



DREAM 2047

July 2013

Vol. 15

No. 10

Rs. 5.00

Math
2013
Mathematics of Planet Earth

Puzzles and paradoxes

Maria Goeppert-Mayer
The Second Woman Nobel
Laureate in Physics



(1906-1972)

**Editorial: Some important facets
of Science Communications** 35

**Maria Goeppert-Mayer: The
Second Woman Nobel Laureate
in Physics** 34

Puzzles and paradoxes 31

**Radhanath Sikdar: First
Scientist of Modern India** 28

**Surgical Options for a Benign
Prostate Enlargement** 25

**Recent developments
in science and technology** 22

VP News 19

Some important facets of Science Communications



Dr. R. Gopichandran

A recent White Paper by Hampson (2012)¹ presents an insightful analysis of the process and impacts of science communication. The author indicates that the faith of the public in science is modulated by the process and outcome of communicating science, with significant importance attributed to understanding the needs and expectations from science by communities. Hampson also highlights the need to improve communication through systematic and logical guidance to institutions to deliver appropriately. This deficit also negatively impacts engagement amongst stakeholders. This results in restricted access to information and consequent loss of opportunities with implications for development. This is probably due to inadequate understanding of the precise role of communication in science and the process of communicating science. Most importantly it is essential to establish links for conversation on options to tackle challenges and understand the optimal mix of communication interventions.

The second facet of science communication is to ensure its effectiveness through consistency and timely delivery. The third and mutually reinforcing facet is the ability to communicate without even inadvertently tweaking the message or its implications; yet in a persuasive manner. This calls for a comprehensive understanding of the content and of the preparedness communities to receive information. Hampson cites Nisbet to reinforce the fact that science communication should strengthen engagement with communities in order to empower, enable and motivate.

Two related aspects of science communication that can strengthen initiatives are the formation of communities of communicators and providing tools and technical assistance for efficient performance. This framework is embedded in the initiatives of the National Science Communication Institute (nSCI), a US-based non-profit organisation.

The report of the British Science Association (IMPACT-Science Communication Conference 2012)² highlights the need for a comprehensive understanding of the process and outcome of science communication with special reference to public engagement. Such interactive processes as science festivals, other

forums for coming together including informal settings appear to help fulfil communication goals. These are also directly relevant to informal yet conducive learning environment in rural areas of India and hence the opportunity to further strengthen such interactions.

Bultitude (2011)³ presents an excellent overview of the “Why and how of Science Communication” with special reference to the motivation to cater to specific needs of the end users of the information. She refers to the utilitarian, economic, cultural and democratic motivations characteristic of the needs of the end users. It is important to recognise the possibility that these could predominate individually or synergistically within populations; thereby calling for need based communication strategies.

These insights are important to help design integrated and inclusive communication strategies duly recognising the potential for synergies across various missions of governments and related institutions. These synergies could pertain to this spread and depth of messages and tools of communication to optimise on the outreach.

References

1. Hampson G (2012) White Paper, Science Communication Today; National Science Communication Institution 17P <http://nationalscience.org/wp-content/uploads/2012/04/science-communication-today.pdf>
2. British Science Association (2012) IMPACT-Science Communication Conference, Report 48P http://www.britishtscienceassociation.org/sites/default/files/root/SCC%20Report_Final_Draft.pdf
3. Bultitude K (2011), The Why and How of Science Communication. 18P In Rosulek P, Ed., “Science Communication”. Pilsen: European Commission. http://www.ucl.ac.uk/sts/staff/bultitude/KB_TB/Karen_bultitude_-_Science_communication_why_and_how.pdf

Editor : Subodh Mahanti
Associate editor : Rintu Nath
Production : Manish Mohan Gore and Pradeep Kumar
Expert member : Biman Basu
Address for correspondence : Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi-110 016
 Tel : 011-26967532; Fax : 0120-2404437
 e-mail : info@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 Dr. Subodh Mahanti on behalf of Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi - 110 016 and Printed at Aravali Printers & Publishers Pvt. Ltd., W-30, Okhla Industrial Area, Phase-II, New Delhi-110 020
 Phone: 011-26388830-32.

Maria Goeppert-Mayer

The Second Woman Nobel Laureate in Physics



Dr. Subodh Mahanti

E-mail: smahanti@vigyanprasar.gov.in

“Mathematics began to seem too much like puzzle solving. Physics is puzzle solving, too, but of puzzles created by nature, not by the mind of man.”

Maria Goeppert-Mayer

“In 1963 she (Goeppert-Mayer) was awarded the Nobel Prize for Physics together with the German physicist Johannes Jensen (1907-73) and Eugene P Wigner for their work on nuclear shell theory. The shell theory of the nucleus is analogous to the shell model of the atom. The theory could help explain why some nuclei were particularly stable and possessed an unusual number of stable isotopes.”

A Dictionary of Scientists, Oxford University Press, 1999.

Maria Goeppert-Mayer was the second woman after Marie Curie to win the Nobel Prize in Physics (1963). It may be noted that Marie Curie received the Nobel Prize in Physics sixty years before Goeppert-Mayer. She happened to be the third woman to receive the Nobel Prize in a science category after Marie Curie (Physics, 1903) and Gert Radnitz Cori (Physiology or Medicine, 1947). Goeppert-Mayer was awarded the Nobel Prize for her work on nuclear shell model. Nuclear shell model is a model in which nucleons (protons and neutrons) are assumed to move under the influence of a central field in shells that are analogous to atomic electron shells. The model successfully explained the unusual stability of certain nuclei. Her prediction of multi-photon excitation processes in her doctoral thesis is viewed as a precursor to the development of multi-photon excitation microscopy. Significantly, it was only at the age of 53 that she could get a full-time salaried academic position.

Maria Goeppert-Mayer was born on 28 June 1906 at Kattowitz, Upper Silesia (then part of Germany, now in Poland). Her parents were Friedrich Goeppert and Maria Goeppert (nee Wolff). She was the only child of her parents. She was greatly influenced by her father who advised her at the early age: “Don’t grow up to be woman”; or in other words he advised her to strive to be ‘more than a housewife.’ Barry R. Masters, commenting on the influence of Maria’s father on her, wrote: “As we all know, the influence of parents on children is paramount, and this fundamental truth



Maria Goeppert-Mayer

is nowhere better illustrated than by the life of Maria Goeppert-Mayer. She was proud of her heritage which was linked, on her father’s side, to seven generations of professors. Her father instilled a strong feeling of high self-esteem in the young Maria, and encouraged experimentation, discovery, and wonder at the natural world—all critical to the formation of a scientist.”

In 1910, the Goeppert family moved to Gottingen, where her father became Professor of Paediatrics at the Georgia Augusta University (better known as “Gottingen University” or simply as Gottingen).

In those days in Germany there were no public funded institutions which

admitted girls for preparing for the examination called *Abitur*, which had to be passed by any student aspiring to attend a German University. So Maria joined a private school for girls called *Fraenstudium* run by suffragettes. However, the school was closed down because of financial problems after one year of Maria’s admission. Though Maria could not complete the preparatory course, she appeared for the entrance examination and passed it. She enrolled at Gottingen University in 1924. Gottingen University was one of the most excellent centres of scientific research in the world, particularly in physics and mathematics. At the time Maria joined Gottingen University, among the eminent physicists and mathematicians in the faculty were David Hilbert (1862-1943), Max Born (1882-1970), James Franck (1882-1964), Richard Courant (1888-1972), Hermann Weyl (1885-1955), Gustav Herglotz (1881-1953), and Edmund Landau (1877-1938). These highly accomplished physicists and mathematicians attracted the best minds from all over the world to Gottingen. During her stay at Gottingen, Goeppert-Mayer met and came to know Arthur Holly Compton (1892-1962), Max Delbruck (1906-1981), Paul A. M. Dirac (1902-1984), Enrico Fermi (1901-1954), Werner Heisenberg (1901-1976), John von Neumann (1903-1957), J. Robert Oppenheimer (1904-1967), Wolfgang Pauli (1900-1958), Linus Pauling (1901-1994), Leo Szilard (1898-1964), Edward Teller (1903-2003), and Victor Weisskopf (1908-2002).

Maria’s early interest was in mathematics. It is possible that she was

inspired by the great German mathematician David Hilbert, who was a family friend. However, in 1927 after attending seminars of Max Born, she moved towards theoretical physics. She started working with Max Born, who also happened to be a family friend. Among Born's students were Fermi, Oppenheimer, Dirac, and von Neuman. Maria received her doctorate degree in 1930. Her doctoral thesis was on the theoretical treatment of double photon processes. Eugene Paul Wigner (1902-1995), the Hungarian-American theoretical physicist and mathematician, termed her thesis as a "masterpiece of clarity and concreteness." Her theoretical predictions could not be confirmed experimentally until the development of the laser in the 1960s. In fact two-photon absorption processes were experimentally verified 32 years after she made the prediction. To honour her fundamental contribution to this area, the unit for the two-photon absorption cross section is named the Goeppert-Mayer (GM) unit.

Maria married Joseph Edward Mayer (1904-1983), the American physical chemist, who had come to Gottingen to work with James Franck on a Rockefeller Foundation scholarship. After her marriage she adopted the surname of Goeppert-Mayer. She moved with her husband to Baltimore, Maryland, USA where her husband joined the Chemistry Department of Johns Hopkins University. Goeppert-Mayer could not secure a normal professional appointment. This was the period of acute Depression and so job opportunity was extremely limited. Moreover the prevailing stringent Anti-Nepotism rules (the summary of which was 'do not hire a relative of an employee') prevented her from being considered for a regular position at the Johns Hopkins University, as her husband was holding a regular position there. Gender bias was another factor. She managed to get some kind of an assistantship without any salary, which enabled her access



Max Born

to the university facilities and a place to work in the physics department. She felt encouraged to participate in the scientific activities of the university. She was also able to teach graduate students towards the later part of her assignment. Commenting on her teaching, Robert G. Sachs wrote: "When she had the opportunity to teach graduate courses, her lectures were well organised, very technical, and highly condensed. She spent little time on background matters or physical interpretation. Her facility with the methods of theoretical physics was overwhelming to most of the graduate students, in whom she inspired a considerable amount of awe."



James Franck

Maria could manage to co-author a number research papers with Karl Herzfeld of the physics department in the areas of kinetic theory, thermodynamics and chemical physics. She also interacted with the faculty members of the mathematics department. During her summer visits to Gottingen (1931, 1932, and 1933), Goeppert-Mayer worked with her former teacher, Max Born. They jointly wrote a review article on 'Dynamische Gittertheorie der Kristalle' (Dynamic Theory of Crystal Lattices) for the famous encyclopaedia of physics, *Handbuch der Physik*. She interacted with Edward Teller (1908-2003), the Hungarian-born American physicist, who was then working in George Washington University in nearby Washington, DC. Teller is regarded as the father of the hydrogen bomb. Maria also collaborated with her husband in writing the book, *Statistical Mechanics*, which was published in 1940.



Enrico Fermi

Goeppert-Mayer could not get any regular academic position when her husband moved to Columbia University and then to Chicago University. But she was able to keep herself engaged in scientific activities. She taught part-time at Sarah Lawrence College in New York. She worked in different project initiated at the Columbia University. One of these projects was headed by the American physical chemist Harold Urey (1893-1981). The objective of this project was to separate uranium 235 (U-235) from natural uranium. This project later came to be known as Columbia University's 'Substitute Alloy Materials Project'. It may be noted that natural uranium contains only about 0.7% U-235; the rest being U-238. Goeppert-Mayer studied the thermodynamic properties of the uranium hexafluoride (UF_6) gas. They were trying to develop a method for separating isotopes by photochemical reaction. They did not succeed in developing a practical method. This possibility opened up only after the invention of laser. Another project in which she worked was the 'Opacity Project', an investigation of matter and radiation at high temperature as part of the development of the hydrogen bomb. It was headed by Edward Teller. She also worked at the Los Alamos Laboratory in New Mexico for some time. She could also work with Enrico Fermi, who had left Italy on the eve of the outbreak of the Second World War. On the advice of Fermi, Maria worked out the electronic structure of the transuranium elements, which were yet to be discovered and reached the conclusion that these elements would constitute a new rare-earth series of elements. Her prediction turned out to be correct.



Joseph Edward Mayer



Harold Urey

when her husband moved to Columbia University and then to Chicago University. But she was able to keep herself engaged in scientific activities. She taught part-time at Sarah Lawrence College in New York. She worked in different project initiated at the Columbia University. One of these projects was headed by the American physical chemist Harold Urey (1893-1981). The objective of this project was to separate uranium 235 (U-235) from natural uranium. This project later came to be known as Columbia University's 'Substitute Alloy Materials Project'.

It may be noted that natural uranium contains only about 0.7% U-235; the rest being U-238. Goeppert-Mayer studied the thermodynamic properties of the uranium hexafluoride (UF_6) gas. They were trying to develop a method for separating isotopes by photochemical reaction. They did not succeed in developing a practical method. This possibility opened up only after the invention of laser. Another project in which she worked was the 'Opacity Project', an investigation of matter and radiation at high temperature as part of the development of the hydrogen bomb. It was headed by Edward Teller. She also worked at the Los Alamos Laboratory in New Mexico for some time. She could also work with Enrico Fermi, who had left Italy on the eve of the outbreak of the Second World War. On the advice of Fermi, Maria worked out the electronic structure of the transuranium elements, which were yet to be discovered and reached the conclusion that these elements would constitute a new rare-earth series of elements. Her prediction turned out to be correct.



K. F. Herzfeld

as part of the development of the hydrogen bomb. It was headed by Edward Teller. She also worked at the Los Alamos Laboratory in New Mexico for some time. She could also work with Enrico Fermi, who had left Italy on the eve of the outbreak of the Second World War. On the advice of Fermi, Maria worked out the electronic structure of the transuranium elements, which were yet to be discovered and reached the conclusion that these elements would constitute a new rare-earth series of elements. Her prediction turned out to be correct.



Edward Teller

Goeppert-Mayer worked as a Voluntary Associate Professor of Physics at the Chicago University. She could get a part-time assignment as a Senior Physicist in the Theoretical Physics Division of the Argonne National Laboratory established at Lemont, Illinois near Chicago in 1946. It was during her stay at Chicago and Argonne

that she developed a mathematical model for the structure of nuclear shell for which she was awarded the Nobel Prize in Physics in 1963.

Finally she got a regular academic position when she was appointed as a full Professor of Physics at the University of California at San Diego in 1960, where her husband was also appointed as Professor. However, soon after her appointment at San Diego, Goeppert-Mayer suffered a stroke and she was unable to use fully use one arm. She never recovered fully. But she continued her teaching and research.

Goeppert-Mayer's nuclear shell model explained why certain numbers of nucleons (protons or neutrons) in an atomic nucleus result in particularly stable configurations. These numbers are usually called 'magic numbers'. The existence of magic numbers was noticed by Goeppert-Mayer during her analysis of the data on the abundance of elements while working with Teller on his cosmological model of the origin of the chemical elements. She was

not the first to notice the existence of magic number. Walter Maurice Elasser (1904-1991), a French physicist, had noticed it in 1933. However, she dealt with extensive data and more nuclei. It dawned on her that to explain the magic numbers it may be assumed that nucleons move independently in shells like electrons move in an atom. She saw the analogy with electron shell structure. But even after assuming that the nucleons move in individual orbits determined by their orbital momenta she could not explain the magic numbers. At this juncture the clue of 'spin-orbit' coupling given by Fermi made her realise how she could explain the magic numbers. After this she worked out a complete shell model for atomic nuclei in which spin-orbit coupling predicted precisely the 'magic number' stable nuclei actually observed. She concluded that the nucleus is a series of closed shells, and pairs of neutrons and protons tend to couple together in what is called spin-orbit coupling. Spin-orbit coupling is any interaction of a particle's spin with its motion. The magic numbers describe nuclei in which certain key nucleon shells are complete. The magic numbers for both protons and neutrons are 2, 8, 20,



David Hilbert

28, 50 and 82. For neutrons 126 and 184 are also magic numbers and for proton 114 is a magic number.

Commenting on magic numbers Goeppert-Mayer in her Nobel Lecture said: "One of the main nuclear features which led to the development of the shell structure is the existence of what are usually called the magic numbers. That such numbers exist was first remarked by Elasser in 1933. What makes a number magic is that a configuration of a magic number of neutrons, or of protons, is unusually stable whatever the associated number of the other nucleons. When Teller and I worked on a paper on the origin of elements, I stumbled over the magic numbers. We found that there were a few nuclei which had a greater isotopic as well as cosmic abundance than our theory or any other reasonable continuum theory could possibly explain. Then I found that those nuclei had something in common: they either had 82 neutrons, whatever the associated



J. Hans D. Jensen

proton number, or 50 neutrons. Eighty-two and fifty are 'magic' numbers. That nuclei of this type are unusually abundant indicates that the excess stability have played a part in the process of the creation of elements."

Goeppert-Mayer was not the only person who discovered the nuclear shell model. As A. Banerjee wrote: "Maria Mayer was not alone in discovering the shell model of the nucleus. On the other side of the Atlantic, J. Hans D. Jensen, working with his colleagues O.Haxel and H. E.Suess in Heidelberg (Germany) had come to an identical conclusion about the shell structure. Mayer and Jensen were not acquainted at that time. They met for the first time in 1950 when she visited Germany. The two became good friends and collaborated in writing the book *Elementary Theory of Nuclear Shell Structure*, published in 1955."

Goeppert-Mayer shared the 1963 Nobel Prize for Physics with J. Hans D. Jensen and Eugene Paul Wigner. She was elected a member of the National Academy of Sciences, USA and a corresponding member of the Akademie der Wissenschaften in Heidelberg, Germany.

Goeppert-Mayer died on 20 February

1972 at San Diego. Her last research paper was published in 1966. It was a review paper on the nuclear shell model jointly written with Hans Jensen.

The American Physical Society has instituted an award in honour of Goeppert-Mayer 'to recognise and enhance outstanding achievement by a woman physicist in the early years of her career, and to provide opportunities for her to present these achievements to others through public lectures in the spirit of Maria Goeppert-Mayer.' The University of Chicago has instituted an annual award in her memory to honour an outstanding woman scientist or engineer. The University of California, San Diego organises an annual Maria Goeppert-Mayer Symposium where woman researchers discuss current science. Maria Goeppert-Mayer featured on the third volume of the American scientists' collection of US postage stamps (2011), along with Melvin Calvin, AsaGray, and Severo Ochoa. A crater on Venus has been named after Goeppert-Mayer.

References

1. Banerjee, B., "Maria Goeppert Mayer", *Resonance*, pp. 6-11, December 2007.
2. Goeppert-Mayer, Maria, "The Shell Model", Nobel Lecture, 12 December 1963.
3. Masters, Barry R., "The Scientific Life of Maria Goeppert-Mayer", *Optics & Photonics News*, September 2000.
4. Moeckly, S. R., "The Life and Work of Maria Goeppert-Mayer", *Augustana Chemistry* 381-Spring 2000 (Available on the Internet).
5. Sachs, Robert G., "Maria Goeppert Mayer 1906-1972: A Biographical Memoir" in *Biographical Memoirs*, Vol.50, Washington DC: National Academy of Sciences, 1979.
6. Available sources on the Internet.

(The article is a popular presentation of the important points on the life and work of Maria Goeppert-Mayer in the existing literature. The idea is to inspire the younger generation to know about Goeppert-Mayer. The sources consulted for writing this article have been listed. However, the sources on the Internet have not been individually listed. The author is grateful to all those authors whose writings have contributed to writing this article. The author is also grateful to the sources from which the illustrations/photographs have been reproduced.)

Puzzles and paradoxes



Rintu Nath

E-mail: math@vigyanprasar.gov.in

Last time I was reading the book on 'Cabinet of Mathematical Curiosities', by Professor Ian Stewart. After finishing it, I got more interested in mathematical puzzles and was intrigued by their elegance and beauty. It was therefore inevitable that mathematical puzzles came up as a topic whenever I spoke with my uncle in recent times.

To stimulate my mathematical mind, uncle opened up several mathematical puzzles for me.

'Ravi bought a used mobile phone for Rs. 900 and put it on sale at Rs. 1,900. A buyer came and bought the mobile by paying a bearer's cheque. However, due to mistake the buyer wrote Rs. 2,000 in the cheque and that was the last cheque in his chequebook. Ravi did not have any money with him. So he requested his friend Hari to give him Rs. 2,000 in cash and in return gave Hari the cheque to get encashed. Ravi returned Rs. 100 to the buyer. However, the cheque was dishonoured and Ravi had to pay back Rs. 2,000 to Hari. Now Ravi is saying he has lost Rs. 4,000 in the whole transaction, which includes Rs. 900, the price of the mobile phone, Rs. 1,000 profit on the mobile phone, Rs. 2,000 which he had to pay to Hari and Rs. 100 which he paid to the buyer. Googol, do you think that Ravi actually lost Rs. 4,000?' Uncle asked me.

'If we take into account the total loss in the business that Ravi could have made, then he had actually lost Rs. 2,000. He had bought the mobile phone for Rs. 900, wanted a profit of Rs. 1,000 on it and had paid the buyer Rs. 100. Although Ravi had paid Hari Rs. 2,000 when the cheque was dishonoured, actually he had already received the same amount in cash from Hari previously,' I answered.

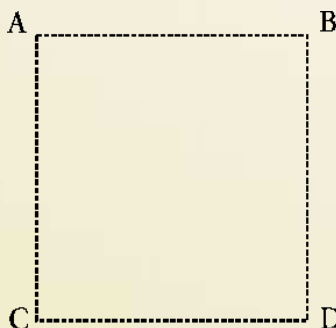
'You've got the logic correctly, Googol. Let me ask you another similar problem. Ravi bought two bicycles and sold both at Rs. 300. He made a loss of 25% on the first

bicycle and profit of 25% on the second one. Overall, did he break even? If not, did he make a profit or loss and by how much?' uncle asked.

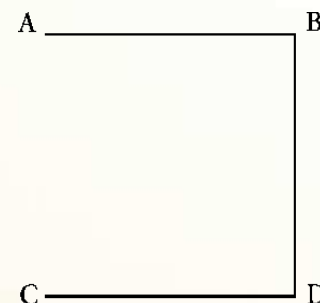
'I can solve this one too. In the first case, a loss of 25% means that if Ravi bought the bicycle for Rs. 100 then he sold it for Rs. 75. Following simple arithmetic, it is obvious that he bought the bicycle at Rs. 400 and sold at Rs. 300, therefore, his loss is 25%. In the second case, a profit of 25% means that Ravi bought it for Rs. 240 and sold it for Rs. 300 with a gain of 25%. So, he paid a total of Rs. 400 + Rs. 240 = Rs. 640 for buying two bicycles. He sold the two bicycles at Rs. 300 + Rs. 300 = Rs. 600. Therefore he lost Rs. 40,' I answered.

'You got it right. Here is another one for you. Four towns - A, B, C and D - they all lie at the corners of a square of side 100 km. Roads need to be constructed to connect them all using the shortest possible network of roads. Can you suggest a possible solution where the length of the road would be minimum?' uncle wanted to know.

'We can construct straight roads connecting A to B, B to C and C to D. That will be 300 km of road,' I said.



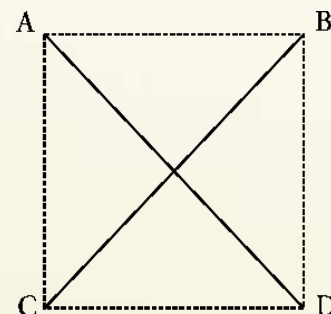
'We can do better than that. If we construct the two diagonals connecting four points the length of the constructed road will be less than 300 km. Using Pythagoras theorems,



$$AD^2 = AC^2 + CD^2$$

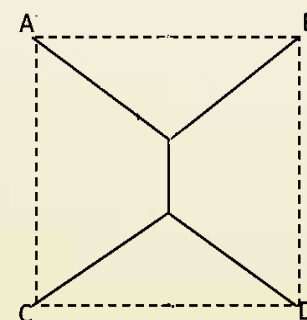
$$AD = \sqrt{AC^2 + CD^2} = \sqrt{100^2 + 100^2} = 100\sqrt{2} \text{ km} = BC$$

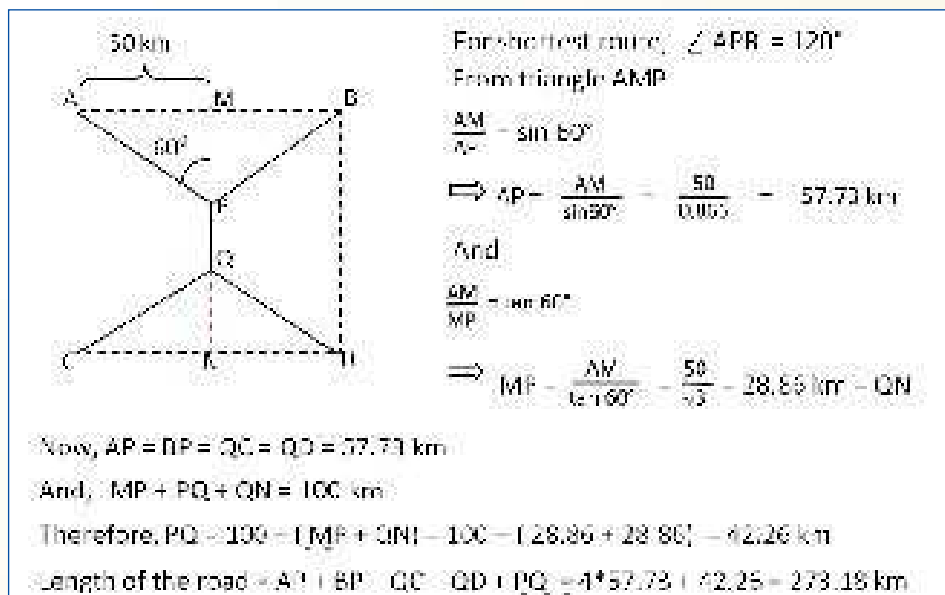
Therefore $AD + BC = 200\sqrt{2} \text{ km}$, which is about 282 km. However, a still better solution exists! Do you have any suggestions, Googol?' uncle asked.



Please help. I can't think any other solution that will be even better than two diagonals!

'Yes. It is possible to construct road network connecting all the four points A, B, C and D. The idea is to construct minimum road network. A single road PQ may be constructed that will reach nearest of all four

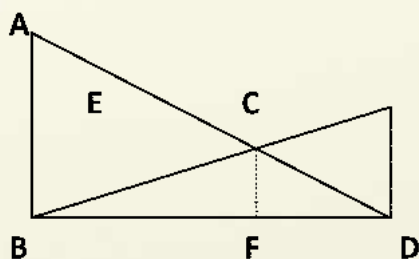




towns A, B, C and D. From points P and Q, two roads each need to be constructed to reach each destination.

'Let's talk about another puzzle. Two straight lines AB and CD are 6 cm and 4 cm long and are separated by some distance. If we draw a line connecting A with D and C with B, they intersect at a point E. Draw a perpendicular line EF on BD. Can you calculate the length of EF?' uncle asked.

'But uncle, without knowing the distance between B and D, how can it be solved?' I wanted to know.



'Well, triangle ABD and triangle EFD are similar.

$$\text{Therefore, } \frac{BD}{AB} = \frac{FD}{EF}$$

Similarly triangle CDB and triangle EFB are similar.

$$\text{Therefore, } \frac{BD}{CD} = \frac{BF}{EF}$$

$$\text{Therefore, } \frac{BD}{AB} + \frac{BD}{CD} = \frac{FD}{EF} + \frac{BF}{EF}$$

$$BD \left\{ \frac{1}{AB} + \frac{1}{CD} \right\} = \frac{1}{EF} \{ FD + BF \} = \frac{1}{EF} (BD)$$

$$\text{Therefore, } \frac{1}{AB} + \frac{1}{CD} = \frac{1}{EF}$$

$$\text{Therefore, } EF = \frac{AB \times CD}{AB + CD}$$

You can note Googol that the

separation between AB and CD is not required for calculating EF' uncle replied.

'That's fascinating uncle! Give me another puzzle please.'



'Three identical looking boxes are filled with equal number of balls, one has red, one has green and the third has red and green mixed. However, all stickers on the boxes are wrongly placed. You can take out only one ball from any of the three boxes to check the colour and re-arrange all the stickers correctly. How will you do it?' uncle asked.

'Let me try this one. I will take one ball from the box marked as Red and Green. As stickers are wrongly marked, this box definitely will not have balls of both colours. If I get a red ball, I will put red sticker in this box. Then I will simply interchange stickers of the other two boxes.' I replied.

'Good Googol. Now let me tell you a famous mathematical paradox. Protagoras was a Greek

lawyer who lived and taught in the fifth century BC. He had a student, and it was agreed that the student would pay for his teaching after he had won his first case. But the student didn't get any client, and eventually Protagoras threatened to sue him. Protagoras reckoned that he would win either way: if the court upheld his case, the student would be required to pay up, but if Protagoras lost, then as per their agreement, the student would have to pay, as the student will be winning his first case. However, the student thought the other way: if Protagoras won, as per the agreement he did not have to pay, as he will pay only when he wins his first case. And if Protagoras lost, the court will rule anyway that the student did not have to pay! Now tell me Googol, who was right, Protagoras or his student, or it is a pure paradox which does not have one single answer.' Uncle said with a smile.

'Both Protagoras and his student seem to be logical. However, if the court orders that the student has to pay, do the student

has any option of not paying the fees?' I wanted to reason out.

'Well, it seems that the court order can actually overrule the original agreement. However, even if we consider purely on a mathematical perspective, there is a fault in the logic of student's argument. If Protagoras lost, the student wins. Therefore as per the original agreement he actually wins his first case and has to pay to Protagoras. Here, the student is using both mathematical logic and court ruling to his advantage.' Uncle explained.

'Mathematical paradoxes are always very fascinating. Please tell me about some more paradoxes.'

'A mathematical paradox is always very interesting as it appears to be false but is actually true, or it appears to be true when actually it is

A mathematical paradox is always very interesting as it appears to be false but is actually true, or it appears to be true when actually it is self-contradicting.

false, or sometimes it is self-contradicting. Let me tell you about one very old self-contradicting paradox, known as 'paradox of the liar'. This paradox is believed to have been told by Greek poet Epimenides in 6th century B.C. Epimenides is supposed to have made his famous remark "All Cretans are liars." Apparently, there is nothing wrong with the statement. However, Epimenides himself was a Cretan. If Epimenides is telling the truth, he is lying, as he is a Cretan. On the other hand, if he is lying, he is telling the truth. This makes the statement self-contradicting.'

'Uncle, I have heard about Zeno's paradox. Will you please explain?'

'The paradox is about travelling from one point to another. It is known as *Zeno's first paradox*. Zeno (490–430 BC) was a Greek philosopher and created a set of philosophical problems. Zeno's first paradox purports to show that any motion is impossible, because if you want to walk from one point to another you must first cross half the distance, then half the remaining distance, then half the remainder and so on. For example, if the two points are one kilometre apart you will first reach 1/2 km from start, then 3/4 km from start then 7/8 km and go on. After you have taken N steps of the journey you will cross a distance equal to $(1 - 1/2^N)$ km. No matter how big the N is, you will never reach your destination, and there will always be some distance left. Therefore Zeno stated that the motion is nothing but an illusion.'

'Uncle, I am quite fascinated by mathematical puzzles and paradoxes. Thanks very much for illuminating me with those entertaining puzzles and paradoxes.'

VP website



www.vigyanprasar.gov.in

Recent Publications of Vigyan Prasar

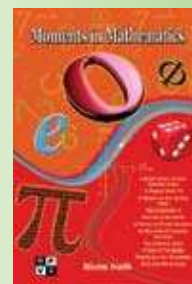
Moments in Mathematics

Author: Rintu Nath

ISBN: 978-81-7480-224-8

Price: 110/-

We encounter mathematics in our everyday life in different forms. It also plays a predominant role in an overall development of the society. An understanding and appreciation of mathematics is therefore an essential life skill. While it helps solve many real-life problems, it makes it possible to develop a logical thinking process. The concepts of mathematics are unravelled through a conversation between young Googol and his uncle, who explains intricacies of mathematical issues in this book and motivates him to ask more questions. The conversation is often witty and unfolds the mystical and the wonderful world of mathematics in an entertaining style. This book will take the reader to the beautiful and mesmerising world of mathematics.



Mars Beckons India: The Story of India's Mission to Mars

Author: Srinivas Laxman

ISBN 978-81-7480-225-5

Price: ₹ 175/-

India is slated to launch an unmanned mission to Mars by October-November 2013, and currently preparations are in full swing for this flight at various ISRO centres. The book is basically an exercise in public outreach about this mission and attempts to explain to the reader, the significance about this project. It contains interviews with some of the key personnel connected with this programme.

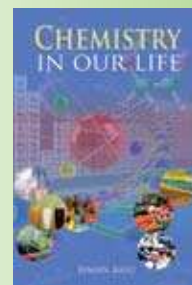
Chemistry in Our Life

Author: Biman Basu

ISBN : 978817482216-3

Price: ₹ 150/-

Although most of us don't realise it, chemistry is all around us. Right from the moment we get up in the morning till we go to bed at night, we come intimately close to chemistry and things related to it. A world without chemistry would be a world without cooking gas, beautiful dyes, or synthetic materials and many others. This book presents a few examples to bring out the magic inherent in chemistry, as visible in the colours of nature, the taste and flavour of foods, the healing power of medicines, the sparkle of festival fireworks, and the multitude of industrial processes that would be impossible without chemistry.



Chinu Visits Microworld

Author Dr. Yeshwant R. Waghmare

ISBN 978-81-7480-213-2

Price: ₹ 150/-

The author has made an attempt to explain some interesting phenomena, such as variety of colours that we see in nature, and why and how they occur. It is pointed out in this book that all phenomena that we see in nature arise from the interactions of atoms and molecules of various species; and their combinations. The author takes the reader 'back in time' and allows interacting with them, and their inventors, through their representative

CHINU, a curious little girl at the school level.

For further information please write to:

Director, Vigyan Prasar

A-50, Institutional Area, Sector-62, NOIDA 201 309 (Uttar Pradesh), India

Phones: 0120-2404430-35 Fax: 91-120-2404437

E-mail: info@vigyanprasar.gov.in

Website: <http://www.vigyanprasar.gov.in>



Radhanath Sikdar

First Scientist of Modern India



Dr. Utpal Mukhopadhyay
E-mail: utpalsbv@gmail.com

In the first half of 19th century, a group of courageous young men of Bengal under the leadership of Henry Louis Vivian Derozio (1809-1831) fought against various social injustices and superstitions prevailing at that time. Radhanath Sikdar was the only person of this 'Young Bengal' group who acquired expertise in mathematics and physical sciences. Among the



Radhanath Sikdar

Derozians, Radhanath was a pioneer of scientific research in modern India. The bicentenary of this great Indian falls this year. The motivation of this article is to make the readers aware of this little-known but talented Indian and pay tribute to him.

Radhanath, son of Tituram Sikdar, was born in October 1813 (the date is unknown) at Jorasanko (famous as the birthplace of Rabindranath Tagore) in Calcutta (now Kolkata). Unfortunately, his mother's name has remained unknown till now. Radhanath was the eldest of two sons (younger son was Srinath) and three daughters of Tituram. Due to financial difficulties, both Radhanath and Srinath had to struggle hard for continuing their studies. However, being meritorious, both of them earned scholarships. Radhanath used to spend most of the money from his scholarship for purchasing books while the family was maintained largely by Srinath's scholarship. Radhanath received his primary education initially in a village school or *pathsala* and then in a school set up by a native Christian named Kamal Basu. In the year 1824, Radhanath entered of the Hindu College (now Presidency University) of Kolkata. In 1830, he started learning

mathematics from Professor John Tytler, a renowned professor of mathematics of Hindu College. In that year, Radhanath read first part of Newton's *Principia* under the guidance of professor Tytler. Incidentally, Radhanath Sikdar and Rajnarayan Basak were the first two Indians to go through *Principia*. Apart from that book, in the period between 1828 and

1832, Radhanath studied Euclid's *Elements*, Windhouse's *Analytical Geometry* and *Astronomy*, and Jephson's *Fluxion* for learning mathematics. As a college student, Radhanath devised a new method for drawing common tangent to two circles. This work of Radhanath was published as a research article in *Gleanings in Science* (vol. III, 1831) and the Editor of that journal commented: "A good deal having appeared in the public prints lately, respecting the Hindoo College, it may not be uninteresting to publish the accompanying solution of a geometrical problem by one of the pupils there, Radhanath Sikdar. The solution is altogether his own discovery, and I have not altered a word in his composition." (bold face by the author). This proved Radhanath's efficiency in mathematics since his early days. Apart



George Everest was a Welsh surveyor, geographer and Surveyor-General of India from 1830 to 1843. He was largely responsible for completing the section of the Great Trigonometric Survey of India along the meridian arc from the south of India extending north to Nepal, a distance of approximately 2,400 kilometres. (Credit: Royal Geographic Society)

service and move over to a place far away from Kolkata.

After studying seven years and ten months in Hindu College, without completing his studies, Radhanath joined the 'Great Trigonometric Survey of India' (GTS) on 19 December, 1831. Trigonometric Survey started its work from St. Thomas peak of Madras (present Chennai) in 1802. It was named as 'The Great Trigonometric Survey of India' from 1 January, 1818. Since then Sir George Everest (1790-1866) started working as an assistant of Colonel William Lambton (1753-1823), Director of GTS. Everest became Surveyor General of GTS in 1830. GTS was divided into two sections – Surveying Department and Calculating Department. Employees of surveying department used to send the results of their survey, done through observations and complex mathematics, to the calculating department for checking the accuracy of the results. So, efficiency in mathematics was a precondition for all the staff of the surveying department. Everest, the then Surveyor General of India, requested

Professor Tytler to send names of some persons who were expert in mathematics. Tytler recommended Radhanath's name. According to Jim Smith: "By the end of 1831 he had appointed eight Bengalese students as computers at an initial salary of Rs. 40 per month. Within a short while Radhanath, who had joined on 19 December 1831, had demonstrated that his mathematical ability was of a superior quality and he was appointed as a sub-assistant to GTS". Radhanath was the first Indian to join the survey department.

Radhanath started his duty of surveying at Barrackpore Trunk Road (the highway



Postage stamp honouring Henry Louis Vivian Derozio was issued in 2009. Derozio was an Indian poet and assistant headmaster of Hindu College, Kolkata, a radical thinker and one of the first Indian educators to disseminate Western learning and science among the young men of Bengal.

linking Kolkata with suburb Barrackpore), where he set up towers for survey work which exist till today. Then, in the year 1832, Radhanath started working with Everest in the Dehradun Circle. At that time, Everest was one of the world experts in the field of geodetic surveying. He introduced the Colby Bar System (or Compensating Bar System) in surveying for the first time in India. Earlier, high accuracy of measurements in surveying could not be maintained due to change in length of surveying chains in different seasons owing to variation in temperature. In the Colby Bar System, bimetallic rods made of iron and brass were used instead of chains so that change in the length of rod owing to temperature variation could compensate each other. Radhanath learnt many theoretical and practical aspects of surveying from Everest. He successfully applied the Colby Bar System and the use of chains in surveying was totally discarded in India. With the help of Radhanath, Everest surveyed 870 miles (more than 1400 km) of land starting from Bidar in Hyderabad to Pando of Mussouri. The result of this work was summarised by Everest in the famous book *An account of the measurements of two sections of meridional arc of India*. After publication of this book in 1847, Everest sent a copy of it to Radhanath where he wrote in his own hand – “Babu Radhanath in acknowledgement of his active participation in the survey”. It may be mentioned that Everest retired from service in 1843 and went back to England.

Everest held Radhanath's mathematical talent in high esteem. Radhanath was very efficient in applying basic rules of physics and mathematics according to necessity, often going beyond the traditional rules. Everest was very pleased with this quality of Radhanath's work. In



Postage stamp honouring Radhanath Sikdar, issued in 2004.

a letter to Tituram, dated 3 July, 1840 Everest wrote: “I wish I could have persuaded you to come to Dehra Dun for not only would it have given me the greatest pleasure to see you personally how much I honour you for having such a son as Radhanath, but you would yourself have, I am sure, been infinitely gratified at witnessing the high esteem in which he is held by his superiors and equals”.

Radhanath was promoted to the post of Chief Computer in Survey of India in 1851. As an employee of the survey department, the most remarkable achievement of Radhanath was the measurement of the height of peak XV (later named Mt. Everest) of the Himalaya. Andrew Waugh, the successor of Sir George Everest as Surveyor General, asked Radhanath to devise a formula for calculating the heights of the peaks of the Himalaya. From a distance of 150 miles (about 242 km), using a theodolite, Radhanath



William Lambton was the Superintendent of the Trigonometric Survey of India, which he began in 1802. (Credit: Royal Asiatic Society of Great Britain and Ireland)

collected necessary data for his work from six different locations. In 1852, according to Radhanath's calculation, the height of the peak turned out as 29,000 ft (8,839.20 m). But Radhanath took it as 29,002 ft (8,839.81 m) because the round figure (29,000 ft) might be misinterpreted as mere approximation.

Regarding this discovery, Kenneth Mason said in his lecture on ‘Himalayan Romances’: “It was during the computations of the northeastern observations that a babu rushed on one morning in 1852 into the room of Sir Andrew Waugh, the successor of Sir George Everest and exclaimed, ‘Sir, I have discovered the highest

mountain of the world’. He had been working out the observations taken to distant hills. It was Sir Andrew who proposed the name Mount Everest, and no local name has ever been found for it either in the Tibetan or the Nepalese side” (The Englishman, 12 November 1928, p. 17). According to C. R. Markham: “The mightiest of the Himalayan peaks are visible from the principal trigonometric stations of this series, and were fixed by measurements with the great theodolite. The heights of 79 peaks were fixed, of which 31 have names, and the rest only numbers. No. 15 peak,

the highest of all, 29,002 feet above the sea was well named by Colonel Waugh, after his old chief Mount Everest”. Of course there are some controversies regarding non-availability of local name for peak XV, but we are not going into that.

The news of this discovery was publicly announced in 1854. Great Indian scientist Professor Meghnad Saha has written about this discovery in ‘Progress of Physics in Past Twenty-five Years’ as: “In 1854, Radhanath Sikdar, the

head computer of Trigonometric Survey and an accomplished mathematician, found from mathematical reduction of the observations made some years earlier on an obscure-looking peak of the Himalayas, that this was actually the highest peak in the world”. It should be mentioned here that J. O. Nicholson, a surveyor who surveyed that region of the Himalayas during 1845 – 1850, first identified peak No. 15. However, Nicholson had no idea about the height of that peak. Then John Henesy used data of Nicholson, but he also could not calculate its height accurately. Radhanath, using altogether six readings (including those of Nicholson and Henesy) and applying intricate mathematical calculations, successfully determined the height of that peak. So, in true sense, all the three persons, viz., Nicholson, Henesy and Radhanath, had played some role in the discovery. But, since accurate calculations, physical interpretation, strong conclusion, etc., are essential parts of a scientific discovery, lion's share of the credit must go to Radhanath.

A hint of Radhanath's mathematical



Trigonometric Survey tower on B.T. Road, Kolkata. The inscription says, “G.T.S. Tower. This 75-ft brick tower was built in 1831 for the Great Trigonometric Survey conducted by George Everest, Superintendent of Great Trigonometric Survey and Surveyor General in charge of all topographical & revenue surveys.”



Radhanath Sikdar was the first to compute the height of Peak XV – the highest peak in the world, which was later named Mount Everest after George Everest.

ability can be found in the report presented on 15 April 1851 in the British Parliament regarding activities of the GTS where it is said: “A more loyal, zealous and energetic body of men than the sub-assistants forming the civil establishment of the survey department is no-where to be found and their attainments are highly creditable to the state of education in India. Among them may be mentioned as most conspicuous for ability, Babu Radhanath Sikdar, a native of India of Brahminical extraction whose mathematical attainments are of the highest order”. A second Indian survey team calculated the height of peak XV in 1855 by using the same technique and it turned out as 29,029 ft (8,848.04 m).

In 1929, the Meteorological Office was established in the premises of the Survey Office located at Park Street, Kolkata. A well-equipped meteorological observatory was set up there through effort of Sir George Everest. Apart from his normal duty as the Chief Computer of the survey department, in the year 1852 Radhanath took over the charge of Superintendent of the Meteorological Department as an additional duty. As soon as Radhanath assumed his post in the meteorological department, he started upgrading and modernising the activities of that department. For the first time, beginning December 1852, he made arrangements for daily weather forecast, which became very useful for the shipping companies. Due to Radhanath's effort, regular publication of observed data started since 1853. Those data were the first set of systematic meteorological data used for climatological work in India. Moreover, Radhanath devised a method for standardising the barometric

reading from raw data. The thermal expansion of the metallic scale attached to the barometer as well as the dilation of the mercury itself affect barometric readings. Formulae for nullifying those effects which were in vogue in Europe were unknown to Radhanath. So Radhanath, using his scientific insight, devised the formula on his own. In a research paper published in the *Journal of Asiatic Society of Bengal* in 1852, Radhanath presented his formula for reduction of

barometer reading at 32° Fahrenheit (0° Celsius). During the period 1857-1862 he was a member of the ‘Meteorology and Physical Science Committee’ of the department of meteorology. Some of his research papers were published in *Asiatic Researches*. Radhanath retired from service in March 1862.

Manual of Surveying, an authentic book on surveying, was published in 1851. The scientific portion of that book was written by Radhanath Sikdar. The book had five parts and it was written in the preface: “In Parts III (On Surveying) and V, the computers have been largely assisted by Babu Radhanath Sikdar, distinguished head of the computing department of the GTSI. The Chapters 15, 17 up to 21 inclusive of Part III, and the whole of Part V are entirely by his own. Besides he compiled a set of auxiliary tables for the surveying department which were found to be greatly useful”. Although Radhanath's contribution was admitted in the first and second (published in 1855) editions of the book, surprisingly, that acknowledgement was absent in the third edition. Incidentally, Radhanath passed away five years before the publication of the third edition in 1875. Omission of acknowledgement was criticised in various newspapers. Even Lieutenant Colonel Macdonald, Deputy Superintendent of GTS, strongly criticised the then Surveyor General H. L. Thuillier in the daily *Friend of India* of 17 and 24 June 1876 for this act. As a punishment of this act, Macdonald was suspended from service for three months and after completion of the period of suspension, as a demotion, Macdonald was made a 2nd class Deputy Superintendent.

Radhanath had a sound background in mathematics which he utilised as a computer of survey department. He made some original contributions in scientific arena in the form of research papers and finally his scientific works were duly appreciated and recognised by experts. So, in every respect he fulfilled all the criteria necessary for being called a scientist. Thus, it can be said that Radhanath was the first scientist of modern India.

Apart from his work in the survey and meteorology departments, Radhanath was involved in various philanthropic activities. He and Peary Chand Mitra (1814-1883) jointly edited a monthly magazine meant primarily for women. That magazine was instrumental in the origin of modern Bengali language. As a mark of recognition of his mathematical ability, Radhanath was elected a member of Bavarian branch of famous ‘Philosophical Society’ of Germany. He was the first Indian to achieve this honour. In the fag end of his life, Radhanath worked for a while as a mathematics teacher of General Assembly Institution of Kolkata. Radhanath built a house beside the Ganges River at Gondalpara of Chandannagore in Hoogly district. In last part of his life he lived in that house. There he passed away on 17 May 1870 at an age of 57. The newspaper *Hindu Patriot* wrote in its obituary on 23 May 1870: “Radhanath was a remarkable man and had many good qualities”. Recently a tablet has been erected in the National Library of Kolkata in memory of Radhanath Sikdar – the first scientist of modern India.

References

1. *Radhanath Sikdar: Beyond the Peak* – Ashis Lahiri; Boi-Chitro, Kolkata, 2010.
2. *Nabya Bharater Protham Bijanani Ganitagina Radhanath Sikdar*–Dipak Kumar Daw (Editing and compilation), The Science Association of Bengal, Kolkata, 2012.
3. *Dwi-satabarse Radhanath Sikdar* – Ashis Lahiri; Sutradhar, Kolkata, 2013.
4. Sources on the Internet for photographs.____

Dr. Utpal Mukhopadhyay, Satyabharati Vidyapith, P. O. – Nabapally, Dist. – North 24 Parganas, Kolkata – 700 126 West Bengal

Surgical Options for a Benign Prostate Enlargement



Dr Yatish Agarwal
e-mail: dyatish@yahoo.com

Until some years ago, surgery was the mainstay of treatment for a benign prostate enlargement. That's no longer the case! Nowadays, doctors recommend surgery only in those patients who don't do well with medication or those with very severe symptoms.

Currently, a number of different types of options are available for those men who can't do without surgery. The key principle behind each surgery is to shave off a part of the prostate gland that's blocking the flow of urine and once again open the narrowed urethra.

The decision about the type of surgery is based on a number of factors. This includes the size of the prostate, the severity of symptoms, and the treatment options on hand at the centre where you're undergoing treatment.

Each type of prostate surgery can produce side effects. Following surgery, some men may find that their semen has begun to flow backward into the bladder instead of out through the penis during ejaculation. This is known as retrograde ejaculation. Others may suffer loss of bladder control (incontinence) and impotence (erectile dysfunction). You must always ask your surgeon about the specific risks of each treatment you're considering.

Minimally invasive surgery

Currently, minimally invasive treatments are the rage of prostate surgery. They are less likely to cause blood loss during surgery and require a much shorter hospital stay. These treatments also typically require less pain medication. Depending on the procedure — and how well it works for you — you may, however, need follow-up treatments subsequently.

Minimally invasive treatments include:

Laser surgery

Laser surgeries use high-energy lasers to destroy or remove overgrown prostate tissue. Laser surgeries generally relieve symptoms right away and have a lower risk of side effects than the transurethral resection of the prostate (TURP), a surgery that was routinely done for the prostate till a few years ago.

Some laser surgeries also come in handy in men who shouldn't have other prostate procedures because they're taking the blood-thinning medications.

Laser surgery can be done with different types of lasers and in different ways:

Ablative procedures (including vaporisation) remove prostate tissue pressing on the urethra by burning it away, easing urine flow. Ablative procedures may cause irritating urinary symptoms after surgery and may need to be repeated at some point.



Enucleative procedures are similar to open prostatectomy, but with fewer risks. These procedures generally remove all the prostate tissue blocking urine flow and prevent regrowth of tissue. One benefit of enucleative procedures over ablative procedures is that removed prostate tissue can be examined for prostate cancer and other conditions.

Types of laser surgery include:

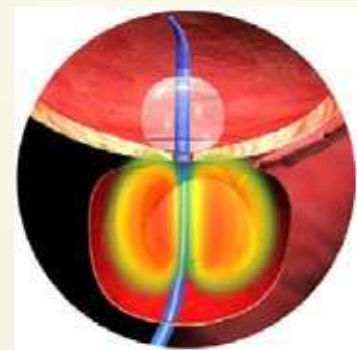
- Holmium laser ablation of the prostate (HoLAP)
- Visual laser ablation of the prostate (VLAP)
- Holmium laser enucleation of the prostate (HoLEP)
- Photoselective vaporization of the prostate (PVP)

Options for laser therapy depend on prostate size, the location of the overgrown areas, the doctor's recommendation and your preferences. Choices available also depend on where you seek treatment. Not all facilities have lasers to perform prostate surgery or doctors who have the specialised skills and training to do the procedures.

Transurethral microwave thermotherapy (TUMT)

In 1996, the United States FDA approved a device that uses microwaves to destroy the excess prostate tissue through heat intensity. This procedure is called the transurethral microwave thermotherapy (TUMT). The device sends computer-regulated microwaves through a catheter. This heats the selected portions of the prostate to at least 43.8°C.

Simultaneously, a cooling system keeps the urinary tract safe during the procedure.



The procedure can be performed on an outpatient basis without general anesthesia and takes about an hour. While carrying out this procedure, the treating surgeon inserts a special electrode through the urethra into the prostate area. Microwave energy from the electrode generates heat and destroys the inner portion of the enlarged prostate gland causing it to shrink and ease urine flow. TUMT has *not* been reported to lead to erectile dysfunction or incontinence.

Although microwave therapy does not cure BPH, it reduces urinary frequency, urgency, straining, and intermittent flow. It does not correct the problem of incomplete emptying of the bladder. Ongoing research will determine any long-term effects of microwave therapy and who might benefit most from this therapy.

This surgery has a lower risk of complications than does TURP, but is generally only used on small prostates in special circumstances, because re-treatment may be necessary.

Transurethral needle ablation (TUNA)

With this outpatient procedure, a lighted scope (cystoscope) is passed into the urethra. The doctor uses the scope to place needles into your prostate gland. When the needles are in place, radio waves pass through them, heating and destroying excess prostate tissue that's blocking urine flow. TUNA basically scars the prostate tissue, which causes it to shrink and open up, easing urine flow. This type of surgery may be a good choice if you bleed easily or you have certain other health problems.

Like TUMT, TUNA may only partially relieve your symptoms and it may take some time before you notice results. The risk of erectile dysfunction with the procedure is very low.

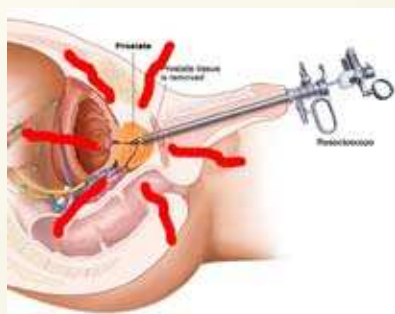
Standard surgeries

Standard surgeries for an enlarged prostate include:

Transurethral resection of the prostate (TURP)

TURP has been a common procedure for enlarged prostate for many years, and it is the surgery with which other treatments are compared. It is still used for 90 per cent of all prostate surgeries done for BPH.

In this type of surgery, no external incision is needed. After giving anesthesia, the surgeon reaches the prostate by inserting special lighted scope (resectoscope) through the male urethra in the penis.



The resectoscope, which is about 30 cm long and 1 cm in diameter, contains light, valves for controlling irrigating fluid, and an electrical loop that cuts tissue and seals blood vessels.

During the 90-minute operation, the surgeon uses the resectoscope wire loop to remove the obstructing tissue one piece at a time. The pieces of tissue are carried by the fluid into the bladder and then flushed out at the end of the operation.

Most doctors suggest using TURP whenever possible. Transurethral procedures are less traumatic than open forms of surgery and require a shorter recovery period. One possible side effect of TURP is retrograde, or backward, ejaculation. In this condition, semen flows backward into the bladder during climax instead of out the urethra.

TURP generally relieves symptoms quickly, and most men have a stronger urine flow soon after the procedure. Following TURP, there is risk of bleeding and infection, and you may temporarily require a catheter to drain your bladder after the procedure. You'll be able to do only light activity until you're healed.

Transurethral incision of the prostate (TUIP or TIP)

This surgery is an option if you have a moderately enlarged or small prostate gland, especially if you have health problems that make other surgeries too risky. Like TURP, TUIP involves special instruments that are inserted through the urethra. But instead of removing tissue, as with TURP, this procedure widens the urethra by

making a few small cuts in the bladder neck, where the urethra joins the bladder, and in the prostate gland itself. Although some people believe that TUIP gives the same relief as TURP with less risk of side effects such as retrograde ejaculation, its advantages and long-term side effects have not been clearly established.

Open prostatectomy

Rarely performed nowadays, this type of surgery is generally done if the patient has a very large prostate, bladder damage or other complicating factors, such as bladder stones. It is called open because the surgeon makes an incision in the lower abdomen to reach the prostate. The procedure requires general anesthesia. Once the surgeon reaches the prostate capsule, he scoops out the enlarged tissue from inside the gland.

Open prostatectomy is the most effective treatment for men with severe prostate enlargement, but it has a high risk of side effects and complications. It generally requires a short stay in the hospital and is associated with a higher risk of needing a blood transfusion.

Recovery following surgery

The amount of time a patient will stay in the hospital depends on the type of surgery he has had and how quick is the recovery.

Keeping a Foley catheter

At the end of surgery, a special catheter is inserted through the opening of the penis to drain urine from the bladder into a collection bag. Called a Foley catheter, this device has a water-filled balloon on the end that is put in the bladder, which keeps it in place.



This catheter is usually left in place for several days. Sometimes, the catheter causes recurring painful bladder spasms the day after surgery. These spasms may be difficult to control, but they eventually disappear.

Antibiotics

You may also be given antibiotics while you are in the hospital. Many doctors start giving this medicine before or soon after surgery to prevent infection. However, some recent studies suggest that antibiotics may not be needed in every case, and your surgeon may prefer to wait until an infection is present to give them.

Blood in the urine

After surgery, you will probably notice some blood or clots in your urine as the wound starts to heal. If your bladder is being irrigated (regularly flushed with water), you may notice that your urine becomes red once the irrigation is stopped. Some bleeding is normal, and it should clear up by the time you leave the hospital. During your recovery, it is important to drink a lot of water (up to 8 cups a day) to help flush out the bladder and speed healing.

Do's and Don'ts

Take it easy the first few weeks after you get home. You may not have any pain, but you still have an incision that is healing—even with transurethral surgery, where the incision can't be seen. Since many

people try to do too much at the beginning and then have a setback, it is a good idea to talk with your surgeon before resuming your normal routine. During this initial period of recovery at home, avoid any straining or sudden movements that could tear the incision. Here are some guidelines:

- Continue drinking a lot of water to flush the bladder.
- Avoid straining when having a bowel movement.
- Eat a balanced diet to prevent constipation. If constipation occurs, ask your doctor if you can take a laxative.
- Don't do any heavy lifting.
- Don't drive or operate machinery.

Getting back to normal

Even though you should feel much better by the time you leave the hospital, it will probably take a couple of months for you to heal completely. During the recovery period, the following are some common problems that can occur.

Problems in urinating

You may notice that your urinary stream is stronger right after surgery, but it may take a while before you can urinate completely normally again. After the catheter is removed, urine will pass over the surgical wound on the prostate, and you may initially have some discomfort or feel a sense of urgency when you urinate. This problem will gradually lessen, and after a couple of months you should be able to urinate less frequently and more easily.

Incontinence

As the bladder returns to normal, you may have some temporary problems controlling urination, but long-term incontinence rarely occurs. Doctors find that the longer problems existed before surgery, the longer it takes for the bladder to regain its full function after the operation.

Bleeding

In the first few weeks after transurethral surgery, the scab inside the bladder may loosen, and blood may suddenly appear in the urine. Although this can be alarming, the bleeding usually stops with a short period of resting in bed and drinking fluids. However, if your urine is so red that it is difficult to see through or if it contains clots or if you feel any discomfort, be sure to contact your doctor.

Sexual function after surgery

Many men worry about whether surgery for BPH will affect their ability to enjoy sex. Some sources state that sexual function is rarely affected, while others claim that it can cause problems in up to 30 per cent of cases. However, most doctors say that even though it takes a while for sexual function to return fully, with time, most men are able to enjoy sex again.

Complete recovery of sexual function may take up to one year, lagging behind a person's general recovery. The exact length of time depends on how long after symptoms appeared that BPH surgery was done and on the type of surgery. Following is a summary of how surgery is likely to affect the following aspects of sexual function.

Erections

Most doctors agree that if you were able to maintain an erection shortly before surgery, you will probably be able to have erections

afterward. Surgery rarely causes a loss of erectile function. However, surgery cannot usually restore function that was lost before the operation.

Ejaculation

Although most men are able to continue having erections after surgery, a prostate procedure frequently makes them sterile (unable to father children) by causing a condition called retrograde ejaculation or dry climax.

During sexual activity, sperm from the testes enters the urethra near the opening of the bladder. Normally, a muscle blocks off the entrance to the bladder, and the semen is expelled through the penis. However, the coring action of prostate surgery cuts this muscle as it widens the neck of the bladder. Following surgery, the semen takes the path of least resistance and enters the wider opening to the bladder rather than being expelled through the penis. Later it is harmlessly flushed out with urine.

In some cases, this condition can be treated with a drug called pseudoephedrine, found in many cold medicines, or imipramine. These drugs improve muscle tone at the bladder neck and keep semen from entering the bladder.

Orgasm

Most men find little or no difference in the sensation of orgasm, or sexual climax, before and after surgery. Although it may take some time to get used to retrograde ejaculation, you should eventually find sex as pleasurable after surgery as before.

Many people have found that concerns about sexual function can interfere with sex as much as the operation itself. Understanding the surgical procedure and talking over any worries with the doctor before surgery often help men regain sexual function earlier.

Would you need further treatment?

Since surgery for BPH leaves behind a good part of the gland, it is still possible for prostate problems, including BPH, to develop again. However, surgery usually offers relief from BPH for at least 15 years. Only 10 per cent of the men who have surgery for BPH eventually need a second operation for enlargement. Usually these are men who had the first surgery at an early age.

Sometimes, scar tissue resulting from surgery requires treatment in the year after surgery. Rarely, the opening of the bladder becomes scarred and shrinks, causing obstruction. This problem may require a surgical procedure similar to transurethral incision. More often, scar tissue may form in the urethra and cause narrowing. The doctor can solve this problem during an office visit by stretching the urethra.

Can BPH lead to Prostate Cancer?

Although some of the signs of BPH and prostate cancer are the same, having BPH does not seem to increase the chances of getting prostate cancer. Nevertheless, a man who has BPH may have undetected prostate cancer at the same time or may develop prostate cancer later.

After BPH surgery, the tissue removed is routinely checked for hidden cancer cells. In about one out of 10 cases, some cancer tissue is found, but often it is limited to a few cells of a nonaggressive type of cancer, and no treatment is needed.

Recent developments in science and technology

Glaciers around Mount Everest retreating fast

According to a survey of scientific literature produced over the past two decades that claims to be the most comprehensive of its kind, an overwhelming majority of



A new study finds a decline in snow and ice on Mount Everest (the dark peak on the left) and the national park surrounding it. (Credit: Pavel Novak)

scientists agree that humans have caused global warming. And one of the major consequences of global warming is loss of snow and ice cover in the Polar Regions and on the world's mountains. A glaring example is the extensive retreat of glaciers in the Mount Everest region in the Himalayas. A recent study has shown that glaciers in the Mount Everest region have shrunk by 13 percent in the last 50 years and the snowline has shifted upward by 180 metres. The study was conducted by a research team led by Sudeep Thakuri, who led the team as part of his PhD graduate studies at the University of Milan in Italy. The findings were presented at the Meeting of the Americas – a scientific conference organised and co-sponsored by the American Geophysical Union, held in Cancun, Mexico from 14 to 17 May 2013. The researchers suspect that the decline of snow and ice in the Everest region is from human-generated greenhouse gases altering global climate.

For the study, Thakuri and his team determined the extent of glacial change on Everest and the surrounding 1,148 square kilometres Sagarmatha National Park by compiling satellite imagery and topographic

maps and reconstructing the glacial history. Their statistical analysis shows that there is a significant increase in the rate at which majority of the glaciers in the national park are retreating. According to the researchers, glaciers smaller than one square kilometre in area are disappearing the fastest and have experienced a 43 percent decrease in surface area since the 1960s.

To evaluate the temperature and precipitation patterns in the area, Thakuri and his colleagues analysed hydro-meteorological data from the Nepal Climate Observatory stations and Nepal's Department of Hydrology and Meteorology and found that there has been a 0.6 degree Celsius increase in temperature and 100 millimetre decrease in precipitation during the pre-monsoon and winter months in the Everest region since 1992.

For India, this is worrying news because the Himalayan glaciers and ice caps are considered a water tower for much of Asia, and especially India, since they store and supply water downstream during the dry season. A large part of the Indian population, especially in the Indo-Gangetic Plain is dependent on the melt water for agriculture, drinking, and power generation during the summer months.

Pear-shaped nuclei detected

An international team of physicists led by Peter Butler, a physicist at the University of Liverpool, UK, has shown that some atomic nuclei can assume the shape of a pear, a finding that can add significantly to our understanding of nuclear structure and the underlying fundamental interactions. The research team included scientists from the UK, Germany, the USA, Switzerland, France, Belgium, Finland, Sweden, Poland and Spain. According to the researchers, the findings could advance the search for a new fundamental force in nature that could

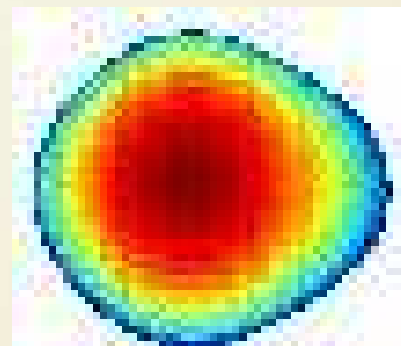


Biman Basu

E-mail: bimanbasu@gmail.com

explain why the Big Bang created more matter than antimatter – a critical imbalance in the history of everything.

Atoms are characterised by their nuclei, which contain protons and neutrons. In addition to its atomic number and mass number, a nucleus is also characterised by its size, shape, and other properties. The nuclei of some atoms are spherical, while others are stretched or flattened into deformed shapes. Most nuclei that exist naturally are not spherical, but are oval-shaped; that is, have the shape of a rugby ball. Modern theories of physics are able to predict the oval shape, and they also predict that for some particular combinations of protons and neutrons,



The pear-shape of radium-224 nucleus deduced from CERN measurements. (Credit: Nature)

nuclei can also assume very asymmetric shapes, like a pear, with more mass at one end of the nucleus than the other.

Until now, it has been difficult to observe pear-shaped nuclei experimentally. However, a technique pioneered at the ISOLDE facility at CERN near Geneva in Switzerland has been used successfully to study the shape of the short-lived isotopes radon-220 and radium-224. The Isotope Separator On-Line-DEtector, or ISOLDE is a facility dedicated to the production of a large variety of radioactive ion beams for many different experiments in the fields of nuclear and atomic physics, solid-state physics, materials science and life sciences. The data show that while radium-224 is

pear-shaped, radon-220 does not assume the fixed shape of a pear but rather vibrates about this shape (*Nature* 9 May 2013 | doi:10.1038/nature12073).

According to physicists, the experimental observation of nuclear pear shapes is important for understanding the theory of nuclear structure and for helping with experimental searches for electric dipole moments (EDM) in atoms. The EDM is a measure of the separation of positive and negative electrical charges in a system of charges; in other words, it is a measure of the charge system's overall polarity.

The Standard Model of particle physics describes the strong and weak nuclear forces and the electromagnetic force and also predicts that the value of the EDM is so small that it lies well below the current observational limit. In order to test these theories there is need to improve the EDM searches and the most sensitive method to do that would be to highly unusual atoms whose nucleus is pear-shaped. Quantifying this shape will therefore help with experimental programmes searching for atomic EDMs.

Physicists have been searching for signs of a new force or interaction that might explain the matter-antimatter discrepancy. The Standard Model cannot fully explain why there is more matter than antimatter in the Universe. If matter and antimatter were produced in equal amounts, they would have almost entirely annihilated one another during the first few seconds of the Big Bang, leaving little but radiation behind. Various ideas have been proposed to supplant the Standard Model that can account for the matter bias. These also predict that some nuclei should generate a weak electric dipole field, similar to the magnetic field of a bar magnet. If that is so, pear-shaped nuclei should have the strongest electric dipoles, and measuring these could help researchers to choose between the various models. The pear-shaped nucleus makes the effects of the new interaction much stronger and easier to detect.

Fundamental property of astatine discovered

Astatine is a radioactive chemical element belonging to the halogen group. It is the rarest element on Earth and occurs only as the result of the radioactive decay of certain heavier elements. Its chemical symbol is At and atomic number 85. All of its isotopes are



The Resonance Ionisation Laser Ion Source helps ionise rare elements like astatine at the ISOLDE facility. (Credit: University of York)

short-lived. Astatine-210, with a half-life of 8.1 hours, is its longest-lived isotope. In fact, the element is named after the Greek word for “unstable”. It is therefore no wonder that much less is known about astatine than most other elements.

For a long time, the characteristics of this elusive element were a mystery, but now, using the ISOLDE facility at CERN, nuclear physicists have been able to measure a key property – the ionisation potential – of this rarest element on Earth (*Nature Communications*, 14 May 2013 | doi:10.1038/ncomms2819). Ionisation potential is the energy needed to remove one electron from the atom, and thereby turning it into a positive ion. The measurement fills in a missing piece of the periodic table of elements, because astatine was the last naturally occurring element for which this property was unknown.

Astatine occurs naturally in only trace amounts on Earth, but physicists at ISOLDE can make artificial isotopes of astatine and then use wavelength-tuneable lasers to study their atomic structure through a technique known as ‘in-source laser resonance ionisation spectroscopy’. To measure the ionisation potential of astatine, physicists at CERN’s ISOLDE (Isotope Separator On Line-Detector) Radioactive Ion Beam facility created artificial isotopes of astatine by firing high-energy proton beams from CERN’s Proton Synchrotron Booster at uranium targets. (which has 92 protons and electrons). The collisions produced a shower of chemical elements, some of which were astatine. The physicists then shined laser beams of varying wavelengths at the atoms

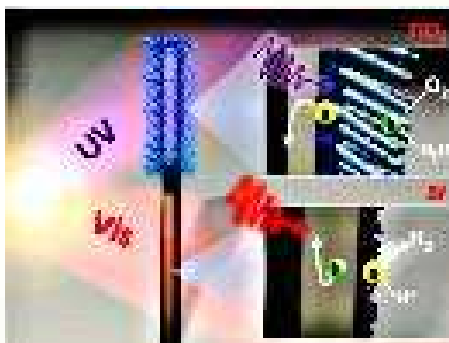
to ionise them. By isolating the astatine ions, and checking which wavelength of laser had created them, the researchers determined astatine’s ionisation potential to be 9.31751 electron-volts.

By looking at the ionisation potential of astatine, the scientists can now understand more about the chemical reactivity of astatine and the stability of its chemical bonds in compounds. This knowledge is of particular interest because it could help chemists to develop applications for astatine in radiotherapy. It could also help scientists in developing theories that predict the structure of super-heavy elements.

Astatine is of particular interest because its isotopes are interesting candidates for the creation of radiopharmaceuticals for cancer treatment by targeted alpha therapy and the new discovery could help scientists develop medical applications for artificial astatine. According to the National Institutes of Health, USA, targeted alpha therapy uses radioactive particles of heavy elements, which “release enormous energy over a short distance ... providing a more specific tumour cell killing ability without damage to the surrounding normal tissues”. Moreover, the extremely short half-life of astatine means that radiation exposure to patients would be lower than existing treatments, and it generally decays back into bismuth, a heavy metal with extremely low toxicity.

Artificial nanosystem-based ‘forest’ for solar water-splitting

Photosynthesis is a natural process by which green plants produce food from carbon



Schematic shows titanium dioxide nanowires (blue) grown on the upper half of a silicon nanowire (grey) and the two absorbing different regions (UV and visible) of the solar spectrum. Insets show photo-excited electron-hole pairs separated at the semiconductor-electrolyte interface to carry out water splitting with the help of co-catalysts (yellow and grey dots). (Credit: DOE/Lawrence Berkeley National Laboratory)

dioxide, water, and nutrients from the soil using the green pigment chlorophyll and sunlight. During photosynthesis, water is split up into hydrogen and oxygen, the hydrogen being used for food synthesis and oxygen released into the atmosphere. Now scientists have reported the first fully integrated nanosystem for artificial photosynthesis that can be used to produce hydrogen by splitting water. The team from the U.S. Department of Energy (DOE)'s Lawrence Berkeley National Laboratory is led by Peidong Yang, a chemist with Berkeley Lab's Materials Sciences Division.

In green plants, chloroplasts carry out photosynthesis, but the artificial photosynthetic system designed by the Berkeley team is composed of two semiconductor light absorbers with large surface area, an interfacial layer for charge transport, and spatially separated co-catalysts (chemical species that improve catalytic activity). To facilitate solar water-splitting in the system, the researchers synthesised tree-like nanowire hetero-structures, consisting of silicon trunks and titanium oxide branches. This is what makes the arrays of these nanostructures very much resemble an 'artificial forest' (*Nano Letters*, 6 May 2013 | doi: 10.1021/nl401615t). Arrays of tree-like nanowires consisting of silicon trunks and titanium dioxide branches facilitate solar water-splitting in a fully integrated artificial photosynthesis system.

A major challenge for artificial

photosynthesis is to produce hydrogen cheaply enough to compete with fossil fuels. Meeting this challenge requires an integrated system that can efficiently absorb sunlight and produce charge-carriers to drive separate water reduction and oxidation half-reactions.

Artificial photosynthesis, in which solar energy is directly converted into chemical fuels, could be one of the most promising carbon-neutral renewable energy sources. However, a major challenge for artificial photosynthesis is to produce hydrogen cheaply enough to compete with fossil fuels. To meet this challenge the researchers designed an integrated system that can efficiently absorb sunlight and produce charge-carriers to drive separate water reduction and oxidation half-reactions.

During photosynthesis, when sunlight is absorbed by chlorophyll in a chloroplast, an energised electron is generated that moves from molecule to molecule through a transport chain until ultimately it drives the conversion of carbon dioxide into carbohydrate sugars. This electron transport chain is called a "Z-scheme". Yang and his colleagues also use a Z-scheme in their system; only instead of chlorophyll they deploy two abundant and stable semiconductors – silicon and titanium oxide – loaded with co-catalysts and with an ohmic contact inserted between them. (An ohmic contact is the contact between a metal and a semiconductor to allow carriers to flow in and out of the semiconductor.) Silicon was used for the hydrogen-generating photo-cathode and titanium oxide for the oxygen-generating photo-anode. The tree-like architecture was used to maximise the system's performance. Like trees in a real forest, the dense arrays of artificial nanowire trees suppress sunlight reflection and provide more surface area for fuel producing reactions.

According to the scientists, using the artificial photosynthetic system, a 0.12% solar-to-fuel conversion efficiency was achieved under simulated sunlight, which is comparable to that of natural photosynthesis. According to the researchers, this rate will have to be substantially improved for commercial use. That may not be difficult, as the modular design of this system allows for newly discovered individual components to be readily incorporated to improve its performance.

Letters to editor

Binary search

The article on Basics of Binary Search' by Rintu Nath (Dream 2047 May 2013) presented some good information about binary search. As I am a computer science engineering student, it was very helpful to me. Please publish some other article on searching methods also.

AnjanMaji
tweet2anjan@gmail.com

Number magic

DREAM 2047 is an all-in-one magazine, which provides information about past, present, and the future. As I am a student of molecular biology, the articles published under "Recent Development in Science and Technology" are useful for me as well as for all the research dreamers.

Even though I hate maths, Rintu Sir has made me love maths, through his lucid narrative style. The article "The Curious World of Numbers" by Dr. C.K. Ghosh (May 2013) showed me the magic in numbers.

Bharaterha S.
Student (M. Sc. Molecular Biology)
Yuvaraja's College| University of Mysore
Karnataka - 570005

Article on Vedic Mathematics

The article "Basics of Binary Search" (Dream 2047, May 2013) was very informative.

I also like the way the author explained mathematics as fun and game. Can I request information on Vedic Mathematics in a forthcoming issue of Dream 2047?

AshishHegde
Senior Executive - Material
Crompton Greaves Limited, Fans Division
Bethora Ind Est, Bethora 403 409, Goa
ashish.hegde<ashish.hegde@cgglobal.com

Prostate surgery

I received a complimentary copy of May 2013 issue of Dream 2047, carrying an article on problems of enlarged prostate. Only on 19 April I had undergone a surgery for the same! It was a laser-based, bloodless surgery, which was available only at a local nursing home.

Before the surgery, on the advice of an expert urologist I took medicines for about a year, but with little success. To my surprise, however, I discovered later that laser-based surgery is not included in the list of treatments for which the costs are reimbursable! Unless the fruits of progress are made affordable, one would agree that people at large cannot reap the benefit of new discoveries.

Through this prestigious magazine of yours may I make an appeal to all concerned employers, both in the government and the non-government sector, to let their employees opt for bloodless surgery for enlarged prostate, which is advantageous in many ways?

Dr. K. Sinha
Lucknow, Uttar Pradesh.
ksinha2000@gmail.com

Screening of “The Genius of Srinivasa Ramanujan”

Along with Indian Institutes of Science Education and Research (IISER) Pune, Vigyan Prasar produced a documentary titled “Genius of Srinivasa Ramanujan”. The documentary features well-known number theorists from around the world associated with Ramanujan’s entire work, including Bruce Berndt, George Andrews, Ken Ono, and others. Shot at various locations in Chennai, Namakkal, Kumbakonam, Erode, and Cambridge, UK, this documentary highlights the trajectory of Ramanujan’s seminal work and its relevance today.

The documentary was screened at 500 different locations around the world, including the University of California, on the death anniversary of Srinivasa Ramanujan (26 April). The mathematics departments of various universities, maths-related regional



Lecture on Ramanujan



Glimpses of screening of “The Genius of Srinivasa Ramanujan”

and national institutions, science centres and science clubs actively participated in the screening of the documentary. At

each screening an average of 50 viewers, comprising scientists, university professors, common people, teachers, and students were

present and appreciated the documentary. At some places media also covered the event.

Articles
invited

Dream 2047

Vigyan Prasar invites original popular science articles for publication in its monthly science magazine Dream 2047. At present the magazine has 50,000 subscribers. The article may be limited to 3,000 words and can be written in English or Hindi. Regular columns on i) Health ii) Recent developments in science and technology are also welcome. Honorarium, as per Vigyan Prasar norm, is paid to the author(s) if the article is accepted for publication. For details please log-on to www.vigyanprasar.gov.in



Vigyan Prasar

&

DD Bharti

jointly telecast a music video

Kyun Kyun Kyun...

Watch the music video,

answer the questions and win attractive prizes

DD Bharti and Vigyan Prasar will jointly telecast a science music video “Kyun Kyun Kyun” from July 1, 2013 at different times. Watch the music video and answer the questions being raised in the song. The music video would be repeated many times during the day and would be telecast whole of July. 500 select best answers would be awarded with attractive gifts. Watch, answer and get prize.

