



**Editor-in-Chief:**

Nakul Parashar

**Editor:**

Nimish Kapoor

**Production:**Pradeep Kumar  
Bipro Kumar Sen  
Amitesh Banerjee**Expert member:**Biman Basu  
Sumita Mukherjee**Address for  
correspondence:**Vigyan Prasar, A-50,  
Institutional Area, Sector-62,  
Noida-201 309, U.P., India**Tel:** +91-0120-2404430, 35**Fax:** +91-0120-2404437**e-mail:**

dream@vigyanprasar.gov.in

**website:**<http://www.vigyanprasar.gov.in>

Vigyan Prasar is not responsible for the statements/opinions expressed and photographs used by the authors in their articles/write-ups published in "Dream 2047"

Articles, excerpts from articles published in "Dream 2047" may be freely reproduced with due acknowledgement/credit, provided periodicals in which they are reproduced are distributed free.

Published and Printed by Nakul Parashar on behalf of Vigyan Prasar, A-50, Institutional Area, Sector-62, Noida-201 309, U.P., India and Printed at Chandu Press, 469, Patparganj Industrial Estate, Delhi 110 092  
Telefax: 22424396, 22526936.

Cover Design By: BIPRO KUMAR SEN

# EDITOR'S WORD

NAKUL PARASHAR

## In the groove

### SLIGHTLY

over a year, from the January 2019 issue, we made some layout changes. That happened with the cover. Process of making changes in the layout continued. A couple of months ago, if you'd have noticed, we made some changes in the internal layout. Amidst this, we made some changes to the content structure. Some new columns have been added, and while we get in the groove, you'll find a few more from this issue onwards. Changes, to keep up with times is obviously required, especially when an effort is to make it more holistic – attend to as many sections of the society as possible, thereby evolve it into new yet complete popular science monthly. Thus, we look forward to your response in our letters-to-editor section called – INBOX.

Dream 2047 has been a bilingual one since its inception and hence has a limitation of space. Thus, it's important to release more pages so that more columns can be accommodated. While we do so, we stand obligated to seek the opinion or preference of our loyal readers/subscribers about their choice of language – Hindi or English.

Amidst all this, yet of lately, we've witnessed a spurt in creating interests amongst children towards Mathematics. Why so? Reasons are many. Is it because future career trends necessarily need a background in Mathematics? Well, whatever it be, India is proud of its heritage that has produced several mathematical prodigies from time to time. Srinivasa Ramanujan has been one of them. He passed away 100 years ago, on April 26th, 1920. We all know that we celebrate his birthday –

December 22nd every year as the National Mathematics Day. This year, to add its bit to the Mathematics Awareness Campaign, Vigyan Prasar has decided to embark upon an eight-month programme of creating interest in what we call the **Ramanujan Yatra**. This program will be a series of lecture-demonstrations, math-science fair(s) & expo(s), and yes, much more. We intend to cover all possible directions, nooks, and corners of the country. We're aware of the paucity of time and, at the same time, the vastness of our nation. Yet, this Yatra that begins from April 26th and culminates on December 22nd, will try to reach as far as it can. It'll start from Kumbakonam, the birthplace of the genius to culminate in New Delhi. Thus, our cover story this month is dedicated to this mathematics legend.

Just a reminder about the month. April otherwise is a month that has several world and national days – World Autism Awareness Day is celebrated on April 2nd; World Health Day on April 7th; World Earth Day on April 22nd; World Book Day on April 23rd; and World Malaria Day on April 25th. Interesting, isn't it! Similarly, some famous scientists too were born during April – James Watson (April 6th) and Malvin Calvin (April 8th).

Stop press, while I write, WHO has declared COVID-19 spread as a pandemic. At a time when health and travel advisories are being issued, prevention is the best form of defence. Hoping that we get a cure in place, all we can wish is to stay healthy, stay safe!

Email: nakul.parashar@vigyanprasar.gov.in



# RECENT DEVELOPMENTS IN SCIENCE AND TECHNOLOGY

## MARSQUAKES MEASURED FOR THE FIRST TIME

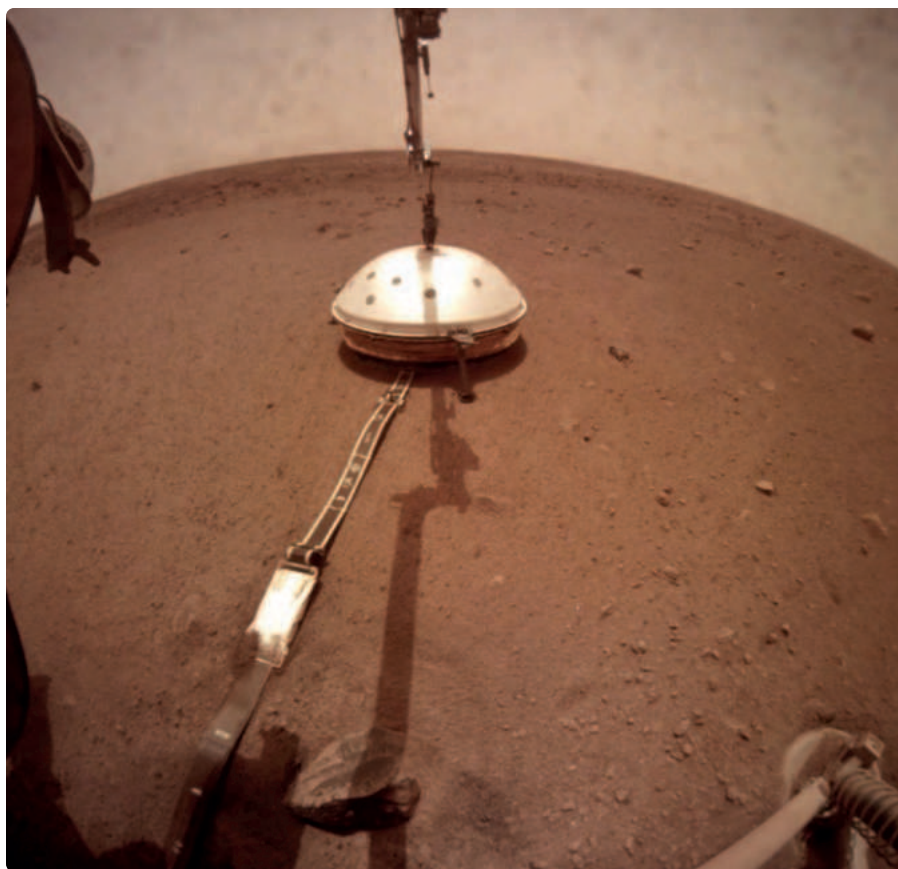
**M**ars is one of the most explored planets of our solar system. Till date, 26 successful missions have been sent to Mars to better understand it; some were flybys, gathering information only in brief bursts, while some others were orbiters that explored the planet from space for years. But all the probes sent to Mars till date primarily investigated the surface history of the Red Planet by examining features like canyons, volcanoes, rocks and soil. None of them was designed to explore the inner structure of the planet. However, according to planetary scientists, signatures of the planet's formation can only be found by sensing and studying its "vital signs" far below the surface.

Despite decades of exploration by spacecraft, there still remains a lot about the Red Planet that we don't know. We know it has a core, but scientists are unsure how big it is or what it is made of. It could be small and dense – made up of iron and nickel like our own core or larger and made of several types of materials. Mars is often referred to as a dead planet, but it is actually pretty active. Past missions have shown that it had active volcanoes just 50-100 million years ago, relatively recently in geologic terms, and researchers would like to know more about how they were formed and why they stopped erupting. All this is what NASA's latest Mars probe InSight, which landed on the planet on 26 November 2018, was

designed to find out. InSight, short for 'Interior exploration using Seismic Investigations, Geodesy and Heat Transport', is a Mars lander designed to give the Red Planet its "first thorough check-up since it formed some 4.5 billion years ago". It is the first outer space robotic explorer to study in-depth the "inner space" of Mars – its crust, mantle and core.

The InSight lander deployed its seismometer on the Martian surface

on 19 December 2018 and it has just sent back the first reports of seismic activity and ground vibrations on Mars. According to NASA scientists, the Red Planet has a moderate level of seismic activity, intermediate between that of Earth and the Moon. Data from the mission's Seismic Experiment for Interior Structure (SEIS) provided the first direct seismic measurements of the Martian subsurface and upper crust – the rocky outermost layer of the planet



NASA's InSight lander deployed its seismometer on the Martian surface on 19 December, 2018. This image captured on 2 February, 2019 by the deployment camera on the lander's robotic arm shows the protective wind and thermal shield which covers the seismometer. (Credit: NASA/JPL-Caltech)

(Nature Geoscience, 24 February 2020 | DOI: 10.1038/s41561-020-0544-y).

According to the scientists, the seismic data acquired over 235 Martian days showed 174 seismic events or marsquakes. Of those, 150 were high-frequency events that produce ground shaking similar to that recorded on the Moon by the Apollo program. Further, the data showed that the seismic waves bounce around as they travel through the heterogeneous and fractured Martian crust. The other 24 quakes observed by SEIS were predominantly low-frequency events. “Three showed two distinct wave patterns similar to quakes on Earth

caused by the movement of tectonic plates.” According to the scientists, “Based on how the different waves propagate through the crust, we can identify geologic layers within the planet and determine the distance and location to the source of the quakes.”

In addition, the seismometer provided important information about Martian weather. Low-pressure systems and swirling columns of wind and dust called dust devils lift the ground enough for the seismometer to register a tilt in the ground. High winds flowing across the surface of the ground also create a distinct seismic signature. Combined

with data from meteorological instruments, SEIS data help paint a picture of the daily cycles of surface activity near the InSight lander.

“This is the first mission focussed on taking direct geophysical measurements of any planet besides Earth, and it’s given us our first real understanding of Mars’ interior structure and geological processes,” said Nicholas Schmerr, an assistant professor of geology at the University of Maryland (UMD) and a co-author of the study. “These data are helping us understand how the planet works, its rate of seismicity, how active it is and where it’s active.”

## AI DISCOVERS NEW ANTIBIOTIC

**A**rtificial Intelligence or AI is the latest buzzword that appears almost everywhere—from machine learning, speech recognition, problem-solving and much more. AI brings with it a promise of genuine human-to-machine interaction. When machines become intelligent, they can understand requests, connect data points and draw conclusions. They can reason, observe and plan future action.

Recently, using a machine-learning algorithm, researchers at Massachusetts Institute of Technology (MIT) have identified a powerful new antibiotic compound. In laboratory tests, the drug killed many of the world’s most problematic disease-causing bacteria,

including some strains that are resistant to all known antibiotics. It also cleared infections in two different mouse models (Cell, 20 February 2020 | DOI: 10.1016/j.cell.2020.01.021). In their new study, the researchers also identified several other promising antibiotic candidates, which they plan to test further. They believe the model could also be used to design new drugs, based on what it has learned about chemical structures that enable drugs to kill bacteria.

Aiming to tackle the growing antibiotic resistance crisis, a collaboration of synthetic biologists and computer scientists has developed a deep learning platform to predict antibiotic activity. In particular, the group wanted to discover compounds with structures distinct from known antibiotics, to boost their chances of success against drug-resistant bacteria.

According to the researchers, the computer model is designed to pick out potential antibiotics that kill bacteria using different mechanisms than those of existing drugs. Says James Collins, the Termeer Professor of Medical Engineering and Science in MIT’s Institute for Medical Engineering and Science (IMES) and Department of Biological Engineering, “We wanted to develop a

platform that would allow us to harness the power of artificial intelligence to usher in a new age of antibiotic drug discovery. Our approach revealed this amazing molecule which is arguably one of the more powerful antibiotics that has been discovered.”

The newly discovered molecule is halicin, which has impressive antibiotic activity, despite having a chemical structure unlike conventional antibiotics. Halicin was one compound identified by the machine learning software and despite its unusual structure for this class of drug, it is proving to be an excellent antibiotic. According to the researchers, halicin turns out to be a remarkably potent novel antibiotic, with broad activity against a range of antibiotic-resistant pathogens. “We applied it to 36 different panels of multidrug-resistant bacterial pathogens from the US Centers for Disease Control, and halicin was effective against 35 of those 36,” they said.

Preliminary studies suggest that halicin kills bacteria by disrupting their ability to maintain an electrochemical gradient across their cell membranes. This gradient is necessary, among other functions, to produce ATP (molecules that cells use to store energy), so if the gradient breaks down, the cells die. This type of killing mechanism could be difficult for bacteria to develop resistance to, the researchers say.

This is a significant breakthrough.



Bacterial culture for testing antibiotics. (Inset) Halicin, a novel antibiotic.

Over the past few decades, very few new antibiotics have been developed, and most of those newly approved antibiotics are slightly different variants of existing drugs. Current methods for screening new antibiotics are often prohibitively costly, require a significant time investment and are usually limited to a narrow spectrum of chemical diversity. In contrast, the AI-enabled system could

screen more than 107 million chemical structures in a matter of days and found nine potential antibiotics, with one in particular (halicin) showing potency against 97% of the drug-resistant bacteria it was tested against.

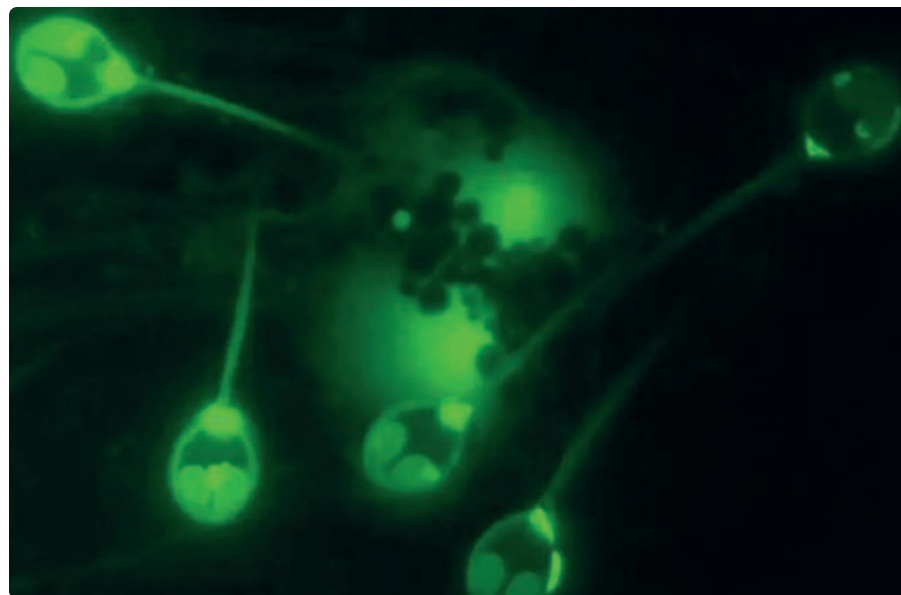
According to the researchers, further work is underway to improve the accuracy of the deep learning tool's predictions and efforts are on to develop

AI methods that can be used beyond an initial screen – so that after identifying a lead molecule, the model can then suggest modifications that could improve its biological activity. Meanwhile, the researchers plan to pursue further studies on halicin, working with a pharmaceutical company or non-profit organisation in hopes of developing it for use in humans.

## WORLD'S FIRST ANIMAL THAT DOES NOT BREATHE

**I**t is known that single-celled organisms such as anaerobic bacteria and protozoans can survive without oxygen as they get their energy from fermentation or use other molecules like mercury or iron. But multicellular organisms including all animals need oxygen for breathing to survive. But recently researchers at Israel's Tel Aviv University (TAU) have discovered a non-oxygen breathing animal – a parasite called *Henneguyasalminicola* – which the researchers say is totally unexpected and changes one of science's basic assumptions about the animal world.

The research led by Dorothee Huchon of the School of Zoology at TAU's Faculty of Life Sciences and Steinhardt Museum of Natural History made the discovery accidentally while doing a genomic study. While sequencing the genome of *H. salminicola*, Huchon found that it did not include a mitochondrial genome – the small but crucial portion of DNA stored in an animal's mitochondria that includes genes responsible for respiration. The mitochondria is an essential component of the cell and is known as the powerhouse of the cell where oxygen is captured to produce energy, so its absence indicated that the animal did not breathe oxygen (Proceedings of the National Academy of Sciences, 24 February 2020 | DOI: 10.1073/pnas.1909907117). The researchers say, *H. salminicola* is the only known animal on Earth that does not breathe. The fact that the creature has no mitochondrial DNA and no way



Fluorescent dye highlighting nuclei and membranes in *H. salminicola*, a parasite that does not breathe (Credit: Stephen Douglas Atkinson)

to breathe are two animal 'firsts'.

According to the researchers, the tiny, less than 10-celled parasite *H. salminicola* lives in salmon muscle. As it evolved, the animal, which is a relative of jellyfish and corals, gave up breathing and consuming oxygen to produce energy. Until this discovery, there was debate regarding the possibility that organisms belonging to the animal kingdom could survive in anaerobic environments. The assumption that all animals breathe oxygen was based, among other things, on the fact that animals are multicellular, highly developed organisms, which first appeared on Earth when oxygen levels rose.

"It's not yet clear to us how the parasite generates energy," says Huchon. "It may be drawing it from the surrounding fish cells, or it may have

a different type of respiration such as oxygen-free breathing, which typically characterises anaerobic non-animal organisms."

According to the researchers, the discovery bears enormous significance for evolutionary research. "It is generally thought that during evolution, organisms become more and more complex, and that simple single-celled or few-celled organisms are the ancestors of complex organisms. But here, right before us, is an animal whose evolutionary process is the opposite. Living in an oxygen-free environment, it has shed unnecessary genes responsible for aerobic respiration and become an even simpler organism."

Biman Basu is a former editor of the Science Reporter, published by CSIR.  
Email: bimanbasu@gmail.com

SRINIVASA RAMANUJAN

## A Self-taught Genius of Inexplicable Originality



Ramanujan's bust at the Royal Society of London



Ramanujan's original notebooks

G.H. Hardy (1877-1947), FRS and Sadleirian Professor of Pure Mathematics at Cambridge University, Srinivasa Ramanujan's mentor who had interacted with his peerless and raw mathematical talent from the closest proximity during his Cambridge days, once told "It was his insight into algebraic formulae, transformation of infinite series, and so forth, that was most amazing. I have never met his equal, and I can compare him only with Euler or Jacobi... He was by far the greatest formalist of his time...one gift it has which no one can deny—profound and invincible originality...He would probably have been a greater mathematician if he could have been caught and tamed a little in his youth. On the other hand he would have been less of a Ramanujan, and more of a European professor, and the loss might have been greater than the gain..." In 2020, as we commemorate the Death Centenary of this self-taught legendary son of our soil, who has left the world of mathematics mesmerised with sheer awe for the last hundred years. His typically original ways of doing mathematics, his mathematical thought process has not yet been totally deciphered and his tragic untimely demise, when he was at the peak of his creative genius, despite his irrecoverable illness, leave us to wonder what could have been his further mathematical achievements had the destiny granted him a longer life!

### Thursday, 22 December 1887

Srinivasa Ramanujan (nicknamed Chinnaswami by his mother) was born to Komalatammal and K. Srinivasa Iyengar in an orthodox, pious, poor and ordinarily educated Tamil Brahmin family. He was the eldest child to his parents. Within next seven years two of his younger brothers and a sister were born but unfortunately died in their infancy. However, two other brothers, much younger to him, Lakshmi Narasimhan (born in 1898) and Tirunarayanan (born 1904)

did survive. His father was a clerk and mother used to sing devotional songs at the Sarangapani temple.

### December 1889

Ramanujan survived an attack of the then deadly small pox.

### 1892-1894

After a few shuffling due to some family crisis between several junior schools in Kumbakonam and Kanchipuram, finally Ramanujan got admitted to Gangayan Primary School, Kumbakonam.

## November 1897

Stood First in the whole district in the Primary Examination that was taken on English, Tamil, Arithmetic and Geography.

## January 1898

Joined English medium Town High School, Kumbakonam. As the anecdote goes, this is where at about thirteen years of age he asked his Mathematics teacher the famous question pertaining to division by zero, "if no fruits are divided among no one, will each still get one?"

## 1903

Passed Matriculation in 2nd class and Joined the Government College, Kumbakonam with a scholarship as an F.A. student (First Arts was then the entrance examination for University education); came in touch with A Synopsis of Elementary Results in Pure and Applied Mathematics, a compendium of about five thousand formulae by G.S. Carr. While trying to understand the results stated in the book all by himself, Ramanujan began to create his own formulae and started to write them in a personal NOTEBOOK.

## 1904

Received K. Ranganath Rao prize on Mathematics for outstanding performance in his last school examination, where the Headmaster of Town High school, K. Iyer introduced him to the audience as a student, who deserved higher than the maximum possible marks.

## 1905

His passionate sojourn of Mathematics, and only Mathematics, started taking its toll and Ramanujan, once

an all-round good student, failed in College final examination except in Mathematics and lost his scholarship. Unable to bear this, he ran away from home sometime in early August and came back after about a month.

## 1906

Joined Pacchayappa's College, Madras, with partial scholarship but discontinued after 3 months because of ill health.

## 1907

Appeared privately and failed in F.A. His name was struck off from the College. Around this period he started reorganising and rewriting his notebooks in formal manner with a hope that those may help him getting some sort of job or scholarship. By then those were growing regularly in volume with list of stunning new results and equations without much of justification, which would in future serve as a challenging homework for generations of mathematicians to try and prove.

## 1908

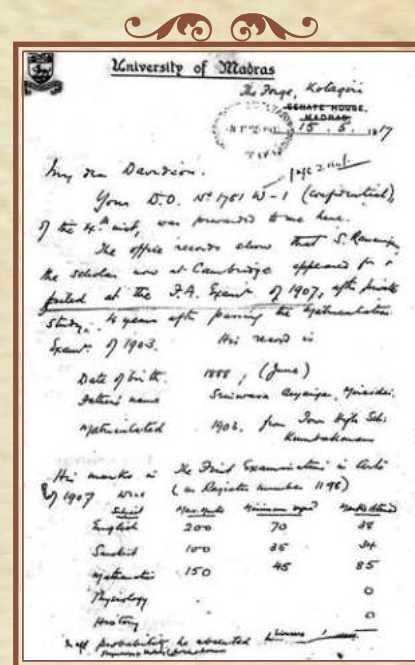
To support his family financially, Ramanujan began coaching some students privately, but unfortunately that did not work either, as his approach to mathematics was found generally unsuitable for examination-oriented need of the students.

## 1909

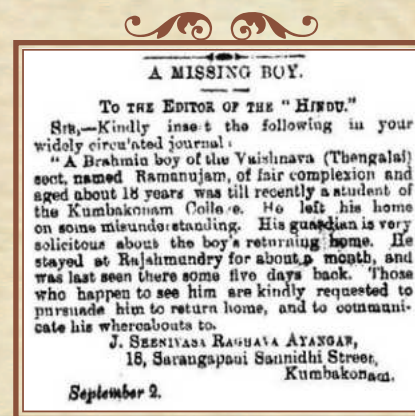
With a hope to bring him back to the routine track of mundane life, his mother got him married to Janakiammal, who was then 9 years of age.

## 1910

He had to undergo some minor surgery in January to get rid of an ailment. Throughout the year he approached



Ramanujan's F.A. Examination Marksheet  
(in which he failed)



From the Archive of The Hindu (A letter to the editor in 1905 by Ramanujan's father)

many people in and around Madras with considerable academic and social influence with the sole request for some sort of job or scholarship towards some financial help on the basis of his notebooks, so that he may continue his private research in Mathematics, while providing a minimum support to his family. But apart from getting a few praising letters of recommendation, it was mostly in vein, as nobody could actually gauge the true merit of his research. Finally, sometime late in this year, he managed to get a private monthly stipend of Rupees twenty five from the then secretary of Indian Mathematical Society and district collector of Nellore, Dewan Bahadur Ramachandra Rao.

### 1911

His first research paper, entitled Some Properties of Bernoulli's Numbers was published in the Journal of Indian Mathematical Society.

### 1912

He got a job at the Madras Port Trust earning Rupees thirty per month as a clerk, upon a recommendation from Ramachandra Rao. Here he met Narayana Iyer, a member of the Indian Mathematical Society, who brought him to the notice of Sir Francis Spring, the Chairman of the Port Trust, and convinced him about Ramanujan's extraordinary talent. Over the next few years, Mr. Iyer stood by Ramanujan's side as a friend, philosopher and guide, while Sir Spring tried to promote Ramanujan to the British mathematical circles as far as he could. Later in this year, Ramanujan started writing letters with chosen sample of his research findings to some of the leading Cambridge Mathematicians seeking their opinion and further help. He approached

H.F. Baker and E.W. Hobson, both FRS, but they did not respond.

### 16 January 1913

Ramanujan wrote a ten-page-long letter packed with about 120 of his original formulae to G.H. Hardy at Trinity College, Cambridge. Hardy would later write about Ramanujan's first letter that some of his formulae "defeated me completely; I had never seen anything in the least like them before. A single look at them is enough to show that they could be written down by a mathematician of the highest class." Eventually, Hardy invited Ramanujan to come over to England with full scholarship towards joint research. However, Ramanujan could not make up his mind immediately because of socio-religious strictures. Later in April, Madras University, now reassured of Ramanujan's mathematical gift, thanks to Hardy's letter, granted him a research scholarship of worth Rupees 75 per month.

### 17 March 1914

Due to E.H. Neville's sincere effort, who was subsequently sent to India by Hardy to persuade Ramanujan (though his formal assignment was to give some lectures at Madras University), Ramanujan finally sailed to England overcoming social taboos and after receiving his mother's permission. He reached England around 14 April 1914. Soon began the extraordinary collaborative mathematical journey with Hardy (and occasionally with J.E. Littlewood) at the Whewell's court, his new address at Trinity College, Cambridge. This journey enriched both the mentee and the mentor equally. Ramanujan had much to learn about the formal way of doing

mathematics, but so did Hardy from the almost magical intuition and conjuring ability of Ramanujan towards creating new mathematical formulae on a regular basis. Unfortunately, by the end of July, First World War began. This directly affected ship movements, causing a break in supply of vegetarian food, fruits, milk products etc. that in turn affected Ramanujan's nutrition very dearly.

### March 1916

Ramanujan received the B.A. degree (for Research on Highly Composite Numbers) from Cambridge University; during this period he worked on Approximate Number of Prime Factors for Large Integer  $n$  and Asymptotic formulae in Combinatory Analysis (both papers later published in the Proceedings of London Mathematical Society).

### 1917

This fateful year saw Ramanujan with recurrent illness and hospitalisation at various sanatoriums for high fever and pain in stomach, which diagnosed finally as (the then incurable) Tuberculosis. During this period he made the seminal collaboration with Hardy On Number of Partitions of a Natural Number  $n$ . Meanwhile Trinity College turned down his candidature for fellowship in October despite Hardy's all out efforts; however, on 6th December, he was elected to the London Mathematical Society.

### Late January or Early February 1918

Out of frustration and possible depression due to loneliness in a foreign land, Ramanujan, away from his family for over four years then, attempted suicide at a

London underground rail station; subsequently, he was bailed out by Hardy from Scotland Yard.

### Late February 1918

Elected as (Second Indian) FRS (Fellow of Royal Society) and then subsequently as the (First Indian) Fellow of Trinity College, Cambridge; unfortunately bouts of illness continued. Back home, Madras University granted him a 250 Pound per year fellowship for six years, about which he requested the authorities in writing to disburse it for the education of the local poor boys and orphans, after paying 50 Pounds annually to his parents.

### 13 March 1919

At the end of First World War, Ramanujan sailed back for India, with critically ill health. His results on Congruence Properties of Partitions and Algebraic relations between certain infinite products were presented on this day to London Mathematical Society by Hardy.

### 27 March 1919

Reached Bombay port and subsequently at Madras on 2 April by train. Later, he was offered Professorship at Madras University, which he said he would accept once his health improved. This year saw him continuously shifting from one house to another, mostly upon local doctors' advice, in search for a better place suitable for his health condition, which was gradually worsening.

### 12 January 1920

He wrote the only letter to Hardy after coming back to India, describing what is now acknowledged widely as his greatest stroke of genius,

that he named as Mock Theta Functions, through 22 examples.

### 26 April 1920

Ramanujan died at Madras at the age of 32 years; left his three Notebooks with about 3542 theorems, without proof; almost each one was later proved by Bruce C. Berndt with his 20 years of relentless research amounting to five volume of books from Springer.

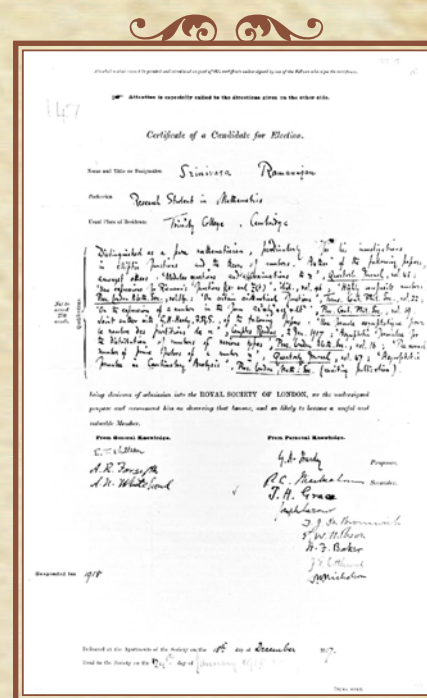
### 1974

Pierre Deligne proved Tau Conjecture posed by Ramanujan in his 1916 paper On Certain Arithmetical Functions and was lauded with the coveted Fields Medal.

### April 1976

George Andrews discovered in the Wren Library of Cambridge, 138 sides of loose pages handwritten by Ramanujan, containing over 600 formulae related mostly to Mock Theta Functions and Modular Equations, listed without any proof as always, the so-called 'Lost Notebook' conjured by Ramanujan during his last days in India despite his terminal illness. Later, Prof. Andrews along with Prof. Berndt deciphered all those results that amounted to another four volumes of book published from Springer, last one being in 2013.

The immense significance of his final work done almost from his deathbed reverberates in many a comment by great mathematicians of our time. "The mock-theta functions give us tantalizing hints of a grand synthesis still to be discovered....this remains a challenge for the future", said Freeman Dyson of Institute of Advanced Study, Princeton, while Fields Medallist Manjul Bhargava of Princeton University pointed out that "We're still trying to understand



Ramanujan's Royal Society election certificate, EC/1918/18.

Credit : The Repository of the Royal Society of London

some of his work today—and when we do, it often transforms entire areas of mathematics.” Let us end by quoting Robert Kanigel, the author of the world famous biography of Ramanujan, The Man Who Knew Infinity: “What Ramanujan did will live forever. It will not, to be sure, live in the hearts of the masses of men, like the work of Gandhi, Shakespeare or Bach. Still, his ideas and discoveries, percolating through those few mind tuned to them, will mingle with the intellectual energy of the cosmos, and thence into the deep, broad pool of human knowledge.”

Dr. Parthasarathi Mukhopadhyay Associate Professor, Department of Mathematics, Ramakrishna Mission Residential College (Autn.), Narendrapur, Kolkata  
Email: dugumita@gmail.com



# The Computer who Wore Skirts and Sent Men to Space

Katherine Johnson  
(Credit: nasa.gov)

**“BEHIND** every successful man there is a woman,” goes a popular saying. Unknown to many, historical space missions that sent men to space— such as the *Mercury* project around the earth, or the *Apollo* missions that placed men on the Moon — also owe their success to stellar efforts by outstanding women. While the world focussed on the men who braved the journey into space, these women trailblazers remained hidden and behind the scenes, quietly contributing to the critical aspects of the scientific endeavours.

One such remarkable woman who played a crucial role in bringing the

spacemen back to Earth safe was Katherine Coleman Goble Johnson, research mathematician and NASA’s orbital mechanics expert. She passed away on 24 February 2020, at the age of 101, leaving behind a legacy of steely-will, courage and dedication. Paying tributes to their ace number cruncher, the American space agency said: “NASA would not be what it is if not for you, Mrs Johnson.”

Johnson’s illustrious career at NASA lasted 33 years – from 1953 to 1986. During this period, she started as the Agency’s human-computer performing complex mathematical calculations

to determine the trajectories of the *Mercury*, *Gemini* and *Apollo* missions. NASA and the astronauts relied heavily on her expertise to take the men to space and ensured they returned home safely.

## The human-computer

It was the early 1940s and 1950s, and the modern-day computing machines were yet to come by. NASA (then known as NACA- National Advisory Committee for Aeronautics) had a massive amount of data coming from instruments in wind tunnel experiments, flight trajectories and flight tests. The engineers had to compute and process the information using mechanical calculators manually. Around this time NASA began recruiting women with mathematics degrees as ‘computers’ to perform these tedious tasks, thereby relieving the engineers to tackle the other projects for the Space Task Force.

It was at this time Katherine Johnson— an African-American — joined the Langley Memorial Aeronautical Facility as a computer. Given her ingenuity, accuracy and expertise with numbers and geometry, she soon rose to become indispensable for NASA, being part of all their major space flight programs, often crunching the numbers with the help of pencils, slide rules, graphs and a simple mechanical calculator.

## Get the girl to check the numbers!

In 1961, when Alan Shepherd – first US astronaut – was to fly to space Johnson and her team had to sketch the parabolic flight path to its minutest detail, from

### THE CHILD PRODIGY

- ★ Johnson loved numbers, and as a child, she would count everything around her — steps, dishes and even the stars!
- ★ In school, she wowed her teachers with her skills in mathematics.
- ★ She completed schooling at the age of 14 and college at 18 — breezing through and skipping several grades.



lift-off to splashdown. The success of the mission saw NASA soon planning the next task with John Glenn to circle the Earth. The project was more complicated than the previous mission with very large amounts of data to process than the earlier one and real-time monitoring of the flight. Hence, NASA commissioned and installed new IBM machines to do the calculations. However, admittedly, John Glenn did not trust the machines entirely. He insisted: "Get the girl to check the numbers. If she says they are good, then I'm ready to go!" such was the trust in her ability and Johnson rose to it with aplomb. She verified all the algorithms, trajectories and entry points processed by the machines, putting Glenn at ease.

The 'girl' also worked on the *Apollo* mission, which took Neil Armstrong to the Moon – a mission fraught with extreme complexity and high tension. Although machines were now doing the repetitive and tedious tasks, critical aspects like the trajectory for the lunar lander and the in-space docking with the Command Module were Johnson's prerogative. In an interview, Johnson recalls those calculations as her most significant contributions to space exploration.

Margot Lee Shetterly, author of the book *Hidden Figures: The American*

## LIFE IN REEL

- ★ For most of her career, Johnson's name remained obscure to the world. Very few, even within NASA, knew about her legendary talents.
- ★ Margot Lee Shetterly, author and researcher, penned a book on the unsung women heroes of NASA, titled, *Hidden Figures*. The book gained critical acclaim and went on to be made into a movie by the same name.
- ★ The book and the movie featured Johnson and her team, brought to limelight her invaluable contributions to NASA's space race. It also showcases the trials and tribulations African-American women faced in realising a science career.
- ★ Despite the name and fame, Johnson remained humble, claiming 'she was only doing her work'.

*Dream and the Untold Story of the Black Women Mathematicians Who Helped Win the Space Race*, wrote about Katherine Johnson and her team and their remarkable contribution to NASA. In a talk, she said: "the incidents involving Johnson are strong examples of how women rise to the occasion in a very high-pressure scientific endeavour. There is no better example of what women are capable of doing in a scientific organisation."

### Not bothered by hurdles

As an African-American, Johnson faced several institutional and societal biases, lack of equal opportunity, access and

acknowledgement. However, none of the obstacles bothered her, as at every point she nullified the discrimination with talent, self-belief and resolve. Inequality never existed in her mind. Her father instilled fearlessness in her from a young age. He would tell her, "You are as good as anybody but no better."

When usually children refuse to go to school, as a child, Katherine was eager to start. "When can I go to school?" was a question little Katherine would often ask her parents when her older siblings were ready for school. So, when she actually got the opportunity, she was so good that she started from the second grade directly. The prodigal child entered high school by the age of 10 and finished college by 18.

She loved geometry from a young age and majored in mathematics and French in college, earning the highest distinction. The school and college she studied were segregated and reserved for black students, but all through she remained unfazed. In college, she found the right mentor in W.W. Schieffelin Claytor, who, realising her potential, personally trained her to become a research mathematician.

Although well trained, Johnson could not find the right opening for her talents. Those were the days when science and technology were considered a male bastion with negligible opportunities for women – more so for women of colour. So, after graduating from college, she became a school teacher, continuing the position for the next ten years.



Active proponent of STEM (Credit: nasa.gov)

It was in 1953 that she chanced upon the opening for women computers (as mathematicians were called back then) for NASA's guidance and navigation department at Langley.

**Asking the right questions**

At the Langley facility, although Johnson knew how to solve many of the mathematical assignments for space projects, she was never satisfied doing them quietly. Always inquisitive, she wanted the whys, how's and why not's to a task. Space trajectories involved geometrical calculations — her forte. By asking the right questions she delivered outstanding solutions to critical space manoeuvres. Although women were not participants of technical meetings at NASA, she questioned the system and soon began attending project meetings. The involvement gave her detailed insights into space flights and missions, thereby enabling her to deliver quality work. Her expertise made her stand out as a leader, and the engineers began relying on her heavily.



The computer at her desk (Credit: economist.com)


**The trailblazer**

Johnson had a long and illustrious tenure at NASA from 1953 to 1986. Barely two weeks after joining Langley facility, she was called to the Flight Research Division to do the math for aerodynamic forces on aeroplanes. She put her geometry expertise to good use and remained in the division for the rest of her career, rising in ranks.

The tedium of complex calculations and repetitive tasks never bothered her. Johnson loved her work immensely, putting in 16-hour days. “There wasn’t one day when I didn’t wake up excited to go to work,” she said in an interview. During her career span, she published more than 24 technical papers.

Her love for mathematics and science did not end at NASA. After her retirement, Johnson became a proponent for STEM, involving in several conferences, talks and giving speeches to students encouraging them to pursue careers in science. She often said, “Some things will drop out of the public eye and will go away, but there will always be science, engineering and technology. And there will always, always be mathematics. *Everything is physics and math.*”

Her motivational speeches encour-



A Lego figure of mathematician and space scientist Katherine Johnson (Credit: Maia Weinstock)

**IMMORTALISED IN LEGO TOYS**

- ★ In 2017, the Lego Toys company released a Women in NASA Toy set to celebrate the iconic contribution of five women pioneers at NASA. Katherine Johnson was one among them.
- ★ The toy set highlights the rich history of women in STEM professions who have historically struggled to be accepted in the fields of science, technology, engineering and mathematics.

raged many youngsters to pursue careers in STEM.

The legendary Katherine Johnson’s message to youngsters rings clear: “Do your best, and like what you do. If you like what you do, then you will do your best.”

Susheela Srinivas is a science communicator, writer and journalist. Email: sushsri@gmail.com



**AWARDS AND ACCOLADES**

- ★ NASA Lunar Orbiter Award;
- ★ Three NASA Special Achievement Awards;
- ★ Mathematician of the Year Award in 1997;
- ★ Honorary Doctor of Law degree from the State University of New York;
- ★ Honorary Doctor of Science degrees from Capitol College in Maryland and Old Dominion University in Virginia;
- ★ A 37000-sq-foot facility opened in her honour– the Katherine Johnson Computational Research Facility at the NASA’s Langley Research Center;
- ★ National Medal of Freedom in 2015 – highest civilian honour in the US;
- ★ She has more than 24 technical papers to her credit.



India-based Neutrino Observatory (INO):

# Hunting for the Ghost Particles

Neutrinos are notoriously difficult to detect in laboratory because of their extremely weak interaction with matter. The background from cosmic rays (which interact much more readily than neutrinos) and natural radioactivity make it almost impossible to detect on the surface of Earth. India is a pioneer in neutrino experiments. Atmospheric neutrino research started in the Kolar Gold Fields (KGF) mine in India, which is one of the deepest mines in the world. It became the first laboratory for the detection of cosmic-ray-produced neutrinos in 1965.

**T**he award of the Nobel Prize in Physics in 2015 to Takaaki Kajita of the University of Tokyo and Arthur B. McDonald, Chief Scientist at the Sudbury Neutrino Observatory (SNO) collaboration, Canada for proving that neutrinos change identities or 'flavours' from one type to another over time encouraged the world scientists to explore new avenues in the field of neutrino research. The India-based Neutrino Observatory (INO) project is a multi-institutional effort aimed at building a world-class underground laboratory with a rock cover of approximately 1,200 m for non-accelerator-based high-energy and nuclear physics research. The country's biggest basic science facility, to be built at a cost of Rs. 1,500 crore, is being funded by the Department of Atomic Energy

(DAE) and Department of Science and Technology (DST) and will study atmospheric neutrinos produced by cosmic rays in the Earth's atmosphere. It is the latest in a series of neutrino detectors and experiments being set up worldwide to promote research in particle physics.

India was a pioneer in neutrino experiments. Atmospheric neutrino research started in the Kolar Gold Fields (KGF) mine in India, which is one of the deepest mines in the world. It became



the first laboratory for the detection of cosmic-ray-produced neutrinos in 1965. Neutrino research progressed further, especially in Japan, and led to two Nobel Prizes for Japanese physicists.

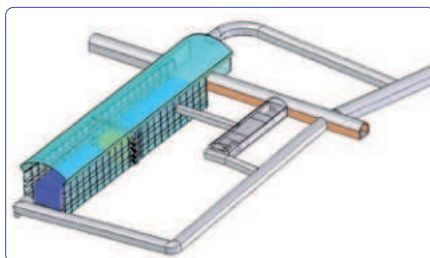
Major underground Neutrino Observatories around the world are Sudbury in Canada, Soudan mines in the USA, Kamioka in Japan, under the Gran Sasso Mountains in Italy and two underwater neutrino observatories — Amundsen-Scott South Pole Station, Antarctica and ANTARES (Astronomy with a Neutrino Telescope and Abyss environmental RESearch project) under the Mediterranean Sea off the coast of Toulon, France.

In particle physics, a lepton is an elementary particle of half-integer spin that does not undergo strong interactions. Leptons can either carry

one unit of electric charge or be neutral. In addition to the electron (and its anti-particle, the positron), charged leptons include the muon (with a mass 200 times greater than that of the electron), the tau (with mass 3,700 times greater than that of the electron), and their anti-particles. Both the muon and the tau, like the electron, have accompanying neutrinos, which are called the muon-neutrino and tau-neutrino, respectively. In particle interactions, although charged leptons and their accompanying neutrinos can be created and destroyed, the sum of the number of charged leptons and corresponding neutrinos is conserved. This fact leads to dividing the leptons into three families, each with a charged lepton and its accompanying neutrino. They oscillate between ‘flavours’ as they propagate. A particle might start out as an electron neutrino, but as it moves, it morphs into a muon neutrino or a tau neutrino, changing flavours as it goes. Without neutrinos, the Sun would not shine and the air we breathe would not have formed.

The finite but tiny mass of the neutrino is important because neutrinos are by far the most numerous of all the particles in the universe (other than photons of light which are mass-less) and therefore even a tiny mass for the neutrinos can make them have an input on the evolution of the universe through their gravitational effects. Scientists don’t know how to subdivide any further at this point of time. However, specific capabilities of the INO detector may be of help to know the ordering of the three masses between the neutrinos. In a sense, neutrinos hold the key to several important and fundamental questions on the origin of the universe and the energy production in the stars.

Neutrinos are completely benign and are present in profusion in our atmosphere. Also known as ‘ghostly particles’ (but of a friendly kind), they are tiny, neutral, elementary particles naturally produced in the Sun, stars and in the atmosphere, which interact with matter via the weak force. There are many other natural sources of neutrinos including exploding stars



Schematic view of the proposed INO underground lab

(supernova), relic neutrinos (from the birth of the universe), natural radioactivity and cosmic ray interactions in the atmosphere of the Earth. They all produce billions of neutrinos which stream through our body every second; yet, only one or two of the higher-energy neutrinos get scattered from our body in a lifetime. They just go through us, unaware of our presence just as we are unaware of their presence.

Neutrinos have no effect on human beings but can help us understand how our universe has evolved as they have played an important role in the evolution of the universe. They are part of nature, but we cannot see or feel them because the probability of neutrinos interacting with matter is negligible and they simply pass through all matter. Hence it requires huge detectors and sophisticated instruments to study neutrinos. The INO is a kind of telescope that will allow scientists to look at and study neutrinos. It is placed underground so that the rocks above shield the detector from other energetic particles coming from space.

**The INO underground laboratory**

The plan of the INO includes setting up the flagship Iron Calorimeter (ICAL) detector in an underground laboratory in Pottipuram in Theni district of Tamil

Nadu and construction of the Inter-Institutional Centre for High Energy Physics (IICHEP) in Madurai.

Neutrinos, as mentioned before, are notoriously difficult to detect in laboratory because of their extremely weak interaction with matter. The background from cosmic rays (which interact much more readily than neutrinos) and natural radioactivity make it almost impossible to detect them on the surface of Earth. This is the reason neutrino observatories are located deep under the Earth’s surface. The key advantage of constructing a laboratory in a cavern in a mountain accessed by a 2-km tunnel is that it offers a low cosmic ray background environment and low-seismic zone (zone 2) which is necessary for specialised experiments.

Geologically, mountains in southern parts of India have compact, dense rock, mostly gneiss whereas the Himalayan region predominantly consists of metamorphic sedimentary rock with pockets of gneiss. A considerable area of mountains in the Tamil Nadu region has mainly the hard rock Charnockite (named after Job Charnock, traditionally regarded as the founder of the city of Kolkata).

**Facilities in INO**

To detect neutrinos, very large and very sensitive detectors are required. For the INO, it is proposed to construct a large Iron Calorimeter (ICAL) – 132-m long, 26-m wide and 20-m high – consisting of 50,000 tons of magnetised iron plates arranged in stacks with gaps in between, where Resistive Plate Chambers (RPCs) would be inserted as active detectors, the total number of 2m × 2m RPCs being around 29,000. Two smaller caverns will

***NEUTRINOS are completely benign and are present in profusion in our atmosphere. Also known as ‘ghostly particles’ (but of a friendly kind), they are tiny, neutral, elementary particles naturally produced in the Sun, stars and in the atmosphere, which interact with matter via the weak force.***



also be used for setting up experiments for neutrino double detector and dark matter. The aim is to make precision measurements of the parameters related to neutrino oscillations.

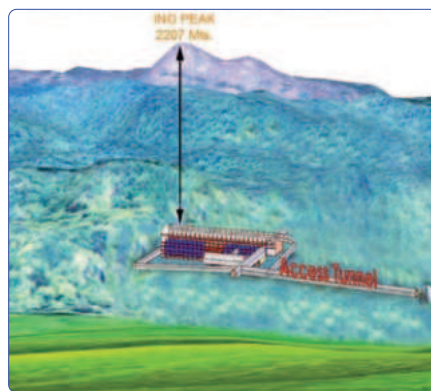
The ICAL at INO will detect and measure atmospheric neutrinos to study their properties, including the mass ordering of the three tiny neutrino masses using matter-enhanced neutrino oscillations. The ICAL detector can also be used to search for evidence of long-range interactions between neutrinos and matter-dark matter annihilation occurring in the Sun, primordial magnetic monopoles and evidence for or against the anomalous events found by the proton decay detector in Kolar Gold Fields. The INO will also aid the development of detector technology and its varied applications, especially in the areas of medical imaging. The location of the detector in the INO will make it possible to push down to almost 8° N latitude in South India, within proximity to the Equator as compared to other detectors that are at latitudes of 35° N and above. This will provide an added advantage to cover the whole sky and study solar neutrinos passing through the Earth's core.

The aim of the INO is to make precision measurements of the parameters related to neutrino oscillations. Because of its ability to distinguish between the positive and negative muons, this detector can determine the ordering of the neutrino masses, which is not very well known at present. No other detector either existing or planned may be able to provide an answer in the next 10 years.

The second phase of the proposed plan is to use this detector as the far-detector of a long-base-line (6,000 to 11,500 km) neutrino experiment using the neutrino beam from a neutrino factory in Japan, Europe or the USA. These are neutrinos that will be produced in a future accelerator facility which would be beamed towards the detectors situated in a different part of the Earth. This is feasible because the proposed detector at the INO will be capable of charge identification, which is crucial for this mode of operation.

### Participating institutions

As a result of the support from various research institutes, universities and scientific community, a Neutrino Collaboration Group (NCG) has been established for the India-based Neutrino Observatory. A memorandum of understanding (MoU) was signed by the directors of the seven primary participating institutes on 30 August 2002 to enable smooth functioning of the NCG; the institutes are: Tata Institute of Fundamental Research (TIFR), Mumbai; Bhabha Atomic Research Centre (BARC), Mumbai; Institute of Mathematical Sciences (IMSc), Chennai; Saha Institute of Nuclear Physics (SINP),



Schematic view of the underground neutrino lab under a mountain

Kolkata; Variable Energy Cyclotron Centre (VECC), Kolkata; Harish-Chandra Research Institute (HRI), Allahabad and Institute of Physics (IOP), Bhubaneswar. There are thirteen other project participants.

### Perceived hazards of the Neutrino Observatory

There are some perceived hazards of the proposed underground observatory claimed by the local community. They fear that the excavation and blasts needed to bore the tunnel in the mountains will endanger the biodiversity of the Western Ghats. Other concerns voiced range from radiation and structural damage to the mountain to the emission of hazardous chemicals. But the fact is that the experiments to be performed in the INO when it comes up will neither produce any radioactivity

nor will it emit any radiation. Experts involved in its planning have refuted all these claims as baseless and unfounded. The proposed laboratory is not expected to cause any adverse effect on the environment and biodiversity. There may be a small impact during the initial construction phase which will be minimised after the laboratory is ready. The entire construction will be under the supervision of a specialised team of scientists, engineering crews, geologists, environmentalists and so on.

The INO will have a great impact on the emerging high-energy physics scenario in the country. The NCG has the goal of creating an underground neutrino laboratory with the long-term goal of conducting decisive experiments in neutrino physics as also other experiments that require such a unique underground facility. The INO will serve as a Centre for Excellent Education to train a large number of youngsters in the field of cutting-edge science and technology. People trained at INO will not only participate in Indian projects but will also have the expertise to contribute to other high-energy and nuclear physics projects around the world. Over the long term, the INO is expected to develop into a world-class underground science laboratory straddling many fields like physics, biology, geology and allied engineering fields. So, the INO will provide an extraordinary opportunity to bring state-of-the-art scientific technology and computing to local area without any adverse environmental impact. Apart from educational training, there will be tremendous economic benefits by stimulating growth of the local industries on a broad set of fronts – engineering, electronics, computer sciences, etc. The INO is expected to recover the loss of scientific achievements in the field of neutrino research in India which occurred due to closure of the KGF mines in 1995.

---

Jyoti Sharma is Senior Scientist and Sanjeev Kumar Varshney is Head & Advisor, International Bilateral Cooperation Division (IBCD), Department of Science and Technology, Ministry of Science and Technology, Govt. of India.  
Email: jyotisharma.dst@gmail.com, skvdst@nic.in

# NATIONAL SCIENCE DAY BRINGS GENDER EQUALITY IN SCIENCE:

## PRESIDENT ANNOUNCES KEY INITIATIVES



**P**resident of India Shri Ram Nath Kovind announced three key initiatives for gender advancement and equality in academic and research institutions on the occasion of National Science Day in a function held at Vigyan Bhavan, New Delhi on 28 February, 2020. This year the theme for the National Science Day was “Women in Science.”

An initiative titled Vigyan Jyoti was announced to create a level-playing field for the meritorious girls in high school to pursue Science, Technology, Engineering and Mathematics (STEM) in their higher education. The Gender Advancement for Transforming Institutions (GATI) will develop a comprehensive Charter and a framework for assessing the Gender Equality in Science, Technology, Engineering and Mathematics (STEM). An online portal for science and technology resources for women will provide E-resources related to all women-specific government schemes, scholarships, fellowships, career counselling with details of subject area experts from various disciplines in science and technology, Shri Kovind highlighted.

Dr. Harsh Vardhan, Minister of Science & Technology, Health and Family Welfare and Earth Sciences, applauded the theme ‘Women in Science’ and marked it a conscious paradigm shift from earlier days. He also said that we must move from tokenism to totalism, especially when it comes to creating a gender parity culture in Indian science.

He mentioned that India has risen considerably internationally in research in recent times. We are now at the third position in terms of number of publications in SCI journals.

President Ram Nath Kovind conferred national awards for science communication and popularization, including women excellence awards for meritorious women scientists. The awards included National Science and Technology Communication Awards, Augmenting Writing Skills for Articulating Research (AWSAR) Awards, SERB Women Excellence Awards, and National Award for Young Woman Showing Excellence through Application of Technology for Societal Benefits.

Professor Ashutosh Sharma, Secretary, Department of Science and Technology (DST), highlighted the importance of National Science Day and said that NSD should bring greater awareness, focus and action across the nation on the challenges and opportunities for the women in STEM. “On the day, let us acknowledge our scientists’ efforts in the progress of the Nation with a deep foundation in science and technology, leading to inclusive growth. Let us also resolve to widen and deepen India’s footprint in S&T,” he added.

Prof. Gagandeep Kang, Executive Director of the Translational Health Science and Technology Institute (THSTI), Faridabad delivered a Special Talk on the occasion; Prof. Kang is the first women Fellow of the Royal Society (FRS) from India.

Prof. K. Vijay Raghavan, Principal Scientific Adviser to Govt., Dr. Renu Swarup, Secretary, DBT, Dr. Shekhar Mande, DG, CSIR and award winners were among those present on the occasion.

### PROF. GAGANDEEP KANG HIGHLIGHTS NEED FOR PREPAREDNESS, RESPONSE & RESEARCH WHEN EPIDEMICS & NEWS GO VIRAL



**PROFESSOR GAGANDEEP KANG**, the first women FRS from India, delivered a special talk on the occasion of National Science Day on Preparedness, Response and Research when Epidemics and News go Viral.

Professor Kang highlighted the role women play in healthcare. “About 75% of the healthcare community is made up of women and women play a great part of health care responders,” she said.

Elaborating on the drivers that spread epidemics, she said, “Today’s world is deeply connected, and people are in direct contact all the time. In such a scenario, epidemics are and will continue to become more frequent, more complex and harder to prevent and contain. Current demographic transitions—driven by population growth, rapid urbanization, deforestation, globalization of travel and trade, climate change and political instability have fundamental effects on the dynamics of infectious diseases.

Dr. Kang pointed out how, in the last twenty years, the SARS, MERS, Ebola, and COVID-19 outbreaks have shown that our concept of epidemics must evolve from crisis response during individual outbreaks to an integrated cycle of preparation, response, and recovery.

She cited the successful example of MenAfrivac, a vaccine developed by India which completely eradicated the Meningitis disease from Sub Sahara Africa and said that “We have a lot to be proud of but a lot more to do.”

Professor Kang has built strong inter-disciplinary research programs on enteric infections, nutrition, and child development. She is internationally recognized for her contributions to vaccine development for rotavirus and vaccine policy.

## ACTIVITY CAMP FOR UNDERSTAND THE NATURE THROUGH HANDS-ON ACTIVITIES

Vigyan Prasar and Tripura State Council for Science & Technology (TSCST) organised a Nature Activity Camp for Children to Understand the Dynamics of Nature through Hands-on Activities during 11-14 February 2020.

Shri Jishnu Dev Varma, Hon'ble Deputy Chief Minister of Tripura, inaugurated the four-day workshop as the Chief Guest on February 11 at S.B.S. Youth Hostel, Agartala. In the camp several hands-on activities, field visits and exhibition of the activities were organized by the participants. Fifty-six students from eight districts of Tripura and guide teachers participated in the camp. Manuals, activity kits and other resource materials were provided to the student.



VIGYAN PRASAR

# DREAM 2047

Please complete and send this to:  
Vigyan Prasar A-50, Institutional Area,  
NOIDA – 201309 Uttar Pradesh Fax: 0120-2404437  
Email: info@vigyanprasar.gov.in

## ANNOUNCEMENT FOR SUBSCRIBERS

From April, 2020, Vigyan Prasar's popular monthly newsletter Dream 2047 will come in a new look with many exciting new features. Price per copy will be changed to Rs. 20.00. You are requested to renew your subscription to get copies of Dream 2047. You can also subscribe for the online edition.

- New subscription rates are given on your right.
- For subscription, please fill the Form on your right properly and post us in the address mentioned in the form. Please mention "DREAM SUBSCRIPTION FORM" on the envelop.
- Please attach Cheque/DD/MO in favour of VIGYAN PRASAR with the subscription form.
- You can also fill the subscription form online and can pay online. For online submission of subscription form, please visit [www.vigyanprasar.gov.in](http://www.vigyanprasar.gov.in)
- For Institutional subscription, please write Name of Institution in place of subscriber's name and use seal of your institution below signature.
- Without renewal of subscription and payment of amount, delivery of Dream 2047 will be suspended from April, 2020.

**Contact us:** [dream@vigyanprasar.gov.in](mailto:dream@vigyanprasar.gov.in)

**PLEASE FILL IN BLOCK LETTERS:**

Name:

Address:

State:  Phone No.

Pin:  E-mail:

Subscription No.

(Only for change of address request)

I would like to receive below version of DREAM 2047  Print  Electronic

I want to subscribe DREAM 2047 for

	<input type="checkbox"/> 1yr.	<input type="checkbox"/> 2yrs.	<input type="checkbox"/> 3yrs.	<input type="checkbox"/> 5yrs.
Print Version	1 yr. (12 issues) <b>Rs. 200/-</b>	2 yr. (24 issues) <b>Rs. 350/-</b>	3 yr. (36 issues) <b>Rs. 420/-</b>	5 yr. (60 issues) <b>Rs. 500/-</b>
	1 yr. (12 issues) <b>Rs. 100/-</b>	2 yr. (24 issues) <b>Rs. 175/-</b>	3 yr. (36 issues) <b>Rs. 210/-</b>	5 yr. (60 issues) <b>Rs. 250/-</b>

I am attaching herewith Cheque/DD/MO no

Dated  Amount Rs.

Date:

Place:  Signature:

Designation:

(if request is on behalf of an institution)

SUBSCRIPTION FORM

# INBOX

## Dangerous chemicals !!!

We recently received the March (Holi Special) issue of the magazine, Dream 2047. It was really nice going through the Editorial and learn about the Quantum Computing. People like me, who are interested in Physics, will wait for such fast computers and new developments.

The cover story on natural colours was also informative. We have been using beetroot for making red water colour for few years now and also use turmeric and khayer (Catechu) for such colours. Please publish something on natural food colouring agents or spices that are free of chemical and adulteration.

Hitesh Kumar, *Class XII; Faridabad*

## Coronavirus outbreak

The story on Coronavirus was timely and informative. We have used the WHO posters in our school to inform everyone on the precautions to be used. It has now spread to India as well. I have a question. If someone has been infected once by the virus and has recovered from it, will he or she again be susceptible to the virus within sometime, say after a month or so?

Jessy Ismail, *Palakkad*

**Dream Editorial:** Once a person is infected by any bacteria or virus, body develops two types of immunity against the infection-causing agents: one is in immediate response to it,

which helps in clearing the infection within a particular time period (say, 7 days); and the other will be in the form of memory immune response.

So, a person who has recovered from any viral/bacterial infection, say Coronavirus, the person is again susceptible to infection, but this time the body will respond immediately (say two days) and protect it from the ill effects of the infectious agent. For example, in the case of polio virus or small pox, people are vaccinated with same but less infectious agent (heat killed bacteria/virus) to develop a memory immune response. This comes into play whenever the same infection occurs in future.

## REQUEST TO THE AUTHOR

Science writers, and scientists, science communicators, doctors, journalists, teachers and researchers interested in popular science writing, are requested to send their articles for publication in Dream 2047 in 1500 to 2000 words in English or Hindi language. Also send high resolution images along with the article. Your articles can be based on the latest research in the field of science and technology, history of science, health and medicine, agriculture, energy, water, interviews with eminent scientists and working of science laboratories. Suggestions, feedback and letters from authors and readers are welcome. Please don't forget to attach your photograph along with your articles or letters/feedback. You can contact us by email: [dream@vigyanprasar.gov.in](mailto:dream@vigyanprasar.gov.in)

GET YOUR SUBSCRIPTION NOW

# DREAM 2047

Rs. 20 PER ISSUE

APRIL 2020 ONWARDS

## MOBILE PHONES MAY TRANSMIT NOVEL HUMAN CORONAVIRUS (COVID-19)

**I**N THE WAKE OF CORONAVIRUS SPREAD, IT HAS BEEN advised to keep our hands clean and not touching mouth, nose, eyes and ears. But our hands aren't the only things that touch our face. What about our phone? In a day, how many times we touch our phone?

Transmission of novel coronavirus to persons from contaminated surfaces has been reported. Though the transmission in general occurs much more commonly through respiratory droplets than through contact with contaminated surfaces, current research suggests that the virus may remain active for days on surfaces made of glass (mobile screen), plastic, cloth and paper. Cleaning of visibly dirty surfaces followed by disinfection is the best way to prevent spreading of it and other viral respiratory illnesses.

Phone is also a principle source of transmission among healthcare providers within the hospitals.

- 1 <https://qz.com/1810508/covid-19-can-likely-live-up-to-96-hours-on-your-phone/>
- 2 <https://www.theverge.com/2020/3/4/21163613/coronavir-smartphone-germs-disinfect-apple-google>
- 3 Kampf, G., Todt, D., Pfaender, S., & Steinmann, E. (2020). Persistence of coronaviruses on inanimate surfaces and its inactivation with biocidal agents. *Journal of Hospital Infection*.
- 4 <https://www.mdedge.com/idpractitioner/article/111734/hospital-acquired-infections/vires-mobile-phones>

Sandhya Jha, Consultant, Vigyan Prasar  
Email: [emailtosandhyajha@gmail.com](mailto:emailtosandhyajha@gmail.com)