cells. On the other hand, the team of Lein at the Allen Institute was trying to find out the genes that make human brain cells unique from each other and from the brain cells of mice. The collaboration began several years ago when Tamás visited the Allen Institute to present the latest findings of his research team on specialised human brain cell types. Quickly they realised that they had hit on the same type of brain cells although they were working from different points of view using different techniques. That is how their collaboration started.



Rosehip neuron discovered from human brain

In their research, they used tissue samples from the brains of two men in their 50s who had died and donated their bodies for research. They used sections of the top layer of the cortex for their research. The Allen Institute group found out that the rosehip neurons turn on a unique set of genes – a genetic signature that has not been found in mouse brain cell types. The University of Szeged group discovered that the rosehip neurons form synapses with pyramidal neurons, another type of neurons in a different part of human cortex. According to Rebecca Hodge, a team member from the Allen Institute, "*Alone, these techniques are powerful, but they give you an incomplete picture of the function of what the cell might be doing. Together, they tell you complementary things about a cell that can potentially tell you how it functions in the brain*."

The newfound neurons are unique in that they attach only to one specific part of their cellular partner, which indicates that they might be controlling the flow of information in a very specialised way. The situation may be clarified in the following manner. All inhibitory neurons, including rosehip neurons, are like the brakes in a car. But the rosehip neurons would let your car (human brain) stop at particular spots (for example, grocery store along your driving path) where other cell types can't stop. In the words of Tamás, "*The car or cell types participating in the traffic of a rodent brain cannot stop in these places*."

The researchers plan to look for rosehip neurons in other parts of the human brain and to explore their role in brain disorder. One thing is for certain – it is not known whether rosehip neurons are unique to human beings. But they do not appear to exist in rodents, which raises the question about the validity of using the laboratory mouse as a perfect model for studying human diseases, especially neurobiological diseases.

The story can best be concluded by the following statement of Tamás: "*Many of our organs can be reasonably modelled in an animal model. But what sets us apart from the rest of the animal kingdom is the capacity and the output of our brain. That makes us human. So it turns out (that) humanity is very difficult to model in an animal system*." ❐

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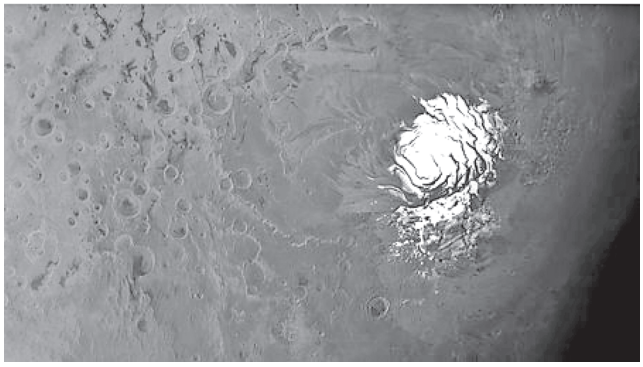
There Is Water On Mars! Is There Life Too?

Scientists are eager to find out if there is life in planets other than earth. They are especially interested in the Red Planet, i.e. Mars which is now cold, barren and dry. But scientists believe that at least 3.6 billion years ago Mars used to have a warm and wet atmosphere and that it had plenty of liquid water. The presence of liquid water at the base of the Martian polar caps was first hypothesised more than 30 years ago. But a group of Italian researchers led by R. Orosei have only recently reported the detection of a massive underground lake under the southern ice cap of Mars (*Science*, 03 Aug 2018: Vol. 361, Issue 6401, pp. 490-493; DOI: 10.1126/science.aar7268). The hope of the existence of life in Mars has thus been kindled.

Radio echo sounding (RES) is a suitable technique to search for underground water. For the RES experiments, the researchers used the Mars Advanced Radar for Subsurface and Ionosphere Sounding (MARSIS) radar instrument on board Mars Express spacecraft of the European Space Agency which had been launched in 2003. MARSIS performs by sending pulses of radio waves that penetrate the surface and the ice caps and then measures how the waves propagate and reflect back to the spacecraft. These reflections provide scientists with information on what lies beneath the surface. MARSIS has surveyed subsurface in Mars for more than 12 years in search of liquid water.

This time MARSIS surveyed during May 2012 – December 2015 a 200 km wide area of Planum Australe centred at 193°E, 81°S. This area is close to the thickest part of South Polar Layered Deposits (SPLD), the southern ice cap of Mars. It is topographically flat and composed of water ice admixed with (10-20)% dust. It is seasonally covered by a thin layer (<1 m) of carbon dioxide ice. A total of 29 radar profiles were acquired when the spacecraft was on the night side of Mars to minimise ionospheric dispersion of the signal. The recorded data profile was similar to that observed for liquid water lakes under the Antarctic and Greenland ice sheets on earth, thus suggesting the presence of a liquid water lake under the southern ice cap of Mars. The lake lies almost 1.5 km deep under the icy surface and is 20 km wide.



Liquid water under ice (white) at south pole, Mars

This subsurface water won't be potable since large amounts of salts, viz. the perchlorates of sodium, calcium and magnesium are suggested to be present in it. Since the temperature at the base of SPLD is around -65°C and since the presence of salts depresses the freezing point of water, the subsurface water is likely to be colder than the freezing point of pure water. But liquid water is expected to be stable below the SPLD at relatively shallow depths (1.5 km beneath surface).

As Allan Duffy, an Associate Professor at Swinburne University, Australia pointed out, "*This is a stunning result that suggests water on Mars is not a temporary trickle like previous discoveries but a persistent body of water that provides the conditions for life for extended periods of time*."

The discovery is undoubtedly tantalising, but a word of caution! David Stillman, a Senior Research Scientist, Department of Space Studies, Southwest Research Institute, Texas, USA pointed out that SHARAD, a higher

frequency radar instrument made by the Italian Space Agency, aboard the Mars Reconnaissance Orbiter launched in 2005, has been unable to confirm the presence of subsurface water in Mars. Stillman rightly pointed out, "*This suggests that something strange is going on here. Thus, I am sceptical about this discovery*." This discovery thus needs to be confirmed by others. However, if the finding is correct, there is no reason to think that the presence of subsurface water in Mars is restricted to a single location.

In November, 2018, InSight Probe (NASA) is scheduled to land near the equator of Mars. It will measure the heat flow in the top 5 metres of the surface there. These data would be useful to find out how much heat might be rising from beneath the south polar cap of Mars, melt the ice and create more potential lakes.

To conclude on a positive note, the presence of subsurface water in Mars raises the hope for the existence of life on the Red Planet. We just have to wait. ❐

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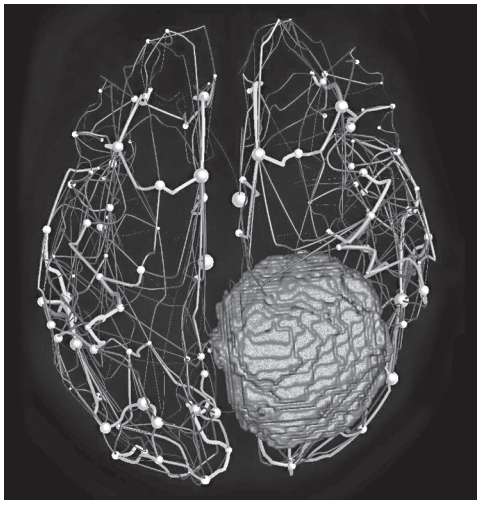
A Virtual Brain - The Benefits of Brain Modelling

Simulations are used in many fields of science. Pharmaceutical companies have been using molecular modelling to understand the behaviour of medicines and guide the design of new drugs. Aeronautical engineers heavily rely on modelling to design aircraft and no aircraft prototype goes into real flight without passing the simulation tests first. The human brain is another complex system that can benefit from modelling and simulations. Modern neuroimaging techniques allow scientists to explore the anatomy and function of brain areas as small as a group of neurons. Moreover, the computational hardware available is becoming powerful enough to gather the colossal amounts of data generated by the brain. Nevertheless, acquiring raw brain data in itself is not very useful unless we understand its meaning and can use it to our benefits.

The Virtual Brain is an open-source software that has made the task of understanding and organising brain data in a useful way much simpler. It is a neuro-informatics platform that tries to simulate the brain organisation on the macroscopic level of detail. It takes a network approach on the largest scale, by manipulating network parameters, in particular the brain's connectivity. This tool is based on the idea of taking advantage of available functional and structural brain data generated by imaging techniques such as MRI, functional MRI (fMRI) and trans-cranial magnetic stimulation. The Virtual Brain simulates brain's behaviour as it is commonly observed in clinical scanners such as EEG, MRI, fMRI, etc. The Virtual Brain embraces and extends novel concepts from computational, cognitive and clinical neuroscience in order to drastically reduce the model's complexity while still keeping it sufficiently realistic – and delivering the same output as clinical brain-scanners.



Structural brain network of a patient with a meningioma (orange). Distinct regions of the brain are depicted as spheres, with larger size indicating increasing relative importance within the network. (Courtesy: Hannelore Aerts)

During trials in Belgium using the Virtual Brain on tumour patients, researchers at Ghent University modelled the brains of 25 tumour patients and 11 controls. They found that the software could accurately predict the effects of the tumour on brain connectivity. Doctors hope to combine neuroimaging data with Virtual Brain modelling to improve surgical planning and outcomes in the future. This could allow doctors to plan surgery that gives the best chance of removing a tumour while keeping the rest of the brain tissue intact. The conventional procedure for mapping tumours is to use non-invasive imaging techniques such as functional medical imaging (eNeuro, 29 May 2018 | doi.org/10.1523/ENEURO.0083.2018).

The Virtual Brain is a great tool for research that will allow doctors to monitor the dynamics of communications between different brain regions and see how the functions of the brain are related to its structure. Scientists can use the Virtual Brain to understand how changes in the brain structure affect neuron communications and in turn lead to

modifications in behaviour and cognitive processes. According to the researchers, another utility of the Virtual Brain is the capability to track normal and physiological brain modifications between different life stages; for example, to understand how a newborn brain can grow up to become mature and capable of very complex functions and cognitive process. ❐

Biman Basu
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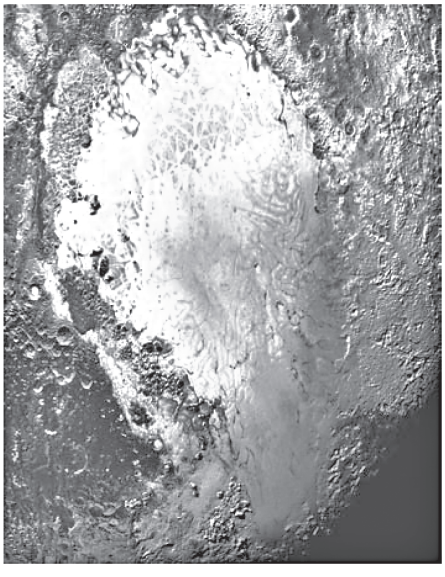
Pluto was Formed from 1 Billion Comets

Pluto was considered the ninth planet of the solar system till 2006, when because of its small size and similarity with other objects discovered beyond Neptune, it was relegated to the status of a 'dwarf planet'. Till recently, scientists typically thought that Pluto was born in the usual way for a planet: in the ancient infancy of the solar system, a rocky core formed amidst a slew of gas and dust, and gravity slowly accreted more and more material, leading to a small spherical ball we now call Pluto. But more recent findings in the 1990s of other small icy objects like Pluto in the Kuiper belt (a vast region of icy objects beyond Neptune) suggested some other, more unique origin of Pluto.



Sputnik Planitia is deep basin with a nitrogen ice sheet; it may be a few kilometres thick. (Credit: (NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute)

The historic fly-by by the NASA spacecraft New Horizons in July 2015 gave new insight into the structure and nature of Pluto. Now, based on astonishing images sent back by the New Horizons spacecraft, researchers from the Southwest Research Institute (SwRI), Texas, USA, have come up with a new theory about the dwarf planet's origins after taking a close look at Sputnik Planitia, the vast nitrogen-ice glacier that constitutes the left lobe of Pluto's famous heart-shaped feature. Sputnik Planitia shows an especially strong signature of nitrogen near the equator. The SwRI scientists have put forward a theory that Pluto may be an agglomeration of a billion comets (Icarus, 23 May 2018 | DOI 10.1016/j.icarus.2018.05.007).

The new theory builds upon the observations made by the Rosetta space probe of the European Space Agency (ESA). The Rosetta mission orbited Comet 67P/Churyumov-Gerasimenko from 2014 to 2016. The orbiting spacecraft also dropped a lander named Philae onto the icy body, pulling off the first-ever soft touchdown on a comet's surface. The Rosetta spacecraft made the first measurement of molecular nitrogen at a comet, providing clues about the temperature environment in which Comet 67P/Churyumov–Gerasimenko formed. The detection of molecular nitrogen is particularly important since it is thought to have been the most common type of nitrogen available when the solar system was forming. In the colder outer regions, it likely provided the main source of nitrogen that was incorporated into the gas planets. It also dominates the dense atmosphere of Saturn's moon, Titan, and is present in the atmospheres and surface ices on Pluto and Neptune's moon Triton.

The SwRI scientists found an intriguing similarity between the estimated amount of nitrogen inside Pluto's nitrogen-ice glacier and the amount that would be expected if Pluto was formed by the agglomeration of roughly a billion comets or other Kuiper Belt objects, similar in chemical composition to 67P, the comet explored by Rosetta. "We've developed what we call 'the giant comet' cosmochemical model of Pluto formation," said Dr. Christopher Glein of SwRI's Space Science and Engineering Division. "Our research suggests that Pluto's initial chemical makeup, inherited from cometary building blocks, was chemically modified by liquid water, perhaps even in a subsurface ocean". He further added, "Using chemistry as a detective's tool, we have been able to trace certain features we see on Pluto today to formation processes from long ago. This leads to a new appreciation of the richness of Pluto's 'life story', which we are only starting to grasp". ❐

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