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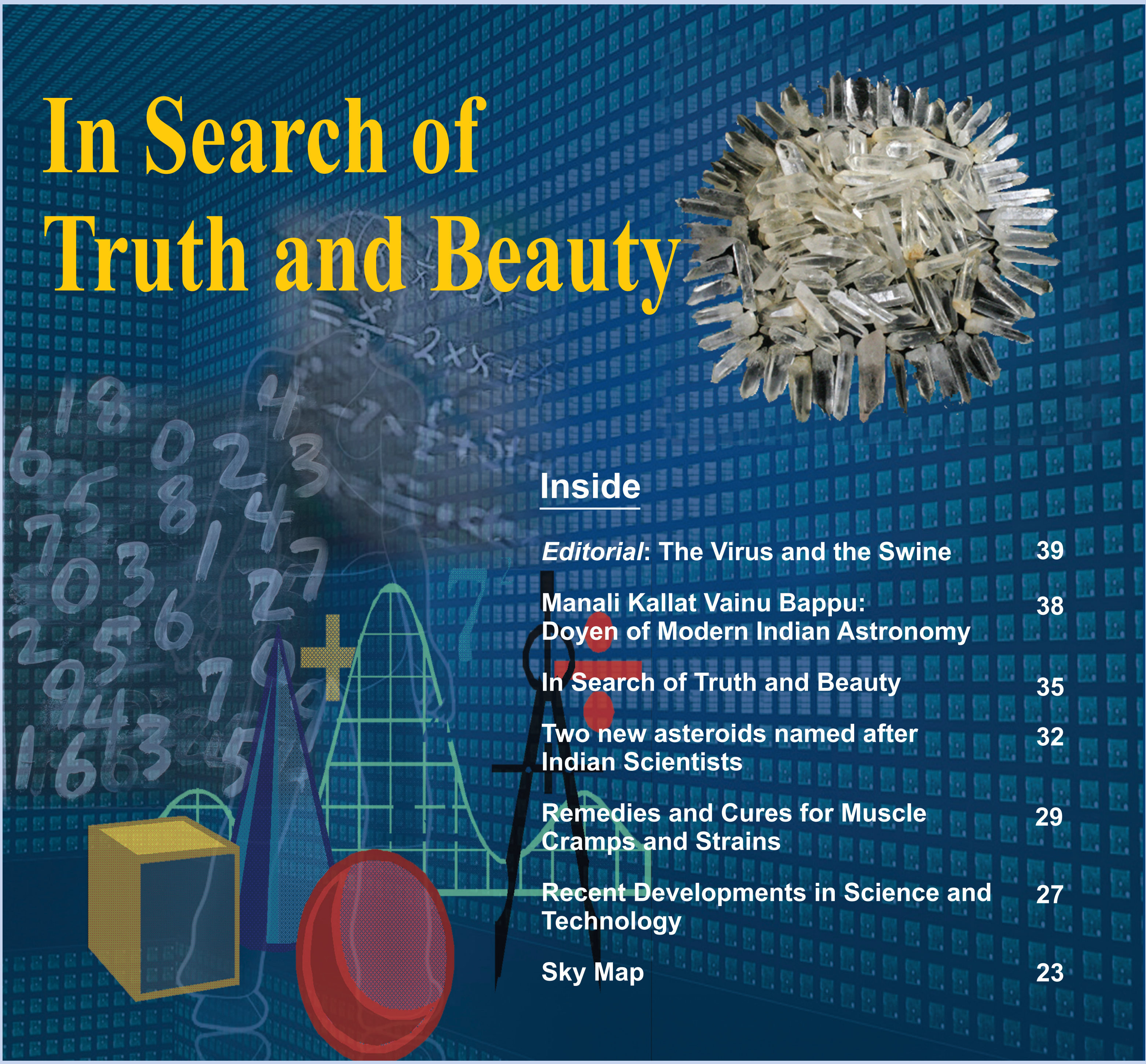

In Search of Truth and Beauty

Inside

... think scientifically, act scientifically... think scientifically, act scientifically... think scientifically, act...

The Virus and the Swine

The first case of swine flu (swine-origin influenza) death in India was reported on 3 August 2009 when a 14-year-old girl died in Pune. Within the next 15 days, the mortality figure shot up to 25. As of 1 September 2009, the number of lab confirmed cases stood at 4,885, and the number of deaths at 135. Initially the cases of infection were largely imported from North America. But, as of now, the transmission of the virus is efficiently taking place even among those who have never travelled abroad, or among those who were never in direct contact with people returning from abroad. The virus has efficiently and firmly established itself in the country.

Since April 2009, the disease caused by the new strain of the flu virus Influenza A(H1N1) has already spread to 170 countries with a rapid and efficient human-to-human transmission. On 11 June 2009, the World Health Organisation (WHO) announced that the world was at the start of the 2009 influenza pandemic, that is, a worldwide epidemic. Incidentally, a pandemic refers to how far across the globe the disease has spread, rather than its severity. However, the mortality rate is relatively low; all over the world some 3.3 lakh people had been infected by the A(H1N1) virus till 10 September 2009, and only 3,430 had died.

Incidentally, there are three types of influenza viruses: A, B, and C. Influenza type A viruses can infect people, birds, pigs, horses, and other animals, but wild birds are the natural hosts for these viruses. Influenza viruses are further divided into *subtypes* based on the two proteins on the *surface* of the virus. For example, influenza type A viruses are divided into subtypes based on the proteins haemagglutinin (HA) and neuraminidase (NA) found on the surface of the virus. There are 16 different HA subtypes and 9 different NA subtypes. Many different combinations of HA and NA proteins are possible. Subtypes of influenza A virus are named according to their HA and NA surface proteins. An H1N1 virus designates influenza A subtype that has an HA1 protein and an NA1 protein on its surface. Similarly an H5N1 virus has an HA5 protein and an NA1 protein on its surface.

Only some influenza A subtypes (H1N1, H1N2, and H3N2) are currently in general circulation among humans. Other subtypes are found most commonly in other animal species. For example, H7N7 and H3N8 viruses cause illness in horses. Influenza B viruses are normally found only in humans. Unlike influenza A viruses, these viruses are not classified according to subtype. Although influenza type B viruses can cause human epidemics, they have not caused pandemics. Influenza type C viruses cause mild illness in humans and do not cause epidemics or pandemics. These viruses are also not classified according to subtype.

But, why is it called 'swine flu'? The virus Influenza A(H1N1) is a genetic re-assortment, or a rearrangement, of different virus strains. When animals or humans are infected with two different flu (influenza) viruses at the same time, those viruses can swap genes, thus generating a third type of virus. This process is called re-assortment and usually produces new viruses that can be a mix of different genes. Influenza A(H1N1) is known as a "re-assortant", as it is composed of swine, avian and human genes. This particular combination has not previously been seen in humans or swine, and the precise origin of the re-assortment is uncertain. A(H1N1) has within it four different virus strains - two swine strains, one avian and one human strain. Since it contains two different swine genes, scientists initially described it as a 'swine influenza virus'. However, with the exception of an isolated herd in Canada, this virus has not yet been found in pigs. The term 'swine flu' thus caused some confusion. Besides, there is no evidence that this virus is circulating in pigs. WHO therefore decided to change its name to the more scientific term 'Influenza A(H1N1)'.

The 'Spanish' (H1N1) influenza pandemic of 1918 -1919 killed as many as 50 million people worldwide (though there was nothing 'Spanish' about it!), and it remains unprecedented in its severity. In India, as many as 17 million died; about 5 per cent of India's population at the time! The majority of deaths were from bacterial pneumonia, a secondary infection caused by influenza, but the virus also killed people directly, causing massive haemorrhages and oedema (swelling from excessive accumulation of watery fluids) in the lungs. The mortality pattern of the 'Spanish' influenza was unusual, with high mortality rates among young adults. It was restricted to the respiratory tract and was probably caused by transmission of an avian-like H1N1 virus. In February 1967, the 'Asian' influenza originated in Southern China. The pandemic was caused by a human/avian re-assortant (H2N2) that introduced avian virus genes into humans. Similarly, the introduction of avian virus genes into human populations led to the Hong Kong influenza in 1968. In 1977, H1N1 viruses reappeared, which closely resembled strains that had been circulating in the mid-1950s. In the late 1990s, re-assortment between human H3N2, North American avian, and classical swine viruses resulted in triple re-assortant H3N2 and H1N2 swine viruses that have since circulated in North American pig populations. A triple re-assortant swine virus re-assorted with a Eurasian avian-like swine virus, apparently in late 2008, resulting in the swine-origin H1N1 influenza viruses (S-OIVs) that are circulating among human beings today.

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Manali Kallat Vainu Bappu

Doyen of Modern Indian Astronomy

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Manali Kallat Vainu Bappu

> "His (Vainu Bappu's) spirit was generous, kind, non-cynical—even hero-worshipping in the best sense of the word. He deeply admired if not even venerated his teachers and those, living or dead, who had really accomplished something. He well knew and understood human frailties, but to Vainu the important things were those qualities and works of great men and women which should be admired and emulated as far as possible in his own life."
>
> *- Harlan J. Smith, the first Director of the McDonald Observatory of the University of Texas, Asutin,* Resonance, *2002*
>
> "Bappu had formulated ambitious plans for the growth of astronomy in India. He had identified new thrust areas and convinced other physical laboratories to take up work in related projects. He played major roles in the formation and growth of academic societies, nurtured a new international journal in astrophysics, and took great interest in the popularisation of astronomy among the young."
>
> *J C Bhattacharya,* Resonance, *August 2002.*

Vainu Bappu is regarded as the 'main architect of revival of astronomical studies in India.' He played an instrumental role in establishing a number of astronomical institutions in India and in establishing the Indian Institute of Astrophysics in Bangalore.

Vainu Bappu was born in Madras (now Chennai) on 10 August 1927. His father Sunanna Bappu was an astronomer at the Nizamiah Observatory, Hyderabad. His mother was Manali Kukuzhi. He was the only child of his parents. Influenced by his father, Bappu developed a keen interest in astronomy since his childhood. Once he said: "I learnt my astronomy on the lap of my father." However, his interests were not limited to astronomy. He had wide ranging interests including painting, music, literature, gardening and architecture. He was an eloquent speaker and he could hold an audience spellbound.

He became an accomplished amateur astronomer while still at school. In 1946, he published two papers on astronomy in *Current Science*, a journal published by the Indian Academy of Sciences, Bangalore. The papers were titled "The effect of colour on the visual observations of long-period variable stars" and "On the visual light curve of LT Eridani."

He joined the Nizam College (1946-1948) as its Fellow. While a student of the Nizam College he built a spectrograph of dispersion 120 ú/mm. He used it to obtain spectrograms of the air glow. In 1949, he obtained his MSc degree in physics from Madras University, for which he submitted a thesis on spectroscopic and photoconducting properties of amethyst quartz.

Subsequent to acquiring the Master's degree he joined Harvard Graduate School of Astronomy as a "Hyderabad state scholar for postgraduate studies in astronomy" (1949-51). At the time that Bappu joined the Harvard Astronomy School, its Faculty included such accomplished astronomers as Harlow Shapley, Donald Menzel, Bart J. Bok, Cecilia Payne-Gaposchkin, and Fred Whipple. Spencer Jones and Harlow Shapley, who visited India, persuaded the Hyderabad government to grant Bappu a scholarship.

Commenting on Bappu's days as a research student at Harvard, his friend and colleague Harlan J. Smith wrote: "…Vainu was anything but solemn. He laughed, and joined in most of the games and jokes. He found the necessary paraphernalia, and organised at the observatory what must have been the only cricket team within a few hundred miles, teaching us the mysteries of the sticky wickets and googly-balls. On one occasion he gaily commented on some virtues of yoga, to the amused condescension of some of the graduate students."

Within a few months of his arrival at Harvard, Bappu, together with Bart J. Bok and Gordon A. Newkirk, Jr., discovered a comet. This purely accidental discovery was made on 2 July 1949. Perhaps Bappu is the only Indian who has discovered a comet. The comet was named Comet Bappu-Bok-Newkirk (C/1949 N1). Sometimes it is also referred to as Comet Bappu-Bok-Whipple.

The discovery of the comet has been beautifully described in an obituary on M. K. Vainu Bappu written by R. K. Kochhar and M. G. K. Menon in the *Bulletin of the Astronomical Society of India*. They wrote: "The discovery (of the comet) has an interesting history. On the early morning of 2 July 1949, Vainu Bappu took a 60 min exposure plate in Cygnus, for a special program, with the 24-33-inch Jewett Schmidt telescope at the Oak Ridge station of the Harvard College observatory. The plate was developed the following afternoon, and just as Bok and Bappu started to examine it for image quality and

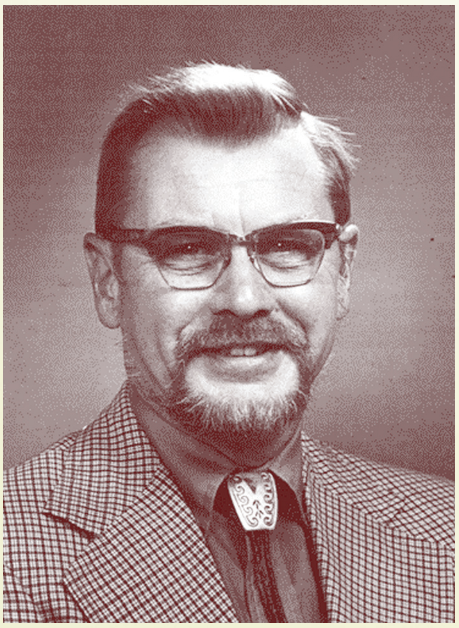
Bart H. Bok

focus, Newkirk, and undergraduate student, who chanced to pass by – it had been a hot day and he was looking for his shirt – was invited to note the excellent quality of the plate. On inspecting it, he noticed the trail of 'an asteroid or something'. Upon which Bok took a look and commented: 'This is no asteroid – this is a hairy comet.' Apart from the discovery of the comet on the plate that he took, Bappu's achievement was in computing its orbit immediately, ahead of the more experienced workers."

When the news of the discovery reached India, the Hyderabad state government sent a communication to the Indian Embassy in Washington DC to advise the student (Bappu) to undertake research as per the terms and conditions and not indulge in discovering comets. "See that your government's wishes are carried out in every respect", the communication noted. Fred Whipple took up the matter with the officials of the Hyderabad state government. He wrote: "This is the first occasion in my experience in which a foreign government has taken on itself the criticism of our educational methods in the Astronomy Department of Harvard University." He further requested them to communicate the reasons for their criticism to the Harvard authorities instead of "reprimanding the student in such a way that he finds it difficult to follow our guidance in his advanced education."

Bappu obtained his Ph.D. in 1952. The title of his thesis was "The problems of Wolf-Rayet atmospheres". His Ph.D. supervisor was Donal Menzel. After his Ph.D. he worked for a brief period as Carnegie post-doctoral fellow at the Mt. Wilson and Palomar Observatories where jointly with Olin C. Wilson he discovered an important phenomenon now called the Wilson-Bappu effect. It is the correlation between the measured width of the emission feature at the centre of the Ca II K line and the absolute visual magnitude of the star. This correlation is independent of spectral type and applicable to stars of type G. K, and M.

Bappu returned India in December 1952; visiting observatories in England, France, and Italy *en route*. In those days, India did not have institutional infrastructure to carry out research in modern astronomy. Bappu was fully aware of the prevailing situation with respect to astronomical research in India. Yet he returned with the determination to put India on the world astronomical map. However, to start with he did not even have a job, although that did not deter him from pursuing his dream.



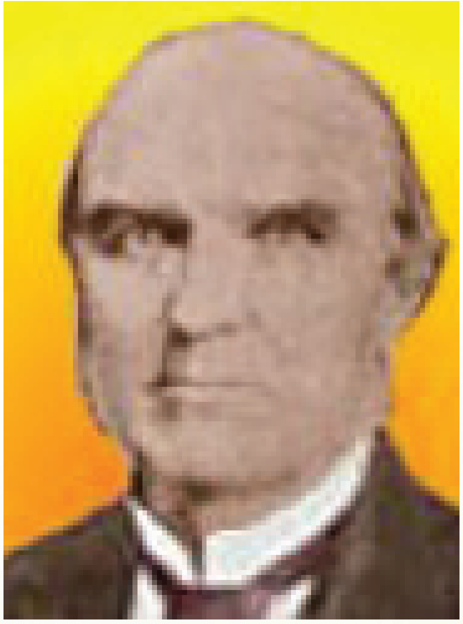
Gordon Allen Newkrik

He himself said: "I was returning to a country with facilities which were primitive compared to those in the United States; the largest telescope I could expect to use was a 15-inch refractor. For this reason, I took…with me…a photomultiplier tube, some optics for a spectrograph, and some Coudé and Cassegrain spectra taken at Mt. Wilson and Palomar. My principal encouragement was some advice from Plaskett on how it was possible to do good work even with limited resources if the topics were chosen carefully. Such words were crucial and have on occasions had great significance; I have had occasion to recall them many times in the next quarter-century."

Fred Lawrence Whipple

One of the conditions of the scholarship, which had enabled him to go to Harvard University was that on return to India he would serve the Hyderabad state. However, the government could not offer him a suitable job and so by July 1953 he was told that he was free to try elsewhere. In January 1954, he got a senior research fellowship of the National Institute of Sciences (later renamed the Indian National Science Academy).

In November 1954, Bappu joined the Uttar Pradesh State Observatory, Varanasi, as the Chief Astronomer. This Observatory had been established in April 1954 thanks to the initiative taken by A. N. Singh, the Principal of the newly established DSB Government College, Nainital, who also



Norman Pogsom

became its honorary Director. After Singh's death in July 1954, Bappu took over as Head of the Observatory. He convinced the then Chief Minister of Uttar Pradesh to promote astronomy in a big way and to shift the Observatory to a location better suited for observation. Thus the observatory was moved to Nainital in November 1955.

In 1960, he took over as Director of the Kodaikanal Observatory in Tamil Nadu. The Observatory had been originally established by the East India Company in the late eighteenth century "to promote the knowledge of astronomy, geography and navigation in India." It had a glorious past and accomplished astronomers like Norman Pogson (1829-1891) and John Evershed (1864-1956) had worked here. However, its glory days were past and when Bappu took over its charge. The Observatory was in a very bad shape. Bappu transformed this old and outdated institution into an active centre of astronomical research.

In early 1970s, Bappu established a new station at Kavalur and it produced results that could be compared to those of the world's leading observatories. He conceived and steered a project to build a 2.36-m telescope. It was designed and fabricated indigenously. However, Bappu passed away before it became functional. Both the observatory and the telescope were named after Bappu.

Bappu was not simply concerned with institution building but also diligently pursued his research career. He worked on diverse topics including structure of the solar atmosphere, planetary rings, Wolf-Rayet stars, clusters, stellar associations and galaxies. Bappu had a special interest in solar eclipses.

Bappu served as a visiting professor at the University of Arizona and Kitt Peak National Observatory (1963), a Fellow of the Japan Society for the Promotion of Science (1981), and as Vikram Sarabhai Professor at the Physical Research Laboratory, Ahmedabad (1981). He also served as Editor of the *Journal of Astrophysics and Astronomy*. He was the first President of the Astronomical Society of India (1973-1974). He served as Vice President (1967-1973) and President (1979) of the International Astronomical Union. He was elected Honorary Fellow of the Belgium Academy of Sciences; an Honorary Foreign Associate of the Royal Astronomical Society, London and Honorary Member of the American Astronomical Society.

Bappu received many awards and honours in his short life. He was awarded the Donhoe Comet-Medal (1949) instituted by the Astronomical Society of the Pacific; the Shanti Swarup Bhatnagar Prize of the Council of Scientific and Industrial Research (1970), the Hari Om Trust's Meghnad Saha Award of the University Grants Commission for research in theoretical sciences (1977), the Satyendranath Bose Medal of the Indian National Science Academy (1983) and the Government of India awarded him Padma Bhushan in 1981.

Bappu died on 19 August 1982 in Munich. At the time of death he was just 55 years old.

The Astronomical Society of India has instituted a Fund in the memory of Vainu Bappu with the objectives to promote knowledge of astronomy and astrophysics and honour the contributions of young scientists, normally not beyond 35 years of age, from any part of the world, in the field of astronomy and astrophysics. As a token of appreciation of his contribution to astronomy and astrophysics, the Astronomical Society of

Harlow Shapley

India awards "Professor M.K. Vainu Bappu Gold Medal" and a citation. 2596 Vainu Bappu (1979 KN) is a main-belt asteroid discovered on 19 May 1979 by R. M. West.

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(The article is a popular presentation of the important points on the life and work of Manali Kallat Vainu Bappu available in the existing literature. The idea is to inspire the younger generation to know more about Manali Kallat Vainu Bappu and her work. The author has given sources consulted for writing this article. However, the sources on the Internet are numerous and so they have not been individually listed. The author is grateful to all those whose works have contributed to writing this article.)

In Search of Truth and Beauty*

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G. H. Hardy, the well known mathematician once said that a mathematician, like a painter or a poet, is a maker of patterns. But, the patterns made by a mathematician are more permanent than those made by a painter or a poet. A painter makes pattern with shapes and colours, a poet with words. A painting may include an idea, but the idea is quite often common place and, hence, not so very important. In poetry, idea counts for a good deal more. A mathematician, on the other hand, has no material to work with but ideas, and so his patterns are likely to last longer, since ideas wear less with time than words. His patterns, however, must be beautiful like the painter's or the poet's, and must fit together in a harmonious way. Surely, beauty is the first test. True, it may be very hard to define mathematical beauty, but that is just as true of beauty of any kind. We may not know what we mean by a beautiful poem, but when we read it, we recognise its beauty.

Could we call a chess problem beautiful? Many of us who play chess may call or recognise a certain chess problem to be beautiful. Yet, a chess problem is simply an *exercise* in pure mathematics, and everyone who calls a problem "beautiful", is applauding mathematical beauty, even if it is beauty of a comparatively lowly kind. Chess problems are like that. Indeed, a chess problem is genuine mathematics, but it is in some way "trivial" mathematics. However ingenious and intricate, however original and surprising moves, there is something essential lacking. Chess problems in this sense are unimportant. As G. H. Hardy says in his *A Mathematician's Apology*, the best mathematics is serious as well as beautiful - important if you would say so. And it retains its beauty and freshness to eternity. No chess problem has ever effected the general development of scientific thought. What Euclid, Pythagoras, Gauss, Euler, Newton, Ramanujan, and Einstein did in their times changed the whole direction of the scientific thought.

We asserted that best mathematics retains its beauty and freshness for ever. To understand this statement, let us consider a few examples from early Greek mathematics - theorems which every mathematician will admit to be first rate. We shall take very simple and intelligible theorems which do not require any specialised mathematical background. The first is Euclid's proof of the existence of infinity of prime numbers. The prime numbers or primes are the numbers which cannot be resolved into smaller factors, say 2, 3, 5, 7, 9, 11, 13, 17, 19, 23, 29 ………..

Srinivasa Aiyangar Ramanujan

The primes are the material out of which all numbers are built up by multiplication. Thus, 666 = 2 x 3 x 3 x 37. It can be easily proved using the method of *reductio ad absurdum* that the series we described never comes to an end. That is, there exists infinity of prime numbers.

Let us consider another example. It is Pythagoras's proof of the irrationality of "2. A rational number is a fraction a/b, where a and b are integers. To say that "2 is irrational is another way of saying that 2 cannot be expressed in the form of $(a/b)^2$. This is the same thing as saying that the equation

$$a^2 = 2b^2$$

cannot be satisfied by integral values of a and b, which have no common factor. This theorem can also be proved by the method of *reductio ad absurdum*. It also follows from this theorem that the diagonal of a square is incommensurable with the side.

Another famous and beautiful theorem is Fermat's two-square theorem. The primes may be arranged in two classes; the primes

5, 13, 17, 29, 37, 41,……..

which leave remainder 1 when divided by 4; and the primes

3, 7, 11, 19, 23, 31,…..

which leave remainder 3. All the primes of the first class, and none of the second can be expressed as the sum of two integral squares:

$$5 = 1^2 + 2^2,\ 13 = 2^2 + 3^2,$$
$$17 = 1^2 + 4^2,\ 29 = 2^2 + 5^2$$

But, 3, 7, 11 and 19 are not expressible in this way. This is Fermat's theorem which is ranked as one the finest in arithmetic.

The examples we gave here are what constitute patterns of ideas, beauty and seriousness. I do hope, now the difference between a chess problem and a mathematical theorem is clear to you.

Let me now digress a bit. The most important breakthroughs in mathematics or science have been made by those in the prime of their youth. In this regard, the story of the discovery of Ramanujan by G. H. Hardy and their legendary collaboration at the Trinity College has been told umpteen times. Indeed, Hardy never forgot that he was in the presence of a genius – although almost untrained. Ramanujan could not enter Madras University because he could not clear matriculation examination in English. Even when it came to mathematics, both had to come to terms with the

G. H. Hardy

difference in their education. Ramanujan was self-taught. He knew nothing of the modern rigour. In a sense, he did not even know what a proof was. Hardy was obliged to teach him some formal mathematics as if Ramanujan had been a scholarship candidate. Ramanujan and Hardy produced together 5 papers of the highest class. Within four years, he became a Fellow of the Trinity College. Soon after, The Royal Society elected him a Fellow at the age of 30, which even for a mathematician is very young. He was the first Indian to be given both the distinctions.

But, Ramanujan soon became ill. Hardy used to visit him as he lay in the hospital at Putney. It was here that during one of those visits, the famous incident of the taxicab number happened. Hardy remarked to Ramanujan soon after entering the hospital room: "I thought the number of my taxicab was 1729. It seemed to me a dull number". Ramanujan replied: "No, Hardy, it is a very interesting number. It is the smallest number expressible as the sum of two cubes in two different ways!" What are the two different ways? One way is $1729 = 10^3 + 9^3$. The other way is $1729 = 12^3 + 1^3$. Surely, every number was a personal friend of Ramanujan.

Ramanujan died of tuberculosis, back in Madras in 1920, two years after the First World War. Hardy wrote in his *A Mathematician's Apology*: "Galois died at 21, Abel at 27, Ramanujan at 33, Riemann at 40 ……!! I do not know an instance of a major mathematical advance initiated by a man past fifty!" What Hardy meant was the fact that any breakthrough or a mathematical advance was possible only by people in the prime of their youth! The work they did was full of seriousness and beauty, and of eternal value.

Despite all odds and lure of greener pastures offered by professional courses, many of our youth do take up a career in pure science or pure mathematics - which is quite gratifying. The first question to ask would be whether what one pursues is worth pursuing at all? And the next question is why one should pursue it, whatever its value may be? The answer to the second question is perhaps easier. We do something because we like it! Let us now consider the first question, the answer to which is somewhat difficult. Most people can do nothing at all well. Five or ten percent of the people can do something rather well. But, it is a microscopic minority who can do anything really well. That is why what we pursue is worth pursuing, and that is what makes a career in pure science or pure mathematics most challenging. Therefore, if anyone has a genuine talent, he or she should be ready to make almost any sacrifice in order to cultivate it to the full. Whatever one may do in pure mathematics or pure science may be small, but it has a certain

Evariste Galois

character of permanence. And to have produced anything of the slightest permanent interest is to have done something utterly beyond the powers of the vast majority of people.

We find that many promising young people turn away from pure science or pure mathematics. The question they invariably ask is, what use it is? True, medicine,

James Clerk Maxwell

engineering or biotechnology contributes to the material well-being and comfort of people. They can promote happiness, and relieve suffering and raise the quality of life. Some mathematics is certainly useful in this way. Some mathematics is needed in every branch of science. May be, in ordinary life the knowledge of science or mathematics may not be of much use. Even if we do not know the constitution of LPG or CNG, it will burn. We would take our cars to a garage when they breakdown. We live either by rule of thumb or on other people's professional knowledge. When we talk of utility or usefulness of science or mathematics, we talk of the applied aspect of science or mathematics. But, what is the difference between the two? How does pure mathematics differ from applied mathematics? And pure science from applied science?

As described by Hardy, the contrast between pure and applied mathematics stands out most clearly in geometry. Here is an example. The auditorium in which a lecture is given is part of the physical world, and has itself a certain pattern. The study of that pattern and its physical reality, we may call "Physical Geometry". Now suppose a massive gravitating body is introduced into the room. Immediately, the physicists would say that the geometry of the room is changed! Its physical pattern has slightly but definitely distorted. But, would the mathematical theorems you have studied or proved become false? Surely, their proofs can never be affected in any way. Shakespeare's plays cannot change if a reader spills his tea over a page. The play is independent of the pages on which it is printed. Likewise, pure geometries are independent of the lecture rooms, or of any other detail of the physical world. It is the same story with pure science.

In this sense, Maxwell and Einstein, Eddington and Dirac, were "real" mathematicians, as Hardy says. But when their theories were developed, many shared the thought that the theories they developed were as "useless" as the theory of numbers! In everyday life, only such mathematics or science is "useful" as is wanted by an engineer or common man. Surely, this "everyday" science or mathematics has no particular aesthetic merit. We must, however, realise that what one requires in "useful" mathematics or science is "technique", and this technique has to be taught through mathematics or pure science.

If it is argued that pure science or pure mathematics cannot contribute to the material comfort of mankind, then it is as good as saying that Newton, Abel, Galois, Riemann, Ramanujan, and Einstein wasted their lives! Not even once a thought may have crossed their minds if what they were doing was "useful"! But, it is the Newton's laws that are at the heart of mechanical engineering, or the launch vehicles for satellites and spacecraft. It is the law of universal gravitation that has made satellites and satellite technology possible. The work of Abel and Galois laid the foundations of Group Theory that has tremendous applications to symmetry and conservation laws in physics. It was Einstein's work on population inversion of energy states of electrons in 1920 that made lasers a reality in 1960s. And it was bending of light in a gravitational field predicted by Einstein in the early 20th century that has been helping us today identify the planetary systems of stars other than our own Sun. After nearly a century, Ramanujan's formulae in number theory and complex analysis find applications today in the theory of superstrings that holds the promise of unifying the four fundamental forces we come across in nature - popularly called "The Theory of Everything". How much we owe to these stalwarts whose discoveries were once considered "useless"?

Arthur Stanley Eddington

The great discoveries in mathematics were made by those who were in their twenties or thirties. This holds true for theoretical physics as well. This implies that fundamental discoveries are almost always made by those who are in the prime of their youth, since they are at their creative best. No doubt, a career in mathematics or science offers thrill and excitement no other career offers. I believe this is one single reason why our youth should pursue a career in pure mathematics or pure science - even if the path is a bit bumpy. If so, in the next few years we can expect earth-shaking discoveries from them, even if they do not prove to be "useful" immediately - or find "use" only after a few decades, making our lives even more comfortable!

Paul Adrien Maurice Dirac

* *This article is based on a talk delivered by the author on 25 May 2008 at the valedictory function of a camp for participants of Mathematical Olympiad 2008 at Amity University, Noida. The reader is encouraged to read* A Mathematician's Apology *by G. H. Hardy for a better understanding of the ideas presented herein.*

Letters to the Editor

Great editorials

The way the contents of *DREAM 2047* are improving, I am sure that by 2047 India will become a scientific country. Thanks to you I have been reading this science magazine for the last one year and it has been the root cause of my interest in modern science and astronomy. All your issues till now were mind-blowing. Especially the editorials by Dr. V.B. Kamble are always great. In the July 2009 issue, the editorial about LHC (CERN), and the debate (on danger of generation of anti-matter), as represented in 'Angels & Demons' was really thought-provoking. In addition, there was much detailed information about the most awaited astronomical event this year – Solar Eclipse of 22 July 2009.

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Indore (M P)

Excellent eclipse coverage

I am a regular reader of your monthly magazine *DREAM 2047*. It is a very interesting magazine. The article on the coverage of the total solar eclipse of 22 July 2009 by VP in the September issue was excellent.

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Two new asteroids named after Indian Scientists

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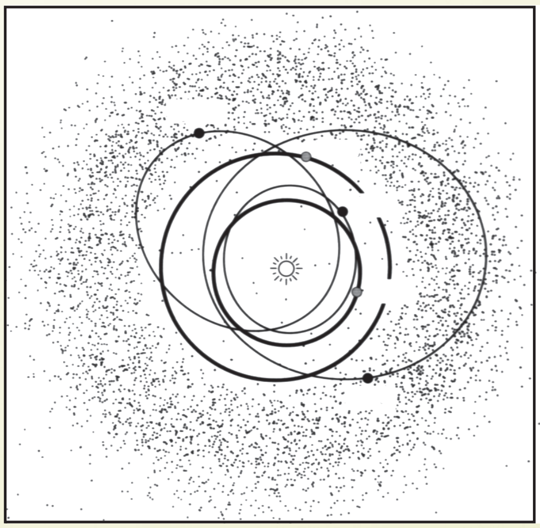
Recently, two distinguished Indians have lent their names to celestial bodies. The International Astronomical Union (IAU) Committee for Small Body Nomenclature (CSBN) has named two asteroids after Professor M G K Menon and Professor J C Bhattacharyya. These two asteroids were discovered at the Vainu Bappu Observatory in Kavalur under 'Project Kalki'. Project Kalki was launched in 1987 to survey and discover asteroids, comets and the elusive tenth planet of the Solar System. It is pertinent that in January 1987, Professor Bhattcharyya was the Director of Indian Institute of Astrophysics (IIA) and Professor Menon, Chairman of the IIA Council.

Discovery of new planets

Since the dawn of civilisation human cultures had identified the five visible planets – Mercury, Venus, Mars, Jupiter and Saturn. Along with Sun and Moon, these seven bodies were distinct from the stars that twinkled in the night sky. After the invention of telescope, the German-born British astronomer William Herschel discovered a new planet – Uranus – on 13 March 1781.

Obviously, the momentous discovery of a new planet inspired many other astronomers to search the skies for other planets that may be lurking around. Meanwhile, Johann Elert Bode, a German astronomer observed that, if you divide the distance from the Sun to Saturn into 100 lengths, then; Mercury is at 4 lengths; Venus is at 7 lengths (4+3); Earth is at 10 lengths (4+6); Mars is at 16 lengths (4+12). Nothing was seen at 28 lengths (4+24); Jupiter is at 52 lengths (4+48); Saturn is at 100 lengths (4+96). Discovery of Uranus too seemed to provide credence to this claim. Bode's rule predicted any planet beyond Saturn to be at 196 lengths (4+192). Although Uranus was actually at 192 lengths, it was so close to 196 that it was thought to affirm Bode's law.

This remarkable confirmation of the relation naturally reinforced Bode's belief, and it likewise persuaded Baron Francis Xaver von Zach, the court astronomer at Gotha, Germany. Both men were convinced there was an undiscovered planet between Mars and Jupiter, near about 28 lengths. Zach was so convinced of the 'missing planet' between Mars and Jupiter that in 1787 he began to search for it in right earnest.



Asteriod belt consist of millions of objects

The Celestial Police and the search for the missing planet

Searching for a new planet was like searching for the proverbial needle in a haystack. However, all the planets then known orbited Sun close to ecliptic along the zodiac. Therefore Zach limited his investigation to the zodiac. But it was not an easy task. Through a telescope a planet so far away might look like a tiny speck of light, just like a dim star. Distinguishing a planet from a star was a daunting task before Zach.

Believing that only a methodical search offered hope of success, he produced for himself a catalogue of zodiacal stars arranged by right ascension. His plan was to first identify all the stars in the zodiac region and catalogue them. Therefore when he saw a speck of light he could verify it with his catalogue – if the speck of light had an entry in the catalogue then it was a star; if not, most likely it could be a planet. The task of cataloguing all the stars in the zodiac region was huge and Zach could not take it alone. He sought help of his fellow astronomers.

21 September 1800, probably without precedent in the history of science, first ever collaborative effort to find the 'missing planet' commenced. On that day six astronomers met in Lilienthal: von Zach himself; J.H. Schröter, the chief magistrate of Lilienthal, whose world-famous collection of instruments included a Herschel reflector of 27-ft (8.23-m) focal length; H.W.M. Olbers, physician from nearby Bremen and a long time collaborator with Schröter; C.L. Harding, who was employed by Schröter and who was himself to discover the third asteroid in 1804; F.A. Freiherr von Ende; and Johann Gildemeister. They decided that even six observers were too few for the task ahead, and nominated instead a group of 24 practising astronomers chosen from throughout Europe. Schröter was elected to be president and Zach the secretary. They named themselves 'Celestial Police'.

The entire zodiac was divided up into 24 zones each of 15° in longitude, and extending some 7° or 8° north and south of the ecliptic in latitude. The zones were allocated to the members by lot. Each member was to draw up a star chart for his zone, extending to the smallest telescopic stars. Like the police who search and ferret out thieves, the Celestial Police, armed with their latest powerful telescopes, went in search of the 'missing planet'.

But Lady Luck had a different plan; she smiled on Rev Father Giuseppe Piazzi, an Italian astronomer. Piazzi was compiling a star catalogue at Palermo Observatory in Sicily, Italy. He unwittingly discovered the first asteroid – a 'missing planet' between the orbits of Mars and Jupiter on 1 January 1801.

Piazzi and discovery of Ceres

It was on a dark and starry night of New Year's Day 1801, Giuseppe Piazzi, an Italian monk, was at work in his observatory on the island of Sicily. He craved for establishment of an observatory at Palermo to chart the southern skies that were not visible to observatories in Europe. That night he was verifying and cataloguing the known stars in the constellation of Taurus. His aim was to catalogue the stars with painstaking accuracy so that measurement of stellar parallax would be feasible. As the earlier catalogues were prepared with imprecise telescopic instruments, he saw the necessity for a revision of the existing catalogues of stars and for the exact determination of their positions.

In fact, in addition to being famous for discovery of Ceres, Piazzi's star catalogue of 1803 and 1814, containing accurate positions of 6,784 and 7,646 stars respectively, are admired and cherished even today. It was while checking the existing star charts to remove inaccuracies that he saw a tiny point of light close by. At first he thought it was just a dim star that had not been included on his chart, so he checked for it the next night, but it alas it had moved from the position it was seen on 1 January. He continued to note its position changes on 3 and 4 January.

Cloudy weather set in for the next few days. Moreover Piazzi fell sick and he could not make his regular observations of the skies. After few days he commenced his regular observation and made a point to notice the movement of the tiny speck of light. By 24 January, when he observed the position of the speck of light, Piazzi realised what he had discovered. He had an inkling that what he was observing was yet another 'wanderer' – a planet. The elusive star-like object had shifted considerably from its position. On 24 January, Piazzi announced his discovery in letters to fellow astronomers. He wrote a friend: "I have announced the star as a comet. But the fact that the star is not accompanied by any nebulosity (clouds of dust and gas) and that its movement is very slow and rather uniform has caused me many times to seriously consider that perhaps it might be something better than a comet. I would be very careful, however, about making this conjecture (this idea) public." Piazzi had in fact measured the position of the object on a total of 24 nights between 1 January and 11 February, though some positions were marked as 'doubtful' or even 'very uncertain'. Clearly what he was observing was not a star!

Vainu Bappu Observatory (VBO)

He wrote a similar letter to Bode, director of the Berlin Observatory the next day, detailing his observations. However, Bode did not receive it until 20 March, as there was a war in Italy. Napoleon had invaded Italy and cut off communication routes. When the letter finally reached Bode, he studied his star maps and convinced Piazzi that he had found the "missing planet" that his 'law' had predicted; after all such a discovery was what Bode was expecting. Piazzi named the object Ceres. Piazzi's friend, Baron von Zach announced the discovery in his *Monthly Correspondence* in the summer of 1801.

Two is company; three is crowd

One may hasten to think that the Zach's effort went waste as Ceres was discovered by Piazzi. In fact, Zach's celestial police was not in vain; rather they discovered too many planets. Heinrich Olbers, a member of the Celestial Police discovered Pallas, which too was in the same orbital area of Ceres, on 28 March 1802. Karl Harding, another member of the Celestial Police, found Juno in September 1804. Heinrich Olbers discovered Vesta in March 1807. Soon other astronomers were also discovering new planets. However, there was something fishy in the discoveries; all these 'planets' seemed to occupy the same orbital area as that of Ceres.

Things appeared to cool off; the fifth planet in the same orbital region, Astraea was discovered only in 1845, nearly 38 years after the discovery of Vesta. However, soon the floodgate of discovery of planets burst at its seam with the discovery of three new 'planets' in 1874. By the end of 1851 there were 15 'planets', although astronomers felt disquieted, they still listed all of them as planets – Solar System then consisted of 23 planets including Neptune (discovered in 1845), Uranus, and 15 'planets' in the orbital region of Ceres. By 1668 more than 100 objects were discovered in that region. Surely things were becoming unseemly.

One, two, three.... planets in the same region and orbit were discomforting, but still acceptable. One hundred 'planets' swarming like bees in the same region was a bit too much. Astronomers realised that something was amiss. In fact, due to their star-like appearance, Herschel had declared even as early as 1802 that "from their asteroidal appearance, I shall take my name, and call them asteroids".

Asteroids in tons

By the late 1890's, with improvements in telescope and photography, some 322 asteroids were discovered. Slowly and steadily the numbers increased and by 1991 more than 4,500 were catalogued, with 4,200 having accurate enough orbital parameters to predict its future positions. In recent years, with the availability of computers to identify the asteroids, the numbers of objects have exploded. By October 2006, 1,25,000 asteroids had been discovered out of which some 1,35,00 have been even given proper or given names. Recent studies estimate that there are about 3,60,000 asteroids. Mostly, we have little information about their physical characteristics, such as their general size and shape – though in recent years the situation has been improving.

Many asteroids orbit the Sun roughly between the orbits of Mars and Jupiter with distances of between 2.0 and 2.5 Astronomical Units (300 to 375 million km). Due to perhaps millions of fragments orbiting the Sun at similar distances, once it was popularly believed that asteroids were formed when a large moon or Mars-sized planet disintegrated. This once prominent theory is losing its favour amongst astronomers. It is now believed that these objects are incomplete remnant from the beginning of the Solar System; rocks and boulders that could not fuse together to form into a proper planet.

Project Kalki

Kalki is the mythical tenth (yet-to-come) *avatar* of Hindu God Vishnu. Alluding to the potential discovery of a tenth planet, Indian Institute of Astrophysics, Bangalore commenced a project, named Kalki, in 1987 to survey the sky to discover planets beyond Pluto, comets, and asteroids. A 45-cm Schmidt telescope was built by the IIA in 1985. The new telescope was installed at the Vainu Bappu Observatory (VBO) at Kavalur. In 1987 January Project Kalki was launched.

As seen from Earth, if any planet is at near opposition (that is the object is opposite to the direction of Sun in the sky) then it would be brighter, and closer to Earth. Thus astronomers decided to search the regions near opposition. Unlike the Celestial Police, astronomers were not planning to painstakingly chart the positions of the stars seen through the telescope; they used photography. Thus, regular photography of the regions near opposition was planned with the same region being repeated after a one-day interval. Comparison of the two photographs would reveal asteroids, as it changes its position from one day to another. The two photographs of the same region taken with a one-day interval were projected on to the screen and blinked. If both the images have same set of objects then no movement would be detected. However, if any object had shifted its position, then that object would appear to flicker in the screen. But not all flickers were due to asteroids; often they were noise in the photographs. To eliminate such errors he photographs were compared with the standard chats of the sky such as the Palomar charts.

R. Rajamohan, led the project team consisting of K. Kuppuswamy, V. Moorthy and A. Paranjpye. In addition Shri PN Shankar of Bangalore Amateur Astronomical Association coordinated the volunteers who assisted in blinking the photographs.

Within a year of commencement of Project Kalki, on 17 February 1988, the first discovery using the new facility was reported. The new asteroid was given a temporary name 1988 DQ1. The asteroid was subsequently followed at VBO and a total of five positions were reported to the Minor Planet Center (MPC) of IAU. An asteroid is given a permanent number under the MPC only when its orbital parameters are calculated and the object is seen to move in the predicted orbit. Thus there is always a delay in between the first sighting of the object and its actual confirmation. In 1989, once its orbital parameters were confirmed, this asteroid was named Ramanujan after the great Indian mathematician Srinivasa Ramanujan.

Way back in 1861, Normon Pogson, a British astronomer, with the assistance of an Indian astronomer Chintamany Ragunathachary, discovered an asteroid, subsequently named Asia, from the Madras Observatory. Between 1861-1885 he discovered four more asteroids from the Madras Observatory. Project Kalki was the first major astronomical discovery in the twentieth century from India. Under project Kalki, five more asteroids were discovered between 1988 and 1990. The details were reported by Rajamohan to the Minor Planet Center and these were assigned the temporary names – 1988 DR, 1989 CD4, 1988 CA, 1988 BX and 1990 BC2. Their paths were followed at VBO for some time, but alas the project Kalki was wound up before these discoveries were confirmed.

All these asteroids subsequently received their numbers when their orbits were confirmed following the procedure of their recovery at predicted positions. Two of these, (4706) 1988 DR and (5178) 1989 CD4 were named Dennisreuter in 2004 and Pattazhy in 2006 respectively, after Dennis C. Reuter, a physical chemist in NASA, USA, and Sainudeen Pattazhy, an environmental scientist in India. Thus three of the five were named and confirmed. Two remained unnamed.

Later, astronomers elsewhere followed 1988 BX and 1988 CA; their orbital parameters were calculated and confirmed. Thus they were given MPC numbers (8348) and (7564) respectively. As these asteroids were discovered by R Rajamohan, he was given the offer to propose the names for these asteroids. He recommended that they be named 'Bhattacharyya' and 'Gokumenon' respectively, after Professor J C Bhattacharyya and Professor M G K Menon for their support and encouragement to Project Kalki. In August 2008, Rajamohan's proposal received official approval. Gokumenon and Bhattacharyya now join Ramanujan (4130), Vainu Bappu (2596), Mrinalini (2986), and Sarabhai (2987), among the asteroids in the sky named after distinguished Indians.

Remedies and Cures for Muscle Cramps and Strains

☐ Dr. Yatish Agarwal
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> I have thought of a pulley to raise me gradually; but that would give me pain, as it would counteract my natural inclination. I would have something that can dissipate the *vis inertiae* and give elasticity to the muscles. . . . We can heat the body, we can cool it; we can give it tension or relaxation; and surely it is possible to bring it into a state in which rising from bed will not be a pain.
>
> —Samuel Johnson *Life of Samuel Johnson*

Muscles make the body go. Without them, man could well have been rooted to Mother Earth like a tree. We rely on them to accomplish all our bodily movements. Together, they make nearly two-fifth of the body weight and are one of the most abundant tissues in the human body. Even children wish for strong muscles so that they can pretend to be Jackie Chan, Captain Planet, or nearer home, Sunil Shetty, Salman or SRK.

Despite being symbols of strength, muscles can run into many different kinds of problems.

MUSCLE CRAMPS

The most common is cramps, wherein a part of one or more muscles ties itself into a knot. There is pain and the affected muscle cannot relax. It happens all of a sudden, and can last up to many minutes.

Most often it is the muscles of the calf or foot that suffer. This causes a halting limp reminiscent of the gait of the lame, old family horse, Charley, and that is how the condition got its name, "Charley horse".

You should never feel anxious about muscle cramps. They are nothing to worry about. With a little guile, you can prevent them. And if they still occur, you can treat them. The recipes are simple.

Do not let cramps be a spoilsport : Any physical exertion on a hot sultry day can cause cramps. Be it the school playground, a tennis court, a cricket pitch, players have been helped off the field due to their being suddenly affected by cramps. The remedy in such a situation is easy. Just drink plenty of isotonic liquids. Add a teaspoon of salt, a pinch of baking soda and lemon to your taste in half a litre of good clean

water and drink. Presto! Make it a habit that whenever you are engaged in any physical exertion, consume lots and lots of liquids.

Give your children plenty of lemony isotonic solution after they return from an exhausting game outside. Let them also carry a water bottle to the play field. This is the easiest way to beat cramps.

Take vitamin E and magnesium : In some people, particularly elders, cramps occur even while resting – at times during sleep. If you suffer from such cramps frequently, try vitamin E pills and magnesium. Magnesium is found in many natural foods. It is in abundance in dried sweet melon seeds (*kharbooje ke beej*), rice bran and spinach and in fair quantity in all cereals and many vegetables.

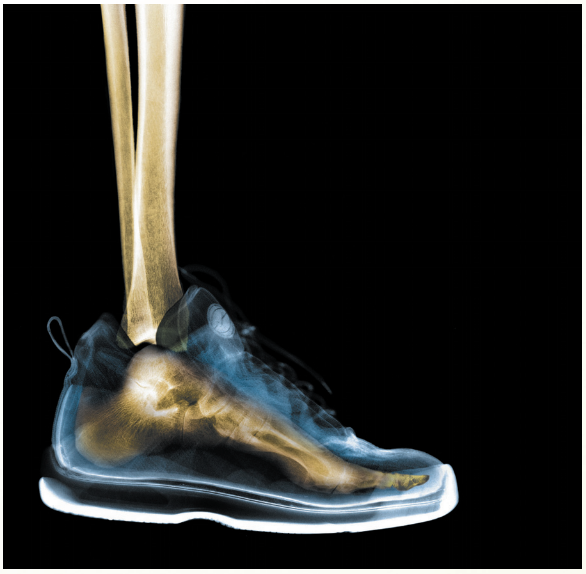
Do not step under a cold shower : A sudden exposure to cold can also sometimes evoke cramps. Never step suddenly into a cold pool or under a cold shower.

Rub for relief : A little kneading can work like magic and quickly relieve you of muscle cramps. But always rub with the muscle, never across it. For instance, if cramps affect your calf muscles, start behind the knee and rub towards the heel.

Stretch for success : A good stretch immediately brings results. Stretching exercises are the best recipe to ease your agony.

The exercise depends on the part that is affected: If it is the thigh that is causing you problems, here is a good method to treat it. Stand on the good leg and grasp the ankle of the affected leg from behind. Then slowly pull the ankle towards your buttocks and hold for ten to fifteen seconds. That provides a nice stretch, and almost always yields results.

Another way of giving a good stretch to the thigh is to sit on the floor and to extend the leg.



Stretching the calf muscle is also not difficult. Just make an upward movement of the foot on the affected side.

Get up and walk : Walking also limbers up and loosens the stiff muscles and provides quick relief from cramps. It is the best measure to adopt during pregnancy when some fifteen to thirty per cent women suffer cramps in the thighs, calves or buttocks.

MUSCLE STRAIN

A muscle becomes strained or "pulled" – or may even tear – when it stretches unusually far or abruptly. This type of injury often occurs when muscles suddenly and powerfully contract. A slip on the ice or lifting in an awkward position may cause a muscle strain.

MEASURING THE SEVERITY OF MUSCLE STRAIN

Muscle strains can vary considerably in their severity:

Mild : Causes pain and stiffness when you move and lasts a few days.

Moderate : Causes small muscle tears and more extensive pain, swelling and bruising. The pain may last 1 to 3 weeks.

Severe : Muscle becomes torn apart or ruptured. You may have significant internal bleeding, swelling and bruising around the muscle. Your muscle may not function at all. Seek medical attention immediately.

FIRST AID MEASURES

If you suspect suffering a muscle strain, take the following first-aid measures:

Protect the limb from further injury: Use an elastic wrap, a sling, splint, cane, crutches or an air cast to give it adequate support. Do not put weight on the injured limb.

Rest the injured part : Avoid activities that cause pain, swelling or discomfort. While the muscle tissues heal, desist from all such activities that may aggravate the strain. This would promote tissue healing and quicken recovery.

Use cold compresses : Apply a cold pack to the sore area to prevent

inflammation and swelling. Use an ice pack or slush bath for about 15 minutes for it to be effective. Repeat every 2 to 3 hours during the first 48 to 72 hours. Cold compresses reduce the pain, swelling and inflammation in the injured muscle tissue, connective tissue and joints. If a tear has occurred, it will also help slow the bleeding.

Wrap the injured limb in an elastic bandage : This will help check the swelling from growing. Begin by wrapping the bandage around the end farthest from the heart. However, do take care not to wrap too tightly. An extra tight bandage can easily hinder circulation. Loosen the bandage if the pain worsens, the affected area begins to feel numb or if the swelling below the wrapped area gets worse.

Elevate the limb . Raise the injured area above your heart, especially at night. Gravity helps reduce swelling by draining excess fluid. After 48 hours, if the swelling is gone, you may apply warmth or gentle heat. Heat can improve the blood flow and speed healing.

Use over-the-counter analgesic medications : A variety of pain relieving medications exist, among them paracetamol, aspirin, ibuprofen, can help alleviate the pain. However, it may be best to avoid aspirin in the first few hours of the injury since aspirin may worsen the bleeding. Don't give aspirin to children.

WHEN TO SEEK MEDICAL HELP

If you experience any of the following symptoms, seek medical help immediately:

- If the injured area is intensely painful and/or swells up severely
- If you suspect a ruptured muscle or broken bone
- If the pain, swelling and stiffness do not show signs of improvement within the next two to three days

The earlier the proper treatment is initiated, the speedier and better is the recovery.

Recent Development in Science and Technology

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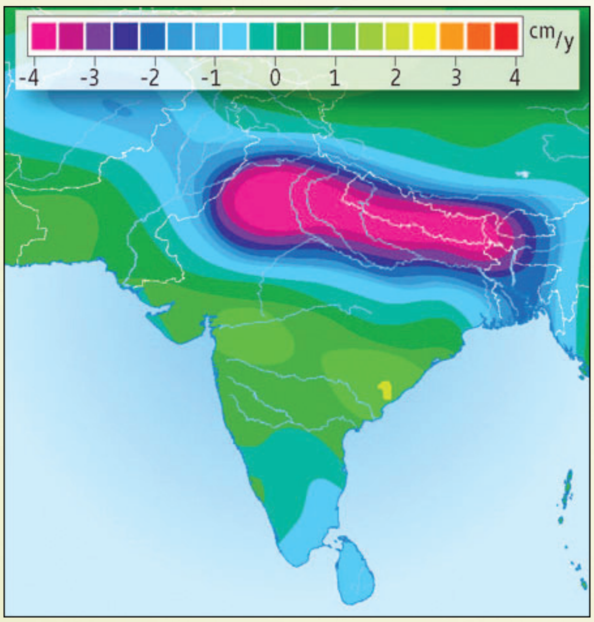
Satellite data confirms dramatic drop in India's groundwater

With the failure of the 2009 southwest monsoon large parts of India has been in the grip of severe drought that may badly impact the country's *kharif* food production. To counter the lack of rain many state governments provide free electricity to farmers for pumping water for irrigation, drawing on underground water. There have been apprehensions that indiscriminate use of groundwater for irrigation and industrial and domestic purposes could lead to sharp fall in underground water table that could seriously affect future water availability, but no quantitative study had ever been done. Now satellite data is available, which show that groundwater beneath northern India has indeed been receding fast – by as much as 4 centimetres per year between August 2002 and October 2008. The finding came out of a six-year study by the *Gravity Recovery and Climate Experiment* (*GRACE*) satellite mission, as a joint effort by the US National Aeronautics and Space Administration and the German Aerospace Center. The *GRACE* satellite mission was launched in March 2002. Actually two satellites orbiting in tandem 220 kilometres apart, *GRACE* allows scientists to estimate changes in groundwater storage by measuring tiny variations in the Earth's gravitational pull. It enables them to observe how water storage evolves from one month to the next in critical areas of the world.



Several centimetres' worth of water (pink) disappears each year from beneath the northern Indian subcontinent. (Map adapted from V. M. Tiwari, et al.*, National Geophysical Research Institute)*

Using data from the two satellites, hydrologists of University of California, Irvine and NASA have calculated that more than 109 cubic kilometres of groundwater disappeared from the region's aquifers between 2002 and 2008 – double the capacity of India's largest surface-water reservoir, the Upper Wainganga in Madhya Pradesh. The finding was published online in *Nature* on 12 August 2009 (doi:10.1038/nature08238). According to the researchers, the loss is particularly alarming because it occurred when there were no unusual trends in rainfall. In fact, rainfall was slightly above normal for the period studied. The researchers also examined data on soil moisture, lake and surface reservoir storage, vegetation and glaciers in the nearby Himalayas to confirm that the apparent groundwater trend was real. The only influence they could not rule out was human.

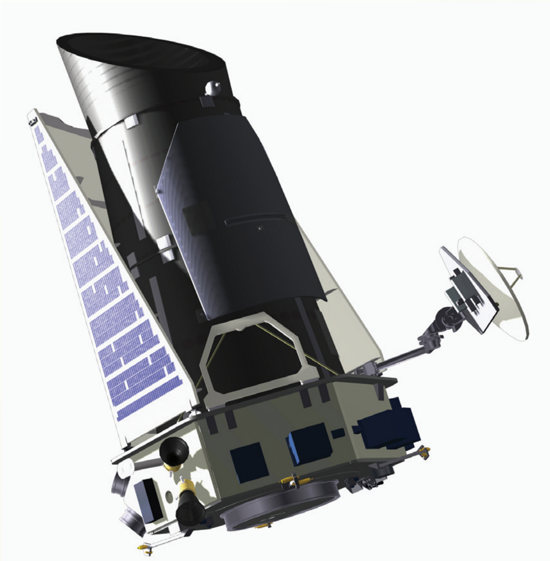
It is true that the region has seen an enormous increase in water use since the 1960s. Part of that is because of the growing population, though even more resulted from the so-called Green Revolution, which dramatically increased India's agricultural production in part by rapid expansion of the use of groundwater for irrigation. In fact, the northern Indian states of Rajasthan, Punjab and Haryana have all of the ingredients for groundwater depletion: staggering population growth, rapid economic development and water-hungry farms, which account for about 95 percent of groundwater use in the region. According to the scientists, groundwater in the region is being pumped and consumed by human activities – principally to irrigate cropland – faster than the aquifers can be replenished by natural processes.

Groundwater comes from the percolation of precipitation and other surface waters down through Earth's soil and rock, accumulating in aquifers – cavities and layers of porous rock, gravel, sand or clay underground. In some underground reservoirs, the water may be thousands to millions of years old; in others, water levels decline and rise again naturally each year. But groundwater levels do not respond to changes in weather as rapidly as lakes, streams and rivers do. So when groundwater is pumped for irrigation or other uses, restoration of original levels can take months or years, which is not happening at present. Groundwater mining – that is when withdrawals exceed replenishment rates – is a rapidly growing problem in many of the world's large aquifers.

The new finding should be an eye-opener for Indian agriculturists and planners, as the situation is really grave. According to Mathew Rodell, lead author of the study, "If measures are not soon taken to ensure sustainable groundwater usage, consequences for the 114 million residents of the region may include a collapse of agricultural output, severe shortages of potable water, conflict and suffering." The only way to prevent the situation from getting worse is to restrict use of ground water and go for extensive rainwater harvesting.

Kepler discovers exoplanet atmosphere

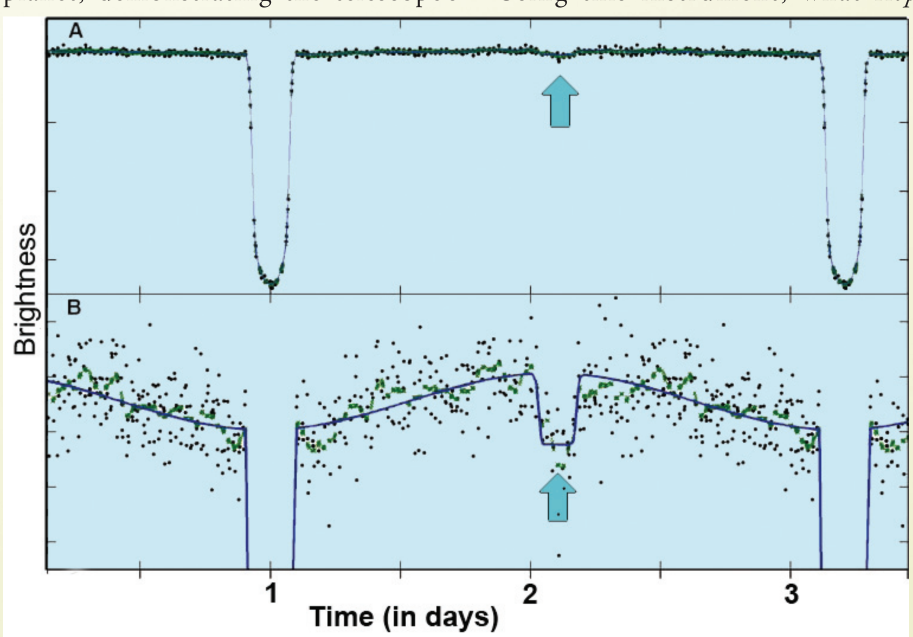
The NASA spacecraft *Kepler*, which was launched in March 2009 to search for



The *Kepler* spacecraft

Earth-like planets, has detected atmosphere around a known giant gas planet, demonstrating the telescope's extraordinary scientific capabilities (*Science*, 6 August 2009). The discovery was made after analysis of just the first 10 days' data, which, according to the researchers, is an extraordinary achievement. The giant extra-solar planet HAT-P-7b is one of the roughly two dozen exoplanets that have been discovered by ground-based observations and the *CoRoT* mission. HAT-P-7b, located about 1,000 light years from Earth, is comparable to Jupiter in size and orbits a star similar to our Sun. The planet orbits the star in just 2.2 days and is 26 times closer than Earth is to the Sun. According to authors of the Science paper, the detection of an atmosphere around so distant a star demonstrates that *Kepler* is operating at the level required to detect Earth-size planets.

The main *Kepler* instrument is a specially designed 0.95-metre diameter telescope with a photometer attached. It has a very large field of view for an astronomical telescope – 105 square degrees, which is comparable to the area of one's palm held at arm's length. Using this instrument, what *Kepler* detected was a smooth rise and fall of the light caused by the changing phases of the planet, similar to the phases of our own Moon, as the orbiting planet transited, or crossed in front of, its parent star. *Kepler* could also see the planet's light vanishing completely when it passed behind its parent star. From the shape and amplitude of the light curve the researchers conclude that the planet has an atmosphere with a day-side temperature of about 2,300 degrees Celsius. With such high temperature, the planet has been aptly described as a 'hot Jupiter.'

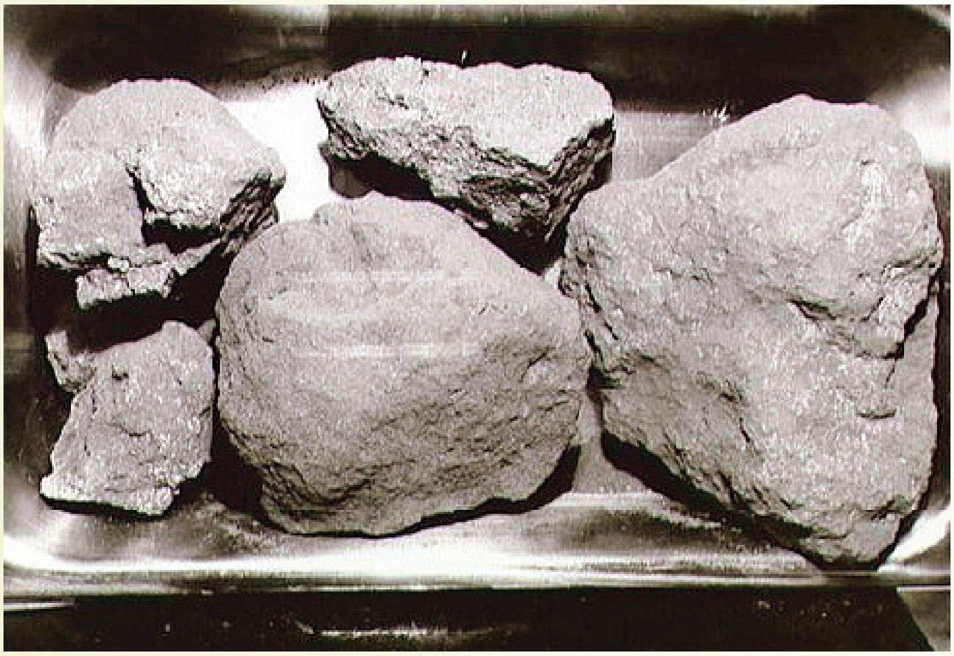


Curve showing the smooth rise and fall of light (as the exoplanet orbited its star), as recorded by Kepler. *The small drop in light exactly halfway between each transit (blue arrow) is caused by an occultation – the planet passing behind the star. In the bottom curve the drop due to occultation is shown magnified. (Source: NASA)*

The observed brightness variation of HAT-P-7b is just one and a half times what is expected for a transit caused by an Earth-sized planet. Although this is already the highest precision ever obtained for an observation of this star, *Kepler* will be even more precise after analysis software being developed for the mission is completed. *Kepler* will spend three and a half years surveying more than 100,000 Sun-like stars in region of the constellations Cygnus and Lyra in the northern sky. Astronomers estimate that if even one percent of stars host Earth-like planets, there would be a million Earths in the Milky Way alone. If that is true, hundreds of Earths should exist in *Kepler*'s target population of 100,000 stars.

Scientists produce oxygen from Moon rock

Moon has no atmosphere and humans need oxygen to breathe. The *Apollo* astronauts had to carry all the oxygen they needed during their brief stay on Moon. If permanent bases are to be set up on Moon, as are being planned now, oxygen has to be made available to the occupants if they have to stay longer on Moon's air-free environment. But carrying huge amounts of oxygen to the Moon would be extremely expensive – perhaps costing as much as US$100 million per tonne according to some estimates. So researchers are examining potentially cheaper ways to produce oxygen on the Moon itself and news of success has already come. Scientists in



Moon rocks

Cambridge, UK, have developed a reactor that can make oxygen from Moon rock, especially the mineral ilmenite – a mineral composed of titanium and iron oxide, or rust, and contains oxygen that is relatively easy to extract.

NASA has been looking for ways to get oxygen from Moon rock for several years. In 2005, as part of its Centennial Challenges programme, the agency offered a US$250,000 prize to the first team to come up with a piece of kit that could extract five kilograms of oxygen in eight hours from some simulated Moon rock. But despite raising the value of the prize to $1 million in 2008 the prize remains unclaimed. Now, Derek Fray, a materials chemist from the University of Cambridge, UK, and his colleagues have come up with a modified electrochemical process to extract oxygen from Moon rocks. The original process used metal oxides – also found in Moon rocks – as a cathode, together with an anode made of carbon. To get the current flowing through the system, the electrodes were immersed in an electrolyte solution of molten calcium chloride ($CaCl_2$) with a melting point of almost 800°C. This arrangement, however, produced the pure metal at the cathode and carbon dioxide, not oxygen, at the carbon anode, which got eroded.

To make the system produce oxygen and not carbon dioxide, Fray had to make an unreactive anode made of calcium titanate to which some calcium ruthenate has been added. This mixture produced an anode that barely erodes at all. But more importantly, it produced oxygen at the anode. In their tests, Fray and his colleagues did not use real Moon rock but a simulated lunar rock called JSC-1, developed by NASA. The findings were published online on 10 August 2009 in the journal *Nature* (doi:10.1038/news.2009.803). According to the researchers, three reactors, each a metre high, would be enough to generate a tonne of oxygen per year on Moon. Three tonnes of rock are needed to produce each tonne of oxygen, and in tests the team saw almost 100% recovery of oxygen.

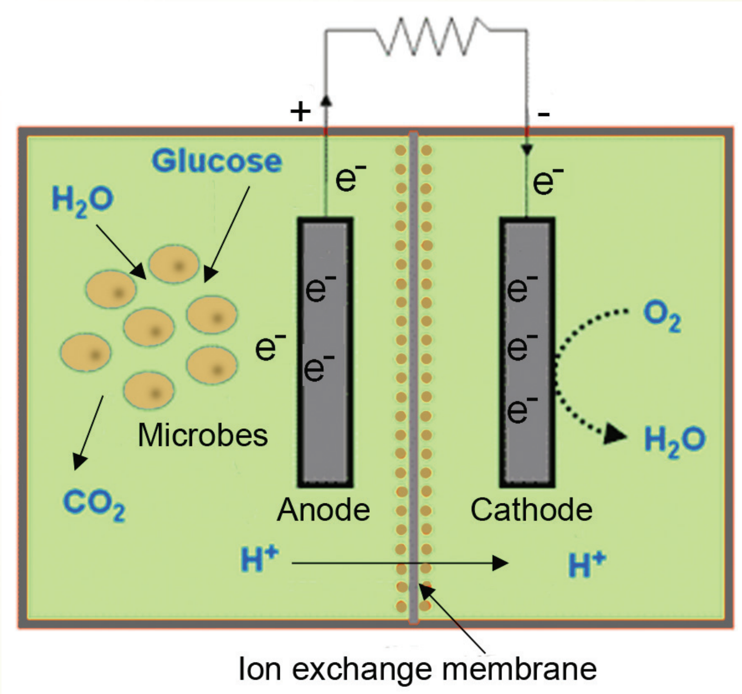
According to Fray, just a small amount of power would be needed to heat the reactor on the Moon and the reactor itself can be thermally insulated to lock heat in. Three reactors would need about 4.5 kilowatts of power, which could be supplied by solar panels or even a small nuclear reactor placed on the Moon.

Microbes clean wastewater and desalinate water

Purifying dirty water is expensive and so is the process of desalinating for getting potable water. Two methods are currently used for desalinating water. One process called reverse osmosis pushes water under high pressure through membranes that allow water to pass but not salt. Another method called electrodialysis uses electricity to draw salt ions out of water through a membrane. Both methods require large amounts of energy. Yet, clean water for drinking, washing and industrial uses is a scarce resource in many parts of the world and is becoming scarcer. Its availability in the future will be even more problematic. Now a team of Chinese and American researchers – Xia Huang of Tsinghua University, China and associates, and Bruce E. Logan of Penn State University, USA – have come up with a process that cleans wastewater and generates electricity and can also remove 90 percent of salt from brackish water or seawater (*Environmental Science & Technology*, 12 August 2009). The new technology is based on microbial fuel cells, which use microorganisms as catalysts to convert chemical energy to electrical energy and also desalinate water without any additional energy.

It has been known that microbes are capable of creating electricity while reducing organic wastes and that these processes can be exploited using devices called microbial fuel cells. Microbial fuel cells have many potential advantages over traditional methods of generating electricity, and have been investigated in the past, including by NASA in the 1960s for application to power generation in space. The most important advance in this area in recent years has been the discovery of microbes that are far more efficient at creating electricity from organic matter than previous candidate organisms. Further, advances in biotechnology have enabled the optimization of these electricity-producing organisms for various applications.

A typical microbial fuel cell consists of two chambers, one filled with wastewater or other nutrients and the other with water, each containing an electrode. Naturally occurring bacteria in the wastewater consume the organic



Schematic diagram of a microbial fuel cell. In the modified cell two membranes are used between the anode and cathode, creating a middle chamber between the membranes for water desalination.

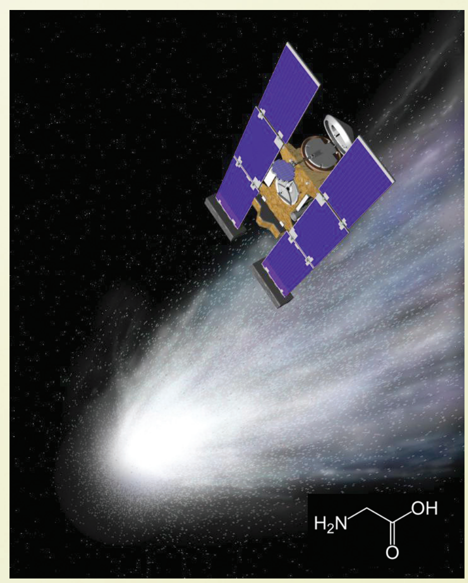
material and produce electricity. The researchers modified the microbial fuel cell by placing two membranes between the anode and cathode, creating a middle chamber between the membranes for water desalination. They placed an anion exchange membrane adjacent to the anode, and a cation exchange membrane next to the cathode. Salty water to be desalinated is placed in the central chamber. When current was produced by bacteria on the anode, ionic species in the middle chamber were transferred into the two electrode chambers, desalinating the water in the middle chamber. Here water desalination is accomplished without using electrical energy or high water pressure by using a source of organic matter as the fuel to desalinate water.

In the modified microbial fuel cell when the bacteria in the cell consume the wastewater it releases charged ions – protons (H^+ ions) – into the water. These protons cannot pass through the anion membrane, so negative ions (Cl^-) move from the salty water into the wastewater chamber. At the other electrode (cathode) protons are consumed, so positively charged ions (Na^+) move from the salty water to the other electrode chamber. Thus both Na^+ and Cl^- ions are removed from the middle chamber, desalinating the water contained there. At the same time the middle desalination cell releases ions into the outer chambers that help to improve the efficiency of electricity generation compared to simple microbial fuel cells.

Life's building block discovered in comet dust

The origin of life on Earth still remains a mystery, notwithstanding a number of hypotheses that have been put forward from time to time. According to one hypothesis, some of life's ingredients formed in space and were delivered to Earth long ago by meteorite and comet impacts, and it appears this may well be true. Recently NASA scientists have discovered glycine, an amino acid and a fundamental building block of life, in samples of comet Wild 2 returned by NASA's *Stardust* spacecraft. Glycine is one of 20 amino acids used by living organisms to make proteins, and this is the first time an amino acid has been found in a comet. In a recent paper in the journal *Meteoritics and Planetary Science*, Jamie Elsila of NASA's Goddard Space Flight Center in USA and her team report the results of analysis of cometary dust brought back by *Stardust*. According to Carl Pilcher, Director of the NASA Astrobiology Institute, which co-funded the research, "The discovery of glycine in a comet supports the idea that the fundamental building blocks of life are prevalent in space, and strengthens the argument that life in the universe may be common rather than rare."

NASA had launched *Stardust* in 1999, and the robot spacecraft met comet Wild-2 beyond the orbit of Mars in January 2004. The craft flew within 240 kilometres of the comet's nucleus and trapped particles spewing from the body in a light, porous foam called aerogel. After a 4.6-billion-kilometre journey, *Stardust* returned to Earth in January 2006 with a payload of thousands of tiny particles from Wild-2. Since then, more than 180 scientists around the world have been busy analysing the samples to learn the secrets of comet formation and our solar system's history, but this is for the first time that an amino acid has been detected in the sample. The researchers ruled out the possibility that the glycine detected could have come from



Stardust *spacecraft and comet Wild 2. The molecular structure of glycine is shown at bottom right. (Credit: NASA/JPL)*

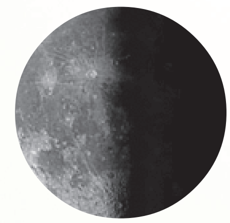
terrestrial sources as contamination by determining it isotopic composition. A glycine molecule from space would tend to have more of the heavier carbon-13 isotope in it than glycine that is found on Earth. And that is exactly what the team found.

Sky Map for October 2009

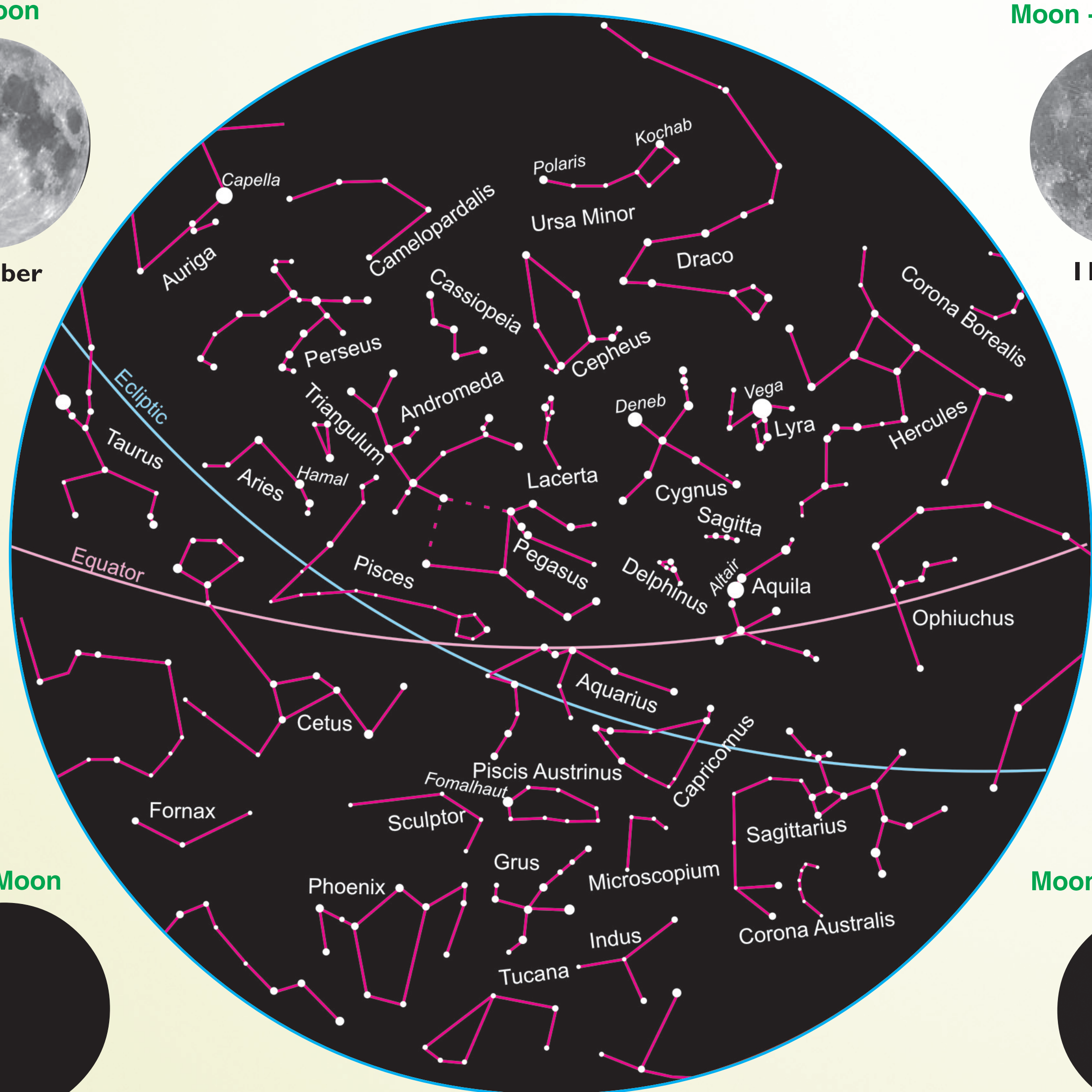
Full Moon

4 October

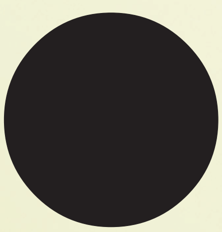
Moon - Last Quarter



11 October



New Moon



18 October

Moon - First Quarter

26 October

The sky map is prepared for viewers in Nagpur (21.090 N, 79.090 E). It includes constellations and bright stars. For viewers south of Nagpur, constellations of the southern sky will appear higher up in the sky , and those of the northern sky will appear nearer the northen horizon. Similarly, for viewer north of Nagpur, constellations of northern sky will appear higher up in the sky, and those of the southern sky will appear nearer the southern horizon. The map can be used at 10 PM on 1 October, at 9 PM on 15 October and at 8 PM on 31 October.

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2009

Tips to use sky map:

(1) Choose a place away from city lights/street lights. (2) Hold the sky-map overhead with North in the direction of Polaris. (3) Use a pencil torch for reading the sky map. (4) Try to identify constellation as shown in the map one by one.

Visibility of Planets[1] (IST)

	Rising	Setting	In the Zodiac
Mercury	05:48	17:10	Leo-Virgo
Venus	04:37	16:46	Leo-Virgo
Mars	00:08	13:22	Gemini-Cancer
Jupiter	14:21	01:35	Capricorns
Saturn	04:30	16:40	Virgo
Uranus*	16:17	04:14	Pisces-Aquarius
Neptune*	14:42	02:05	Capricorns

[1]Time shown is subject to vary (± 1 hr) from place to place.
*Not naked eye object

Sky Event

Date	IST	Event
06	06:29	Mercury at greatest Elongation (W)
12	06:56	Moon Mars
13	17:58	Moon at perigee
13	19:12	Venus-Saturn
17	00:28	Moon-Venus
26	04:48	Moon at apogee
27	14:12	Moon-Jupiter

□ Arvind C. Ranade
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Editorial (Contd. from page 39)

Influenza or flu viruses have their genes in eight segments. If two or more strains of flu infect the same animal, their progeny can receive a mix of these segments, thus giving rise to a new strain. Pigs are a particular problem because apart from swine flu viruses, they can also carry human and bird flu viruses. The new H1N1 virus has never been seen before, either in humans or in animals, but is already well-adapted for transmission in humans.

So far, most people who have contracted the new A(H1N1) virus infection have experienced influenza-like symptoms [such as sore throat, cough, runny nose, fever, malaise (mild sickness or depression), headache, joint/muscle pain] and recovered without antiviral treatment. But, how does the A(H1N1) virus work, anyway? The influenza virus usually enters the body through the respiratory tract. In the absence of antibodies - which is the case when a *new* virus invades the cells - the virus enters the cell and makes its own copies. It is the haemagglutinin (HA) protein on its surface that allows virus to bind to host cells and enter it. The neuraminidase (NA) protein would then help the viruses that have multiplied inside the cell to break out and infect other healthy cells in the body. But now our body fights back. Our immune system has several layers of defences including killer T-cells, which attack the cells overcome by the viruses. The first time we get infected, our immune system has to rely initially on innate, non-specific defences. But it also evolves specific defences, learning to make antibodies and immune cells. Eventually new antibodies are created that can neutralise viruses before they infect cells. This process can take a few weeks or more. Antibodies bind to the virus's haemagglutinin (HA) receptors and block the virus from entering the cells.

True, there is no cure for viral infections, but antiviral drugs can lessen the severity and duration of influenza. There are two classes of antiviral drugs for influenza: inhibitors of neuraminidase (NA) such as oseltamivir (Tamiflu) and zanamivir (Ralenza); and adamantanes, such as amantadine and rimantadine, that prevent the flu virus from multiplying inside the infected cells. Tests on viruses have indicated that current new A(H1N1) viruses are sensitive to neuraminidase inhibitors, but are *resistant* to the other class, the adamantanes. However, over a period of time resistance can develop to antiviral drugs used for influenza.

How about vaccines to treat influenza? We may note that new strains of influenza viruses continue to appear and replace older strains. While multiplying inside a cell, viruses can make mistakes in their genetic material or even re-assort with other influenza viruses, creating new strains that our immune system cannot recognise. When a new strain of human influenza virus emerges, antibody protection that may have developed after infection or vaccination with an older strain may not provide protection against the new strain. This is why seasonal human influenza vaccines against A(H1N1) and A(H3N2) and an influenza B virus need to be redeveloped every 1-3 years to account for mutations in the HA and NA proteins of circulating viruses. Influenza vaccines generally contain a dead or weakened form of a circulating virus. Since the A(H1N1) virus is new, there is no vaccine currently available made with this particular virus. Making a completely new influenza vaccine can take five to six months. Most of these vaccines are produced using chicken eggs, while a few manufacturers use cell culture technology for vaccine production.

We may note that seasonal influenza causes 3 million to 5 million cases of severe illness, and kills from 2,50,000 to 5,00,000 people every year! Continued immunization against seasonal influenza is therefore equally important. Hence we cannot stop production of seasonal vaccine to make a vaccine for A(H1N1). Moreover, stopping seasonal vaccine production immediately would not allow a pandemic vaccine to be developed faster anyway!

The first of several vaccines for A(H1N1) is expected to be available by October 2009. However, a survey conducted recently in Hong Kong has revealed that over half of the 8,500 healthcare workers were unwilling to be vaccinated against influenza A(H1N1) owing to fear of the vaccine's side-effects and doubts about its effectiveness. A third of nurses in the United Kingdom refused to be vaccinated for the same reasons. Surely, a complete clinical evaluation is highly advisable. But, it becomes difficult in the case of influenza because the virus keeps changing continuously. Decades of experience with seasonal influenza vaccines indicates that introduction of a new strain in a vaccine should not substantially affect the safety or level of protection offered. This is all the more important because a healthcare breakdown during an epidemic owing to doctors and healthcare workers remaining absent is a horrifying prospect! And it must be averted at all costs!

What next for the A(H1N1) virus? It could mutate in such a way that it would become less transmissible and hence may disappear, but scientists believe that is unlikely. Or else, it could stay genetically stable, remaining highly infectious, but not especially deadly. In the worst scenario, A(H1N1) could re-assort with seasonal flu or the bird flu virus A(H5N1) becoming even more virulent and lethal. Shall we never be able to beat the virus?

Many once-common diseases, from smallpox to polio, have been eliminated, or nearly so, by vaccinating the children. If only we could develop a vaccine that was effective against *all* strains of flu, we might prevent both annual epidemics and occasional pandemics like A(H1N1) now under way. Recent work suggests that it may be possible to create *just* such a vaccine! When our immune system attacks the flu virus, it mainly targets haemagglutinin (HA), and to a lesser extent neuraminidase (NA). These proteins mutate rapidly, so our immune "memory" does not protect us from new flu strains. However, there are 'conserved' proteins that are almost identical in all flu viruses. The idea is to create vaccines containing only the 'conserved' proteins, rather than whole viruses. Hence, of late, most attention has focussed on the M2 protein, an ion channel, that protrudes from the virus's surface and tells it when it is inside a cell. M2 also appears in abundance in the membrane of cells producing new flu viruses. So targetting it with antibodies could lead to the destruction of infected cells as well as the virus itself (*New Scientist*, 21 August 2009). In fact, the effectiveness of one potential universal vaccine is to be tested in people for the first time in September 2009. Could we be on the brink of beating the flu?

Meanwhile, let us scrupulously follow the Do's and Don'ts to keep the flu at bay, despite the saga of the virus and the swine (along with birds and humans) likely to continue for quite some time in the foreseeable future.

❑ Vinay B. Kamble

YOUR OPINION

Dream 2047 has been inviting your opinion on a specific topic every month. The reader sending the best comments will receive a popular science book published by VP. Selected comments received will also be published in *Dream 2047*. The comments should be limited to 400 words.

This month's topic:

"Does the heavy pressure of studies and homework deprive today's children of adequate physical activity, thus affecting their healthy growth?"

Response should contain full name; postal address with pincode and email ID, if any; and should be accompanied by a recent passport size photograph. Response may be sent by email (**opinion@vigyanprasar.gov.in**) or by post to the address given below. If sent by post, "**Response: *Dream 2047* October 2009**" should be clearly written on the envelope.

Vigyan Prasar
A-50, Institutional Area, Sector-62, NOIDA 201 307
Phone: 91-120-240 4430/35 Fax: 91-120-240 4437
Email: info@vigyanprasar.gov.in Website: www.vigyanprasar.gov.in

Winners of "Your Opinion" contest for June 2009.

Topic June : "Is opening of new Institutes of Technology a viable means of improving the technological capability of the country?"

Ankur Dubey
S/O Shri Suresh Singh Dubey
EWS- 259, Bank Colony, Bharhut Nagar,
Satna-485001 (M.P.)

"In my opinion think there is need to open new universities and institutions as well as overall improvement of our education system. Already a large number of talented students who appear for CBSE and ICSE exams are unable to get admission in engineering colleges after passing out for lack of seats. It is the time when we need to pay our attention to improving our education system and for this we need new Govt. universities and institutes, with highly qualified faculty, to prevent real talent of the country going waste".

Winners of "Your Opinion" contest for July 2009.

Topic July : "Do our science students get enough hands-on experience in school to motivate them to take up higher studies and a career in science?"

K.N. Chetry, Teacher,
Kendriya Vidyalay Namrup
P.O.: Parbatipur, Assam.
Email : chetry_kn@yahoo.co.in

"To create an interest in science, the language of teaching can play a crucial rule. Indeed, language should not become a hurdle in the way of learning science. Teaching of science at school level should be in the languages of a child's preference instead of English only. To culture a child's brain towards scientific thinking it necessary that the child never hesitates to express the topics of science freely. However, even if science is taught in the regional language, specific scientific terms should be expressed or maintained in English to make the child familiar with them*.

The winners will receive a copy of VP Publication