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Monthly Newsletter of Vigyan Prasar

DREAM 2047

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# VP News

## Southern Regional VIPNET meeting

The Southern regional VIPNET meeting was held at Thiruvananthapuram between October 9-11, 2002 at Mar Ivonis Renewal Centre. Renowned bio-technologist and former Director of Rajiv Gandhi Centre for Biotechnology, Dr. M.R. Das, inaugurated the programme, and in his speech appreciated the Vigyan Prasar's efforts, in particular VIPNET initiative, and recalled how he was inspired towards basic science, during his student days, as a result of exposure to good popular science literature.

*Participants at the meet*

About 65 participants representing Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, and Lakshadweep attended the programme. Orientation towards the VIPNET initiative was provided and deliberations on possible activities were conducted. Sh. K.K. Krishnakumar, Prof K. Pappootty, Sh. KMS Rao, Dr. C.P. Aravindakshan, Dr. A. Vallinayagam, Sh. Ganesan, Sh. Jacob George, and Dr. T.V. Venkateswaran from VP conducted various sessions. Amateur Radio demonstration by the Trivandrum Amateur Radio Society was well received by the participants, who could directly interact with Dr. V.B. Kamble, himself a ham, and Dirctor, VP at Delhi through Ham radio. The participants welcomed the idea of a massive nation-wide science popularization campaign built around the Venus transit in 2004.

## Ham Radio Activities

An awareness programme on Ham Radio was organised by Vigyan Prasar in coordination with Colonel's Central Academy School, Gurgaon as a part of the 'Disaster Mitigation Training Programme' initiated by the Deputy Commissioner's Office, Gurgaon, on October 8, 2002. 115 youth volunteers from Gurgaon participated in the event. The purpose of the workshop was to introduce the volunteers into various skills of disaster rescue operations. Lt. Colonel Pratap Singh, Chairman, Colonel's Central Academy School and Captain Aman Yadav (Armed Forces) emphasized the need of familiarising the volunteers with the skill of wireless communication. A live demonstration of ham radio communication on HF & VHF was organised for the disaster rescue trainees by Shri Sandeep Baruah (VU2MUE) from Vigyan Prasar including a multimedia presentation. Shri Baruah was

*Contd. on page ...24*

*Shri Chhagan Bhujbal, Hon'ble Deputy Chief Minister of Maharashtra at Vigyan Prasar's Stall at the International Book Fair held at Mumbai during14-20 October, 2002*

## Inside



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

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# Retain Traditions Change Attitudes

Diwali – the festival of lights represents the return of the legendary king Rama to his kingdom, Ayodhya. The festival brings with it the spirit of joy and happiness. It also brings with it tonnes of pollution caused by fire-crackers and deafening noise. Surely, the objective should be to have Diwali as a glowing and lightened festival of the year – not a noisy, disturbing, and a polluting event that may even cause serious accidents at times. In the Capital this year, pollution levels were marginally lower than those recorded last year. Apparently, oxides of nitrogen levels showed a marginal decrease compared to the previous year, while levels of sulphur dioxide remained more or less the same, but within permissible limits. A good sign indeed! However, the pollutants in the air, that is, the suspended particulate matter, remained five to eight times higher than the permissible limits (though somewhat less than the previous year!). As regards the noise levels, the peak was about 90 decibels (dB) as compared to 100 dB last year. The noise continued well past midnight, despite the Supreme Court order permitting bursting of crackers only between 6 pm and 10 pm. Surely, all this made Diwali a festival of noise and pollution.

The higher level of suspended particles due to bursting of crackers during Diwali causes eye, throat and nose problems. Although many of us do not feel the immediate impact, these problems could develop into serious health hazards. Exposure to suspended particulate matter to the level of 100 parts per million (ppm) results in headache and reduced mental acuity. The effects are more pronounced in people with heart, lung or central nervous system diseases. Indeed, for millions of those suffering from asthma, Diwali is not a festival of light and gaiety, but that of smoke, coughing and wheezing. They need to hold on to their inhalers which can help them breathe easier! A typical fire-cracker may contain 75 per cent potassium nitrate, 15 per cent carbon and 10 per cent sulphur. Potassium nitrate is a strong oxidizing agent, and when it burns along with carbon and sulphur, it releases noxious gases such as carbon dioxide, sulphur dioxide, and oxides of nitrogen. Oxides of sulphur, phosphorus and nitrogen are corrosive and highly acidic. These irritate the delicate linings of the airways that carry oxygen to the lungs and lead to asthma attacks. Sulphur dioxide is readily soluble and dissolves in the larger airways of the respiratory system and at higher levels, can cause severe contraction restricting the breathing process. Nitrogen dioxide is less soluble and so penetrates to the smaller airways and into the lungs and hence can cause respiratory allergies like asthma. Bursting fire-crackers in small lanes and passages creates what is known as the valley effect that creates big pockets of polluted air causing difficulty in breathing. Crackers like anar, wire and rockets which burn for a longer time cause more pollution. Indeed, the number of asthma and bronchitis cases shoots up significantly during Diwali days.

When the noise level increases, it results in restlessness, anger, impulsive behaviour, and even over reaction to many situations. Most crackers used have more than 80 dB noise level that can cause temporary hearing loss, according to medical practitioners. It could even cause high blood pressure, heart attack and sleep disturbances. Normal decibel level for humans is 60 dB. It would be worth noting that an increase of 10 dB signifies double the noise level. In particular, children, pregnant women, and those suffering from respiratory problems suffer the most due to excessive noise.

Even the trees and plants do not escape the fury of pollutants during Diwali. Trees and plants are covered with a layer of sulphur dust and suspended particulate matter. This blocks the stomata, or the pores on the leaves, obstructing the process of photosynthesis. This implies that the trees are prevented from releasing oxygen and moisture into the air. Even the birds' nests are not spared.

No doubt, school children have played an important role by organizing "say no to fire-crackers" campaigns and rallies to sensitize the people on the need and virtues of celebrating a peaceful Diwali. According to newspaper reports, children might have said a loud "No" to crackers, but not the adults – especially the neo-rich and the compulsive rebels, who defied the "say no to firecrackers" campaign. True, there was a slight decline in the air pollution levels compared to last year in Delhi, but the noise levels were higher at several places, in particular, in the posh colonies of the Capital. Dileep Biswas, Chairman, Central Pollution Control Board, remarked that the children seemed to be reconciled to the idea of a Diwali without crackers, but the adults are not! No doubt, it is imperative that our focus should now shift to the compulsive adults, and not just children alone.

The darker side of the festival of lights also manifested itself in its worst form this year. Eight teenagers died in an explosion in a fire-cracker unit in Tamil Nadu's Villupuram district on the eve of Diwali. There must have been dark in the homes of those children, who perished trying to bring joy and smiles to the faces of countless others. Are we not guilty of abetting a crime as heinous as child labour when we purchase firecrackers? No doubt, manufacturers of fire-crackers are even guiltier. Delhi's school children have set an example by not buying firecrackers made with child labour. But this cannot put an end to it. It may continue in silk factories or in factories producing beautiful glassware. There is no gainsaying the fact that parents who earn reasonably well, may not be compelled to send their children to a cracker factory, but would educate them. How shall we bring smiles to their faces? The day we shall realize this dream, limiting health and environmental hazards at the same time, that we shall be able to restore Diwali to its pristine glory. We may retain the traditions, but change attitudes in the larger interests. Let us resolve to celebrate Diwali by lighting lamps, not by bursting crackers.

❑ **V. B. Kamble**

**Editor : V.B. Kamble**

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# Meghnad Saha

## A Pioneer in Astrophysics

Subodh Mahanti

"The impetus given to astrophysics by Saha's work can scarcely be overestimated, as nearly all later progress in this field has been influenced by it and much of the subsequent work has the character of refinements of Saha's ideas."

*S. Rosseland in Theoretical Astrophysics (Oxford University Press, 1939)*

"Scientists are often accused of living in the "Ivory Tower" and not troubling their mind with realities and apart from my association with political movements in my juvenile years, I had lived in ivory tower up to 1930. But science and technology are as important for administration now-a-days as law and order. I have gradually glided into politics because I wanted to be of some use to the country in my own humble way."

*Meghnad Saha*

"He (Saha) was extremely simple, almost austere, in his habits and personal needs. Outwardly, he sometimes gave an impression of being remote, matter of fact, and even harsh, but once the outer shell was broken, one invariably found in him a person of extreme warmth, deep humanity, sympathy and understanding; and though almost altogether unmindful of his own personal comforts, he was extremely solicitous in the case of others. It was not in his nature to placate others. He was a man of undaunted spirit, resolute determination, untiring energy and dedication."

*D. S. Kothari in Biographical Memoirs of Fellows of the National Institute of Sciences of India, Vol .2, New Delhi, 1970*

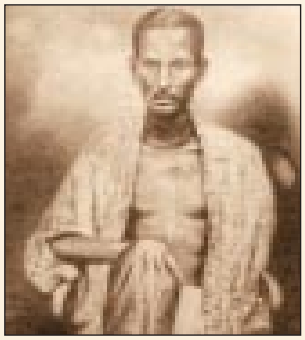
'Meghnad Saha's place in the history of astrophysics and in the history of modern science in India is unique', wrote Subrahmanyan Chandrasekhar (1910-95). Saha's theory of thermal ionisaiton, which explained the origin of stellar spectra, was one of India's most important contributions to world science during the 20th century. It was an epoch-making discovery. Arthur Stanley Eddington (1882-1944), while writing on stars in the *Encyclopaedia Britannica,* described Saha's theory of thermal ionisaiton as the twelfth most important landmark in the history of astronomy since the first variable star (Mira Ceti) discovered by David Fabricius (1564-1617) in 1596. Besides his epoch-making discovery Saha made important contributions in different branches of physics. Saha (jointly with B.N. Srivastava) wrote the renowned textbook, entitled, *Treatise on Heat,* which was originally published in 1931 under the title, *A Text Book on Heat.* It was Saha who first started the teaching and training in nuclear physics in the country. The first cyclotron in the country was built with Saha's initiatives. Saha was a great institution builder. Among the institutions that he built were: National Academy of Sciences, India, at Allahabad, Indian Physical Society, Kolkata, National Institution of Sciences of India (which was later renamed Indian National Science Academy), New Delhi, Indian Science News Association, Kolkata, and Saha Institute of Nuclear Physics, Kolkata. Saha was an active member of the National Planning Committee constituted by the Indian National Congress in 1938 with Jawaharlal Nehru as its Chairman. He was the Chairman of the Indian Calendar Reform Committee constituted by the Council of Scientific and Industrial Research in 1952. He was an elected Independent Member of the Indian Parliament. He advocated large-scale industrialisation for social development.

*M.N. Saha*

Meghnad Saha was born on October 06, 1893 in the village of Seoratali in the Dhaka (then Dacca) district (now in Bangladesh) of undivided India. He was the fifth child of his parents, Jagannath Saha and Bhubaneswari Devi. His father, Jagannath, was a petty shopkeeper. Given their social and economic background his parents had neither the means nor the inclination for educating their children beyond the primary education. Saha's elder brother Jainath, after failing to pass the matriculation examination, started working in a jute company on a monthly salary of Rs.20. His second brother had to discontinue his school education in order to help his father in running the shop. At the age of seven Saha joined the village primary school and from the very beginning he demonstrated an unusual aptitude for learning.

After the completion of his primary education there was no certainty that his education would continue further. Their parents would have preferred to have him work in the family's grocery shop. In any case they did not see any use of further education in running the shop. Moreover there was no middle school nearer to his village. The nearest middle school was at Simulia, which was 10 kms away from his village. Saha's parents did not have the means to take care of the expenses of his boarding and lodging. At this stage his elder brother Jainath came in his rescue by locating a sponsor in Ananta Kumar Das, a local doctor. The kind-hearted doctor agreed to provide Saha free boarding and lodging in his house provided Saha washed his own plates (a condition that reflected the prevailing rigid caste system) and attend minor household works including the taking care of the cow. Saha readily accepted all the conditions as he had a strong urge to continue his studies further. Every weekend he used to visit his village. When the village became flooded he

would row all the way, otherwise he would simply walk down. Saha completed his middle school by topping the list of successful candidates in the entire district of Dhaka. As a result he secured a scholarship of Rs.4 per month. In 1905 Saha came to Dhaka, where he joined the Collegiate School, a government school. His elder brother sent him a monthly allowance of Rs.5, it was indeed a great sacrifice on his part, as his total monthly salary was Rs.20. The *Purba Banga Baisya Samiti* gave another Rs.2 per month. So Saha had Rs.11 to manage his food, lodging and other expenses.



*Jagannath Saha, Father of Saha*

There were widespread political disturbances in Bengal in 1905. In this year Lord Curzon, the then Viceroy of British India, had decided to partition Bengal. Saha, like many others, was affected by this political upheaval. He, along with some other students, were rusticated from the Collegiate School, because of their participation in the demonstration against the visit of the Bengal Governor, Sir Bamfylde Fuller, to the school. It is not certain whether Saha actually participated in the demonstration or not, because there is another version of the story. According to this version, Saha did not take part in the demonstration. On that fateful day as usual he had gone to school barefooted. For Saha it was a usual practice, as he had not enough money to buy shoes. But on that day the authorities took it as a deliberate insult directed against the Governor. Besides being rusticated Saha was deprived of his scholarship. Fortunately a private school, named Kishori Lal Jubilee School, accepted Saha with a free studentship and a stipend. In 1909 Saha passed the Entrance Examination from Kishori Lal Jubilee School standing first amongst all the candidates from erstwhile East Bengal.

In school Saha's favourite subject was mathematics and he also liked history. He was particularly fond of reading Todd's *Rajasthan*. He used to be fascinated by the heroic tales of Rajput and Maratha warriors. Among his favourite books were Rabindranath Tagore's *Katha O Kahini*, which glorifies the values of the Rajput and Maratha warriors and Madhusudan Dutt's epic poem *Meghnad Badh*. During his school days Saha also attended the free Bible classes conducted by the Dhaka Baptist Mission. He stood first in one of the competitive examinations of Bible conducted by the Mission and received a cash prize of Rs.100.

After passing the Intermediate Examination of the Calcutta University in 1911 from the Dhaka College, Dhaka, Saha joined the Presidency College at Kolkata (then Calcutta). Among his classmates was Satyendranath Bose, of the Bose-Einstein Statistics fame. Prasanta Chandra Mohalanobis, the founder of the Indian Statistical Institute, was his senior by a year. His teachers included Prafulla Chandra Ray in chemistry and Jagadis Chandra Bose in physics. Saha passed his BSc Examination with Honours in Mathematics in 1913 and MSc (Applied Mathematics) Examination in 1915. Saha stood second in order of merit in both the examinations. The first position in both cases went to S.N. Bose.

Saha was appointed lecturer in the Department of Applied Mathematics in 1916 in the University College of Science. The foundation stone of the University College of Science was laid down on 27 March 1914 just four days before Asutosh Mookerjee laid down his office as Vice Chancellor of the University. It may be noted here that Mookerjee who was the Vice Chancellor of the Calcutta University during 1906-14 and then again during 1921-23. Both Saha and S.N. Bose, who also joined the Department as a lecturer, got themselves transferred to the Physics Department, where a year later C.V. Raman joined as Palit Professor of Physics. After joining the physics department Saha started giving lectures to the post-graduate classes on topics like hydrostatics, the figure of the Earth, spectroscopy and thermodynamics. For teaching physics to the postgraduate classes, Saha had to learn it himself first, as he studied physics only in the undergraduate classes. It was a great challenge indeed.

*Bhubaneswari Devi, Mother of Saha*

Besides teaching Saha also started doing research. It was not an easy task. In those days there was no experimental laboratory in the Department of Physics of the University College of Science. He had only one 'research facility' that is the well-equipped Library of the Presidency College. Saha had no guide for supervising his research work. He totally depended on his knowledge acquired from private studies. During this period Saha did not have enough money to pay for publication of his research paper in foreign journal. To quote Saha :

"By the end of 1917, I had written a long essay on `Selective Radiation Pressure' elaborating on theory of the role of radiation pressure' acting on the atom selectively and compensating the action of gravity on solar atoms. This paper was sent to the *Astrophysical Journal* for publication, but the editors replied that as the paper was rather long, it could be published only if I were willing to bear a part of the printing costs which ran to three figures in dollars. Much as I would have liked to do so, it was not possible me to find out so much money as my salary was small and I had to maintain my old parents and a younger brother who was studying within this salary. So I wrote to the editors of the *Astrophysical Journal* expressing my inability to pay the costs of printing, but never heard anything more about the publication of this paper nor was it returned to me. Years afterwards, in 1936, when I visited Yerkes Observatory, Dr. Morgan showed me the manuscript which was still being kept there. I got a short note published in the *Astrophysical Journal*, Vol. 50,220 (1919) and submitted a duplicate of the original article on `selective radiation pressure and problem of solar atmosphere' (*Journal of the Department of Science*, Calcutta University, 1919) sometime afterwards for publication in our own university journal which had no circulation worth mentioning. I am mentioning these facts because I might claim to be the originator of the Theory of Selective Radiation Pressure, though an account of above discouraging circumstances, I did

*Radharani Saha, wife of Saha*

not pursue the idea to develop it. E.A. Milne apparently read a note of mine in *Nature* 107, 489 (1921) because in his first paper on the subject `Astrophysical Determination of Average of an Excited Calcium Atom, in Month. Not. R. Ast. Soc., Vol.84, he mentioned my contribution in a footnote, though nobody appears to have noticed. His exact words are: `These Paragraphs develop ideas originally put forward by Saha'."

*At the opening cenrmony of Central Glass & Ceramic Research Institute at Calcutta in 1950. Also seen in the picture are Dr. B.C. Roy, S.S. Bhatnagar, Pandit Jawaharlal Nehru and Dr.*

Initially Saha worked on diverse topics as reflected from the titles of his published research papers as indicated below:

1. "On Maxwell's Stresses" (*Philosophical Magazine*, 1917), this paper was based on his studies of the electromagnetic theory of radiation;
2. "On the Limit of Interference in the Fabry-Perot Interferometer" (*Physical Review*, 1917),
3. "On A New Theorem in Elasticity" (*Journal of the Asiatic Society*, Bengal, 1918),
4. "On the Dynamics of the Electron" (*Phil. Mag.* 1918)
5. "On the Pressure of Light" (*Journal of the Asiatic Society*, Bengal, 1928)
6. "On the Influence of Finite Volume of Molecules on the Equation of State" (*Phil. Mag* , 1918). This paper was jointly written with S.N. Bose.
7. "On the Mechanical and Electro-dynamical Properties of the Electron" (*Physical Review*, 1919);
8. "On the Radiation Pressure and the Quantum Theory" (*Astrophysical Journal*, 1919);
9. "On the Fundamental Law of Electrical Action" (*Phil. Mag.* 1919).

Based on his above work Saha submitted his thesis for the degree of Doctor of Science of the Calcutta University in 1918. He was awarded the degree in 1919. The same year he was awarded the *Premchand Roychand Scholarship* for his dissertation on the 'Harvard Classification of Stellar Spectra'.

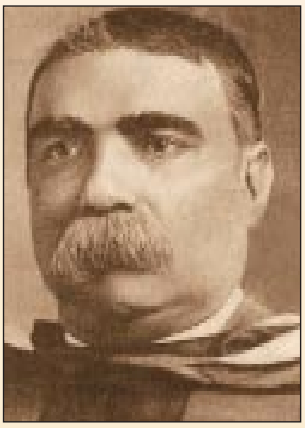
While working on diverse topics he was also preparing for his main work in astrophysics. For this work he profited from reading Agnes Clarke's two popular books on astronomy and astrophysics. He had also read Planck's *Thermodynamics* and Nernst's Das *Neue Warmestaz* and research papers of Niels Bohr and Arnold Sommerfeld on the quantum theory of atom. He published four papers on his astrophysical research in the first six months of 1920 in the *Philosophical Magazine* viz. "Ionisation of the Solar Chromosphere" (March 04, 1920), "On the Harvard Classification of Stars" (May 1920), "On Elements in the Sun" (22 May 1920) and "On the Problems of Temperature-Radiation of Gases" (25 May 1920). In these papers Saha formulated his Theory of Thermal Ionisation. His thesis on the 'Origin of Lines in Stellar Spectra' won him the Griffith Prize of the Calcutta University in 1920.

*With President Rajendra Prasad*

It is interesting to note here that Saha, jointly with S.N. Bose prepared an English translation of Einstein's papers on theory of relativity and got it published in a book form. Incidentally their translation of Einstein's work on the theory of relativity happens to be the first on record. Chandrasekhar wrote : "…In 1919, only three years, after the founding of the general theory of relativity, Saha and S.N. Bose should have taken the time and the effort to translate and publish Einstein's papers which have since become epochal. At a celebration of the Einstein centennial at Princeton University, three years ago, reference was made to a Japanese translation of Einstein's papers as the first on record and I was glad that I was able to correct the impression. A Xerox copy of the Saha-Bose translation is now in the Einstein Achieves at Princeton".

The *Premchand Roychand Scholarship* of the Calcutta University awarded in 1919 enabled Saha to spend about two years in Europe. He first went to London where he spent about five months in the laboratory of Alfred Fowler (1868-1940). From London he moved to Berlin where he worked in Walther Nernst's Laboratory.

For a long time after Saha published his work on thermal ionization theory, the European scientific community used to believe that Saha did this work under the supervision of Albert Fowler. For example in 1972 while commenting on Saha's paper on the ionization in the solar chromosphere, A.J. Meadows in his biography of Sir Norman Lockyer wrote : "Shortly after Lockyer's death, an Indian physicist M.N. Saha, came to work under Fowler at Imperial College. The paper he wrote during this visit ... showed how the spectra of stars could be understood in terms of the new quantum theory of the atom together with the dissociation hypothesis. After some initial opposition, his results were rapidly accepted. The theory showed that both temperature and pressure affected the dissociation of atoms in stellar atmospheres. So both Lockyer and his opponents had been partly right. It is only fair to Lockyer to add that the influence of temperature on stellar spectra is much more marked than of pressure."



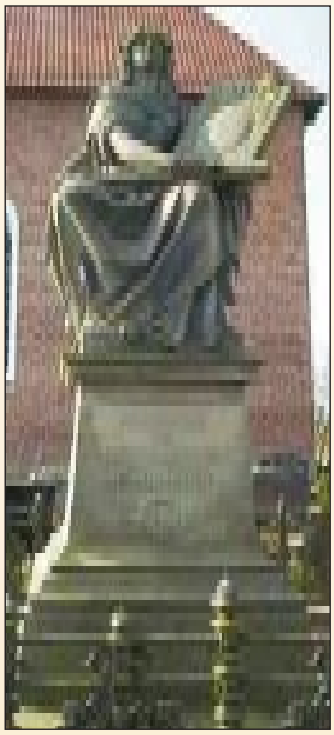
*Asutosh Mookerjee*

Medows' observation was far from truth. To quote D. S. Kothari : "It is pertinent to remark that the ionization theory was formulated by Saha working by himself in Calcutta, and the paper quoted above was communicated by him from Calcutta to the *Philosophical Magazine* - incorrect statements to the contrary have sometimes been made. (Saha's first visit to Europe was made a couple of months later.) Further papers soon followed. It is not too much to say that the theory of thermal ionization introduced a new epoch in astrophysics by providing for the first time, on the basis of simple thermodynamic consideration and elementary concepts of the quantum theory, a straight forward interpretation

of the different classes of stellar spectra in terms of the physical condition (temperature and to a lesser extent pressure) prevailing in the stellar atmospheres."

To describe how Saha got the idea of working on this topic and when he completed his work we quote Saha rather extensively:

"It was while pondering over the problems of astrophysics, and teaching thermodynamics and spectroscopy to the MSc classes that the theory of thermal ionization took a definite shape in my mind in 1919. I was a regular reader of German Journals, which had just started coming after four years of first world war, and in course of these studies, I came across a paper by J.Eggert in the *Physikalische zeitschrifts* (p.573) Dec. 1919, "*Uber den Dissociationzustand der Fixterngase*" in which he applied Nernst's Heat Theorem to explain the high ionization in stars due to high temperatures, postulated by Eddington in course of his studies on stellar structure.



*David Fabricius*

Eggert, who was a pupil of Nernst and was at the time his assistant, had given a formula for thermal ionization, but it is rather strange that he missed the significance of ionization potential of atoms. Importance of which was apparent from the theoretical work of Bohr, and practical work of Franck and Hertz which was attracting a good deal of attention in those days…Eggert used Sackur's formula of the chemical constant for calculating that of the electron, but in trying to account for multiple ionization of iron atoms in the interior of stars on this basis, he used very artificial values of ionization potential.

While reading Eggert's paper I saw at once the importance of introducing the value of ionization potential in the formula of Eggert, for calculating accurately the ionization, single or multiple, of any particular element under any combination of temperature and pressure.

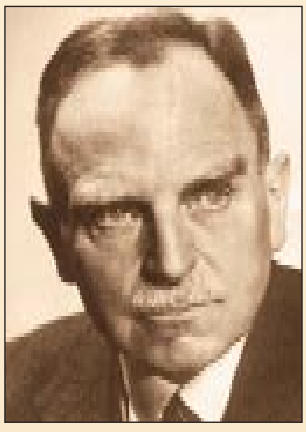
I thus arrived at the formula which now goes by my name. Owing to my previous acquaintance with chromospheric and stellar problems, I could at once see its application. I prepared in the course of six months of 1919 (February to September) four papers and communicated them for publication in the *Philosophical Magazine* from India within August to September."

*Walther Hermann Nernst*

"I had no personal acquaintance with Prof. A. Fowler except that I had read his paper on the spectrum of ionized helium.

"On my arrival in England, I saw Prof. Albert Fowler who at first thought that I had come to work for the DSc degree of the London University like other Indian students working under him. But when I explained to him that I wanted to work there only for a short period to obtain verification of my theory, he did not show himself very enthusiastic, but allowed me to read and work in his laboratory. Probably he had not much time to listen to me at the first meeting. This was in November of 1920. If you look at the records of Imperial College, you will find that I never got my name registered for my degree work. In the meantime, my first paper "Ionization in the Solar Chromosphere" communicated from India had appeared in *Phil. Mag*, thanks to a personal call which I made on Mr. Francis, the publisher of the journal. After its publication, Prof. Fowler began to take a more lively interest in my work and in my views."

In November 1921 Saha returned to India and joined the University of Calcutta as Khaira Professor of Physics, a new Chair created from the endowment of Kumar Guruprasad Singh of Khaira. But Saha did not stay long in Kolkata. He moved to Allahabad in 1923 as Head of the Department of Physics. Saha's decision to move out of Kolkata was mainly because there were no financial grants for carrying out research. Though Asutosh Mookerjee could create additional chairs out of donations but the Government did not approve his plan for expansion. The then Governor Lord Ronaldshay, while praising the work done in the post-graduate departments of the Calcutta University, said: "In a poor country there are obvious limits to the extent to which such studies can be financed by public funds. The legislature will, I hope, be prepared to make some additional contribution towards the university in the present difficulties. But the legislature itself with extremely exiguous resources is faced with many urgent demands. And under the circumstances it appears to me that the university may have to consider whether it is bound to provide post-graduate teaching on every subject in which it is prepared to examine and confer awards…" Irrespective of Governor's assurance there was no increase in the funds allocated to the Calcutta University. In 1922 the Government was willing to give an additional grant of two-and-a-half lakh. But the grant was subjected to certain conditions and which were not acceptable to Asutosh Mookerjee. While declining the offer Mookerjee said:



*Otto Hahn*

"We will not take the money. We shall retrench and we shall live within our means. We shall go from door to door and make the people of Bengal realise their responsibility. Our Post-graduate teachers will starve themselves rather than give up their freedom." Under these circumstances Saha's decision to leave Calcutta evoked adverse feelings. The *Calcutta Review* made scathing attack on Saha's decision to leave Kolkata. However, it may be noted that Saha before leaving the Calcutta University wrote to its Syndicate :

"I am however, willing to continue to serve my alma mater, provided the university is willing to grant me a graded scale of pay namely Rs. 650-50-1000 plus Rs. 15,000 to be placed immediately at my disposal as my personal research grant." The Syndicate rejected his request stating that "….in view of the present financial position of the university and in view of the

claims of other university teachers, his request cannot be complied with." And so finally Saha went to the Allahabad University. At Allahabad before he could start research work he had to improve the workshop, the laboratory and the library. Moreover, he found hardly any time for research after discharging heavy teaching responsibilities. But Saha was not to be detracted by adverse conditions. And very soon research papers started appearing from Saha and his students. Among his collaborators at Allahabad were N.K. Sur, P.K. Kichlu, D.S. Kothari, R.C. Majumdar, Atmaram, K.B. Mathur and B.D. Nag Choudhary. After his becoming Fellow of the Royal Society in 1927, the Governor of the United Province, Sir William Morris provided a research grant of Rs. 5,000 per year to Saha's Department. At Allahabad, besides continuing his research work on astrophysical problems, he initiated and organized research in several other branches of physics viz. statistical mechanics, atomic and molecular spectroscopy, electron affinity of electro-negative elements, active modification of nitrogen, high temperature dissociation of molecules propagation of radio waves in ionosphere and physics of the upper atmosphere. It is here that Saha wrote his famous textbook, *A Treatise on Heat,* which was first published in 1931 under the title of *A Textbook of Heat*. The book was written jointly with B.N. Srivastava. C.V. Raman in his foreword to the book wrote : "By undertaking the necessarily laborious task of producing a systematic and up-to-date treatise on the theory of heat, Prof. Saha has earned a claim to the gratitude of the wide circle of readers both in and outside of India, who it is confidently hoped, will study this book and appreciate its merits." A concise version of this book was published for science graduates. It was tilted *Junior Text Book of Heat*. He wrote another book (jointly with N.K. Saha ) titled *Treatise on Modern Physics*. At Allahabad Saha established the United Province Academy of Sciences in 1930. Interestingly the suggestion for establishing such an Academy had come from the Governor of the United Province, Sir Malcolm Hailey. While addressing the scientists of the United Province gathered at Allahabad on the occasion of the Indian Science Congress Association Malcolm said : "Now I am well aware that there are definite limits to the extent to which the efforts of our research workers or students can be directed to these problem (of economic and utilitarian value), and I am also well aware that coordination of their labours cannot be directed from outside. It must be voluntary effort, or at the most, it must be advice given by some Academy of Science which will contain authoritative representatives of all the specialized branches of scientific activity now at work in the province. But if some form of visible co-ordination could be attempted, and if it could be proved to the public that science workers were contributing at least some of their energies in the direction I have suggested, then I believe we should have a far more effective case in calling for that public support and private liberality on which the further progress of scientific work must depend."

*Shyama Prasad Mookherjee*

*Arthur Stanley Eddington*

Saha returned to the Calcutta University in July 1938. He became the Palit Professor and Head of the Department of Physics. At that time Shyama Prasad Mookerjee was the Vice Chancellor of the University and who was soon to be succeeded by Sir Mahammed Azizul Haque. After joining Saha immediately got involved in organizing research in the Palit Laboratory. He also took the task of remodeling the MSc syllabus in physics. Saha introduced a general and a special paper in nuclear physics in 1940. One may note that, the phenomenon of the fission, was discovered in 1939 by Otto Hahn (1879-1968) and Fritz Strassmann (1902-80). Saha also added a general paper in quantum mechanics. Commenting on Saha's research work at the Calcutta University D.S. Kothari wrote: "His researches in Calcutta were concerned largely with the systematics of atomic nuclei, particularly beta-activity, the propagation of electromagnetic waves in the ionosphere, and the problem of the solar corona."

Saha was a great institution builder. He made the Physics Department of the Allahabad University, which he joined in 1923, as one of the most active centres of research in the country, particularly in the field of spectroscopy. The Department attracted students from all over the country. In 1911 Saha founded the UP Academy of Sciences at Allahabad, which was later renamed as National Academy of Sciences, India. The Academy, which was inaugurated on March 1, 1932, was modelled on the lines of the Asiatic Society of Bengal. Saha was its first President. In 1933 Saha founded the Indian Physical Society at Calcutta. The Society published the *Indian Journal Physics*. Eminent scientists like Raman, Saha and Krishnan regularly contributed their important papers to the *Indian Journal of Physics.* With Saha's initiative National Institute of Sciences of India was established in Calcutta. Its formation was formally announced on January 7, 1935 in the Senate Hall of the Calcutta University under the Chairmanship of the J.H. Hutton. L.L. Fermor was elected the first president of the Institute. The formation of such an All India Academy of Sciences was first proposed by Saha in his Presidential Address of the Indian Science Congress Association in Mumbai (Bombay) in 1934. The National Institute of Sciences was later renamed as the Indian National Academy of Sciences and its headquarters were transferred to New Delhi. Saha was closely associated with the planning and establishment of the Central Glass and Ceramic Research Institute, a constituent laboratory of the Council of Scientific and Industrial Research, at Kolkata. In 1944 Saha was elected the Honorary Secretary of the Indian Association for the Cultivation of Science and he was its President during 1946-50. Saha became the full-time Director of the Laboratories of the Association in 1952, a post he held till his death. Under the leadership of Saha, there was a large-scale expansion of the activities of the Association. As President of the Indian Association for the Cultivation of Science he built its modern laboratories.

*Fritz Strassmann*

Saha played a significant role in the establishment of departments of Radio Physics and Electronics and Applied physics of the Calcutta University.

In 1950 Saha founded the Institute of Nuclear Physics. The Foundation Stone of the Institute was laid by Dr. Shyama Prasad Mookherjee, the then Civil Supply Minister of the Government of India. The institute, which was formally inaugurated by Irene Joliot-Curie on January 11, 1950, was originally situated in the campus of the Calcutta University. Among those who attended the inauguration ceremony were Robert Robinson and J.D. Bernal.

*Netaji Subhash Chandra Bose*

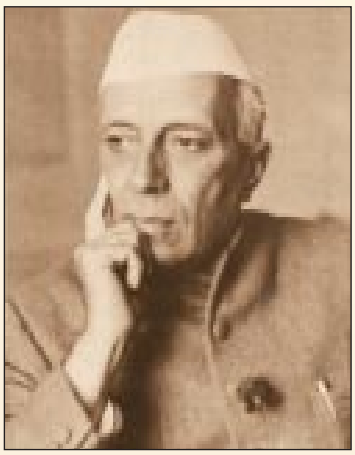
It was Saha, who first introduced nuclear physics in the MSc physics syllabus of the Calcutta University in 1940. He also started a post-MSc course in nuclear science for the country. He initiated steps for building a cyclotron, the first of its kind in the country.

The Conference of Scientific workers in Britain held in July 1946 led to the formation of the World Federation of Scientific Workers. Saha had participated in this Conference and after coming back to India he wrote editorials in the *Science and Culture* urging Indian scientific workers to form a similar kind of organisation. Explaining the objectives of such an Association Saha wrote: "the aim and objects of the Association are for fuller use of science for national life – for education through meetings and for action in public field." On some other occasion he wrote: "It is high time for the scientific workers in India that they exert their inherent right to live like decent citizen and shoulder responsibilities for the betterment of their motherland." The Association for Scientific Workers (India) was eventually formed an 7th July 1947

Saha founded the Indian Science News Association at Calcutta in 1935. Its main objective was to disseminate science amongst the public. The Association started publishing its journal called *Science and Culture*. On receiving, a copy of the first issue of the Journal, Netaji Subhash Chandra Bose wrote: "The appearance of *Science and Culture* is to be warmly welcomed not only by those, who are interested in abstract science but also by those who are concerned with nation-building in practice. Whatever might have been the views of our older "Nation builders" we younger folk approach the task of nation building in a thoroughly scientific spirit and we desire to be armed with all the knowledge which modern science and culture can afford us. It is not possible however, for political workers with their unending preoccupations to glean that knowledge themselves, it is therefore, for scientists and scientific investigators to come in their rescue." Saha himself wrote more than 200 articles in *Science and Culture* on a wide range of topics which included: organization of scientific and industrial research, atomic energy and its industrial use, river valley development projects, planning the national economy, educational reforms and modification of Indian calendar. The journal is presently running in its 68th volume.

*Dr. B.R. Ambedkar*

Saha wrote extensively on his vision of scientific economic planning for India. It was Saha who persuaded Netaji Subhash Chandra Bose, then President of the Indian National Congress, to set up a National Planning Committee. At the beginning M. Visvesvaraya, the most celebrated Indian engineer, was the Chairman of the Committee. However, Saha thought that to have its impact the Committee should be headed by a powerful Congress leader and he persuaded Rabindranath Tagore to convince Jawaharlal Nehru to accept the Chairmanship of the Committee.



*Pt. Jawaharlal Nehru*

Saha was an advocate of the peaceful use of nuclear energy. He had initiated the first Parliament debate on this subject on 10th May 1954. Saha was against the establishment of the Atomic Energy Commission. He was of the view that the researches on nuclear energy could be undertaken in the university sector. In fact he wanted the 'Indian Atomic Energy Act' to be scrapped altogether. Saha wanted that the Government should first build up necessary infrastructure and trained manpower before it undertook such a programme. However, in spite of Saha's opposition the Atomic Energy Commission was created in 1948 under the chairmanship of Homi J. Bhabha. Many people may agree with what D. M. Bose had to say in 1967. "The decision of the Prime Minister (Jawaharlal Nehru) to locate the Department of Atomic Energy and Atomic Energy Commission with Bhabha as Secretary of the former and Chairman of the latter must have caused some disappointment to Saha. Since 1935 Nehru and Saha co-operated in many fields of common interest, including the formation of the planning committee in 1938 by Subhash Chandra Bose with Nehru as Chairman and Saha as an important member. A growing estrangement with the Prime Minister with some of the later decisions may have been one of the factors, which decided Saha to enter politics in 1952. There can be no doubt, however, as the events shaped subsequently that the Prime Minister Nehru was undoubtedly right in entrusting Bhabha with the development of India's plan for utilization of atomic energy. Bhabha identified himself completely with the development of atomic energy in India. Saha's interest was many and varied."

Saha was deeply concerned with the recurring disastrous floods in many Indian rivers. The extensive damage caused by floods in North Bengal in 1923 prompted Acharya Prafulla Chandra Ray to organize relief operation under the aegis of North Bengal Relief Committee. Ray was able to collect a large fund from the general public for the relief work and he was assisted by Subhash Chandra Bose, Meghnad Saha and Satish Chandra Dasgupta. And it was while carrying out the relief work Saha got a first hand experience of the devastating power of floods. Saha wrote about his experience in newspapers and magazines. In his Presidential address to

the Indian Science Congress in Mumbai in 1934 he drew specific attention to serious problems caused by floods. He also emphasized the need for a River Research Laboratory. Again in 1938, in his presidential address to the National Institute of Sciences of India he highlighted the danger posed by recurrent floods in Indian rivers particularly in the deltaic ones. In 1943 the flood in Bengal isolated Kolkata from rest of India and Saha wrote extensively on the issue. Saha's writings and speeches made the government realize the gravity of the situation. As a result the Damodar Valley Enquiry Committee came into being in 1943. The Committee was chaired by the Maharaja of Burdwan. Saha was also a member of the Committee. Saha presented a plan for handling the Damodar river system before the Committee. He also wrote extensively on river control based on modern science and technology. He argued that the model of Tennessee river system under the Tennessee Valley Authority (TVA) in USA could be adapted to the Damodar Valley. At the instance of Dr. B. R. Ambedkar, the then member-in-charge of power and works in the Viceroy's cabinet, the Government adopted a resolution to set up a Damodar Valley Corporation (DVC) after the model of TVA. The DVC was set up in March 1948. Saha's interest was not confined to Bengal rivers alone.

Saha's work relating to reform of Indian calendar was very significant. Saha was the Chairman of the Calendar Reform Committee appointed by the Government of India in 1952 under the aegis of the Council of Scientific and Industrial Research. Other members of the Committee were: A. C. Banerjee, K. K. Daftari, J. S. Karandikar, Gorakh Prasad, R. V. Vaidya and N. C. Lahiri. It was Saha's effort, which led to the formation of the Committee. The task before the Committee was to prepare an accurate calendar based on scientific study, which could be adopted uniformly throughout India. It was a mammoth task. The Committee had to undertake a detailed study of different calendars prevalent in different parts of the country. There were thirty different calendars. The task was further complicated by the fact that with calendar religion and local sentiments were involved. Nehru, in his preface to the Report of the Committee, which was published in 1955, wrote: "They (different calendars) represent past political divisions in the country…now that we have attained Independence, it is obviously desirable that there should be a certain uniformity in the calendar for our civic, social and other purposes and this should be done on a scientific approach to this problem." Some of the important recommendations of the Committee were:

i. The Saka era should be used in the unified national calendar. (The year 2002 corresponds to the Saka era of 1923-24.)
ii. The year should start from the day following the vernal equinox (occurs about March 21) day.
iii. A normal year would consist of 365 days while a leap year would have 366 days. After adding seventy-eight to the Saka era, if the sum is divisible by four, then it is a leap year. But when the same becomes a multiple of 100 it would be a leap year when it is divisible by 400, otherwise it would be a common year.
iv. *Chaitra* should be the first month of the year. From *Chaitra* to *Bhadra* each month would have thirty-one days and the rest to have thirty days.

According to Saha, large-scale industrialization was the only answer for improving the quality of life. He thought that India had no hope if she failed to develop science and technology. Saha wrote: "The philosophy of kindliness and service to our fellow-men was preached by all founders of great religions, and no doubt some great kings and ministers of religions in every country and at all ages tried to give effect to this (altruistic) philosophy. But the efforts were not successful, for the simple reason that the methods of production of commodities were too indifferent to yield plenty for all, which is an indispensable condition for practical altruism. We can, therefore, hold that so far as individual life is concerned, science has achieved a target aimed at by the great founders of religions in advanced countries of the world. The effects of maldistribution of wealth, due to historical causes, are being rapidly cured by introduction of social laws."

In 1952 Saha was elected Member of the Parliament as an independent candidate from the North-West Calcutta constituency. Welcoming Saha's election JBS Haldane said: "May I also be allowed to congratulate him on his recent successful reentry recently into politics. India (and Britain too) needs men who will bring some understanding of science to the government of the country. Even those who do not share his political views may rejoice that he can make his voice heard in the council of the people." Many wonder why Saha, an internationally known scientists decided to fight election.

*D.S. Kothari*

Saha died suddenly due to a massive heart attack on his way to the office of the Planning Commission on 16 February 1956. As D. S. Kothari, one of Saha's illustrious students, wrote: "The life of Saha was in a sense an integral part of the growth of scientific research and progress in India and the effect of his views and personality would be felt for a long time to come in almost every aspect of scientific activity in the country. His dedication to science, his forthrightness and utter disregard of personal comforts in the pursuit of his chosen vocation will long remain an inspiration and an example."

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4. *Treatise on Modern Physics*, Vol-1 (with N.K. Saha) Indian Press, Allahabad, 1934.
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# Neutrinos and X-ray Sources

V.B. Kamble

The Nobel Prize in Physics for the year 2002 was awarded jointly to Raymond Davis Jr. and Masatoshi Koshiba for their pioneering contributions to astrophysics, in particular for the detection of cosmic neutrinos; and Riccardo Giacconi for his pioneering contributions to astrophysics, which led to the discovery of cosmic X-ray sources. This year's Nobel Laureates have used the smallest components of the universe to increase our understanding of the largest entities of the universe: the Sun, stars, galaxies and supernovae. Indeed, the new knowledge has changed the way we look upon the universe. Detection of cosmic neutrinos and the discovery of cosmic X-ray sources have opened up two new windows on the universe.

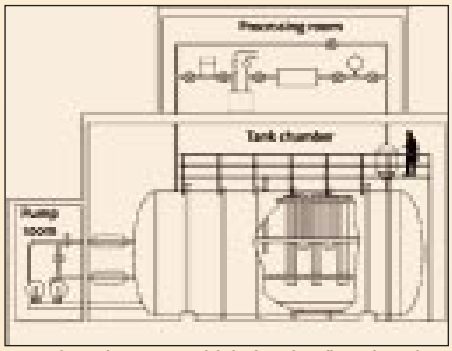
Masatoshi Koshiba

Raymond Davis Jr

Riccardo Giacconi

## Neutrinos

The mysterious particle neutrino was predicted some 72 years ago by Wolfgang Pauli to explain beta-decay, a kind of radioactivity in which a nucleus changes to another by emission of an electron, that is, a beta-particle. Pauli was awarded Nobel Prize for his exclusion principle in 1945. But it took nearly 25 years to prove its existence by Frederick Reines (awarded Nobel Prize in 1995). It would be worth mentioning that interactions involving neutrinos were studied in India as well. In 1964 MGK Menon, then Assistant Director of the Tata Institute of Fundamental Research in Mumbai participated on the Anglo-Indian-Japanese Team that detected the first cosmic ray neutrino. The reason why it is so difficult to observe neutrinos is that they hardly interact at all with matter. When the Sun and other stars produce energy through the fusion processes by converting hydrogen into helium, a large number of neutrinos are produced and ejected into space. Indeed, thousands of billions of neutrinos pass through us every second without noticing them. The transformation of hydrogen into helium in the Sun gives rise to two neutrinos for each helium nucleus that is formed by a series of reactions. The dream of verifying this theory by detecting neutrinos was considered a practical impossibility by most scientists.



*Davis's detector, which for the first time in history proved the existence of solar neutrinos. The tank, which was placed in a gold mine, contained more than 600 tonnes of tetrachloroethylene and was 14.6 metres long, with a diameter of 6.1 metres.*

## Neutrinos from the Sun

In the late 1950s, Raymond Davis Jr. was the only scientist who dared to try to prove the existence of solar neutrinos. It so happens that most reactions in the Sun create neutrinos with energies so low that they are very difficult to detect. Sad indeed. But there is one rare reaction that creates a high-energy neutrino. The Italian physicist Bruno Pontecorvo proposed that it ought to be possible to detect this neutrino after it had reacted with a nucleus of chlorine, forming a nucleus of argon and an electron. This argon nucleus is radioactive and has a life of about 50 days.

In 1960s, Davis placed a tank filled with 615 tonnes of the common cleaning fluid tetrachloroethylene in a gold mine in South Dakota, USA. The tank was 14.6 metres long, with a diameter of 6.1 metres. Altogether, there were some $2X10^{30}$ chlorine atoms in the tank. He calculated that every month approximately 20 neutrinos ought to react with the chlorine. As a result of reaction between neutrinos and chlorine atoms, 20 argon atoms ought to be created. Davis's pioneering approach was the development of a method for extracting these argon atoms and measuring their number. He released helium gas through the chlorine fluid and the argon atoms attached themselves to it. It is said that this was an achievement considerably more difficult than finding a particular grain of sand in the whole of the Sahara desert !

Davis's experiment gathered data until 1994. He could extract approximately 2000 Argon atoms. But here was a surprise. This was fewer than expected. Through control experiments Davis could show that no argon atoms were left in the tank of chlorine. Did it mean that some of the neutrinos had disappeared on their way to the earth? Or was it that our understanding of these processes in the Sun was incomplete?

## Neutrinos from Space

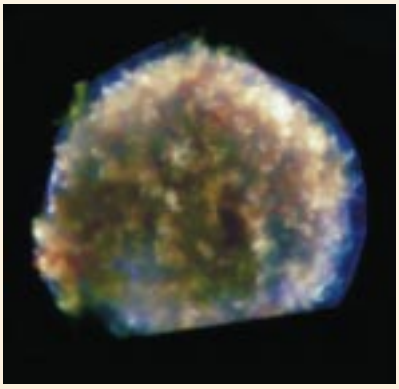
While Davis's experiment was going on, the Japanese physicist Masatoshi Koshiba and his team constructed another detector, which was given the name Kamiokande. It was placed in a mine in Japan and consisted of an enormous tank filled with water. It was expected that when neutrinos passed through this tank, they would interact with the atomic nuclei in the water. This reaction incidentally leads to the release of an electron, creating small flashes of light. To detect these small flashes, the tank was surrounded by photomultipliers. These photomultipliers captured these flashes. By adjusting the sensitivity of the detectors the presence of neutrinos could be proved and Davis's result was confirmed. However, there were decisive differences between the experiments of Davis and Koshiba. Koshiba's experiment could register the time for the events and was even sensitive to direction - that is the direction from which the neutrinos arrived. It therefore, became possible for the first time to prove that neutrinos do come from the Sun.

The Kamiokande detector was hit in February 1987 by a bursts of neutrinos from a supernova explosion, named 1987 A, in a neighbouring galaxy to the Milky Way called the Large Magellanic Cloud. The supernova 1987 A lies at a distance of about 170,000, light years from the Earth. Incidentally, one

light year corresponds to about ten thousand billion kilometers. If a neutron star is formed when a supernova explosion takes place, most of the enormous amount of energy released would be emitted as neutrinos. A total of about $10^{58}$ neutrinos is estimated to have been emitted from supernova 1987 A, of which Koshiba's group observed 12 of the approximately $10^{16}$ that passed through the detector. His results were confirmed in a similar experiment in the United States.

## Neutrinos Today

In order to increase sensitivity to cosmic neutrinos, Koshiba constructed a larger detector in 1996, called Super Kamiokande. Only recently this experiment has observed effects of neutrinos produced within the atmosphere, indicating a completely new phenomenon called neutrino oscillations. Here, one kind of neutrino can change into another type. If so, neutrinos would have a non-zero mass. The non-zero mass of neutrino is of great significance for the Standard Model of elementary particles and also for the role that neutrinos play in the universe. It could also explain why Davis did not detect as many neutrinos as he had detected. Incidentally, in standard model, there are six "flavours" of quarks and corresponding six "flavours" of leptons consisting of electrons and neutrinos.



*Remnants of the supernova – an exploding star – in the Cassiopeia constellation which Tycho Brahe discovered in 1572 from Herrevadsklosster and described in detail. The supernova lies at a distance of 7,500 light years from Earth and is 20 light years wide (one light year corresponds to $10^{16}$ metres). This image was taken by the Chandra satellite in X-ray radiation. NASA/CXC/SAO. http://chandra.harvard.edu*

Davis's and Koshiba's discoveries and their development of instruments gave birth to an entirely new field - neutrino astronomy. Neutrino astronomy is of great importance for elementary particle physics, astrophysics and cosmology. If neutrinos do have a non-zero mass, the standard model for elementary particles will have to be modified. The non-zero mass of neutrinos can be highly significant for the collected mass of the universe. However, it is necessary to prove or disprove the neutrino oscillation theory. Studies are in progress at many laboratories throughout the world for the purpose.

## Giacconi Looks for Cosmic X-ray sources

Despite the fact that X-rays were discovered over a century ago in 1895 and were put to use by physicists and doctors all over the world, it took almost half a century for astronomers to study this radiation. Why was it so? X-rays which can so easily penetrate human tissues and other solid materials, are almost entirely absorbed by the air in the Earth's atmosphere. It was only in the 1940s when rockets were developed that instruments could be sent high enough in the atmosphere. The first X radiation outside the Earth was recorded in 1949 by instruments placed on a rocket. It was shown that this radiation came from areas on the surface of the Sun with Sun spots and eruptions and from the surrounding corona, which has a temperature of several million degrees Celsius. No doubt, this type of radiation would have been very difficult to record if the Sun had been as far away as other stars in the Milky Way.

In 1959 the then 28 year old Riccardo Giacconi, together with the late Bruno Rossi, worked out principles for how an X-ray telescope should be constructed. This construction collected radiation with cone shape, curved mirrors onto which the radiation falls very obliquely and is totally reflected. Giacconi and his group carried out rocket experiments to try to prove the presence of X-radiation from the universe, primarily to see whether the moon could emit X-radiation under the influence of the Sun. Although no radiation from the Moon could be detected, a surprisingly strong source at a much greater distance was recorded since the rocket was rotating and its detectors swept the sky. In addition, a background X-radiation was detected evenly distributed in the sky. These unexpected discoveries gave an impetus to the development of X-ray astronomy. In time, the way in which the direction of the radiation could be determined was improved and the sources could be identified with observations made in normal course. The source to be discovered in the first successful experiment was a distant ultraviolet star in the Scorpio were double stars, in which one star circles in a narrow orbit around another object which is very compact. This could be a neutron star or even a black hole. However, it was difficult to carry out the studies due to the short observation times from the balloons and rockets.

Giacconi initiated the construction of a satellite in order to extend observation times and survey the sky for X-radiation. This satellite was launched in 1970 from a base in Kenya and was called UHURU. It was 10 times more sensitive than the rocket experiment and every week it was in orbit, it produced more results than all the previous experiments put together. Later, Giacconi constructed in 1978 a high definition X-ray telescope to provide sharp images called the Einstein X-ray Observatory which was sent into space. It provided relatively sharp images of the universe at X-ray wave lengths. This telescope made a large number of discoveries. Many X-ray double stars were studied in detail, including a number of objects that were thought to contain black holes. Indeed, more normal stars could also be studied for the first time in X-radiation. Remnants of supernovae were analysed, X-ray stars in galaxies outside the Milky Way were discovered and eruptions of X-radiation from distant galaxies could be examined more closely. The X-radiation from the gas between galaxies in galaxy group help scientists draw conclusions about the dark matter content of the universe.

Giacconi initiated the construction of an improved, even larger X-ray observatory in 1976. However, it was not launched until 1999, and was named CHANDRA after the famous Indian astrophysicist and Nobel laureate Subrahmanyan Chandrasekhar. CHANDRA has provided extraordinarily detailed images of celestial bodies in X-radiation corresponding to those from the Hubble Space Telescope and the new Earth-based telescopes that use visible light. Our picture of the universe has changed in decisive ways as a result of X-ray astronomy, thanks to Giacconi and other pioneers. 50 years ago our view point was dominated by a picture of stars and star constellations in equilibrium, where any developments were very slow and gradual. Today, we know that extremely rapid developments take place in the universe in which enormous amounts of energy are released in extremely short processes lasting less than a second. In connection with objects which are incredibly compact and not much larger than the Earth. The processes going on in these objects and in the central parts of active galaxy cores are largely based on data from X-ray astronomy. The universe seems highly remarkable, much more than we believed nearly half a century ago - thanks to X-ray astronomy.

*Note: This article is based on the information available on the Nobel website viz., http;//www.nobel.se*

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# The Problem of Junk and Congestion in Space

P. K. Mukherjee

The problem of garbage and pollution is nothing new for us. However, perhaps not many have heard of the problem of junk in space. Of late, this problem has indeed attained alarming proportions leading to pollution and congestion in space.

Ever since the launch of Sputnik-I, the World's first artificial satellite, in 1957 by the erstwhile Soviet Union, numerous satellites were put into orbit around the earth by various nations. Today, more than a thousand satellites are orbiting the earth.

Besides, satellites spacecrafts, space stations etc. have also been sent by man into space. Powerful rockets, called launch vehicles, are used to send these objects into space. Such multi-stage rockets have three or more than three stages. The upper stage of the rockets, also called the booster stage, is fired to put the object to be launched into the desired orbit.

After performing its function, the final stage gets separated. The process of separation releases springs, clamps, heat shields, nuts, bolts and other attachments which are thrown into space. All these objects keep traveling in the orbit of the satellite following is closely by remaining separated by only a fraction of a kilometer. All these objects add to the population of debris or junk in space.

The upper stage of the rockets after completing its desired objective becomes defunct and remains as debris or junk in space. The non-active rocket's upper stage has at times some unused fuel left in it which may often cause explosion. An accident of this kind occurred in 1986 when the booster stage of the rocket Ariane exploded after delivering a payload into orbit, spreading much debris in space.

*The satellites and the booster stage of rockets lead to the problem of debris and congestion in Space*

A satellite or a space station is launched into space to fulfill certain objectives. Once this purpose is over, it also becomes part of the drifting junk in space.

Metallic powder, which many rockets use as fuel, produces fine metallic ashes upon combustion. This is released in the form of a spray of fine particles in space just to compound the menacing problem of space debris.

The paints on the outer surfaces of satellites and spacecrafts have a tendency to peel off. Also, their metallic surfaces tend to corrode with time. The pain flakes and the corroded grains are thrown into space to become part of the debris.

The man-made objects sent into space are, therefore, the main source of debris or junk in space. It is estimated that about 10,000 objects have so far been sent into space by various countries and space agencies.

These objects are continually being tracked by radar and laser beams, and by using optical telescopes. The US space command is actively engaged in the tracking of these objects which are over 10-cm. size, using large parabolic dishes. The diameter of these dishes may be as high as 27 meters. This way about 8500 objects have been identified. A catalogue of such objects has been prepared after collecting information about their orbit and their approximate shape and size.

Surprisingly, the operational satellites constitute only about 5 percent of those objects. The rest comprises satellites that are out of order, the upper stage of launchers and various other fragments. The European Space Agency (ESA) also maintains a complete database of the junk-ridden area of space.

In addition to the above detected junk pieces, there are numerous other pieces too which are difficult to be tracked in view of their small size. The number of such intractable fragments, measuring between 1 and 10 cm., has been estimated to be between 70,000 and 1,50,000. The patent target of the fragments are the operational satellites which are orbiting the earth at low altitudes and the satellites in the geo-stationary orbit.

An ordinary satellite may sometimes explode in space. In the process, some chemicals present in the satellite may cause pollution by getting exposed to the gases in space. Besides, a large number of small fragments created as a result of such explosion may add to the problem of junk in space.

The fragments or small chunks wandering in space collide among themselves. The big pieces of junk thus disintegrate into smaller pieces, increasing the number of junk pieces further. The increase in the number of pieces causes more collisions which in turn leads to the creation of still more junk pieces. The process continues indefinitely and a chain reaction is finally set off.

Some of the pieces or fragments constituting junk or debris move with phenomenal speed in space. For instance, a half-millimeter sized metal chip traveling at a break-neck speed of 10 km per second could hit an astronaut working outside a spaceship by penetrating his space suit. These fast-moving junk pieces have even the potential of damaging or destroying a spacecraft in orbit. So, these junk pieces are a source of potential threat to space stations and operational satellites orbiting the earth.

An accident due to the space debris occurred in July 1996 when a French military satellite 'cerise' collided with a big fragment of a 10 years old rocket's upper stage orbiting around the same orbit as the satellite. Also, a few years ago, the American space shuttle 'Colombia' came into collision course with a space debris.

The fast-moving junk pieces colliding with satellites carrying nuclear power stations may lead to potentially dangerous consequences. Possibly realizing this, the American environmentalists had launched a strong protest campaign against the launch of the American Saturn probe 'Cassini'.

Even when a satellite becomes inoperational or non-active, it continues to move in the same orbit indefinitely provided it has acquired what is called the first cosmic speed. There is, however, a continual diminishing in the speed of the satellites due to the atmospheric drag force acting on them. These satellites, therefore, start failing down to earth slowly and gradually taking a spiral-shaped path. On entering the relatively dense layers of the atmosphere, they are soon set ablaze due to the enormous heating produced by the aerodynamic friction. Eventually, they fall down to earth in ashes.

*PSLV lift-off from SHAR Centre, Sriharikota*

However, at times some hard metal equipment or components of a satellite or space station may escape burning. Such unburnt fragments may indeed pose hazard to human life on earth. For instance, the fall of the remnants of the US space station Skylab over the Indian Ocean and Australia in 1979 created much panic on earth. The re-entry of the Russian space station Salyut in 1991 also created a similar situation. In March 2001, the Mir station, after successfully completing fifteen years of its useful life span, also came down to earth although coincidentally no human harm was caused.

The number of satellites being sent into space is always increasing day by day, thanks to the latest technological advancements. Besides communication satellites, some of the companies are also venturing to launch groups or constellations of special-purpose satellites into space. Globalstar, Teledesic etc. are some of these satellite constellations which companies are planning to launch. It is estimated that about 220 such satellites will shortly become the part of the satellite population in space. The crowding of satellites in space will undoubtedly add to the mounting problem of space debris.

The European Space Agency (ESA) has been active for quite sometime now addressing the problem of junk in space. The ESA has recommended adequate measures to be taken by the nations to limit the debris formation in space. Other recommendations made by the ESA include emptying the upper stage of launch vehicles to prevent explosions in space and transferring geostationary satellites to high orbits, called 'graveyard' or 'cemetery' orbits, with a view to clear the orbits in which the satellites operate.

Some scientists have suggested that very large and long-lasting manned or unmanned space vehicles should be provided with metal shielding to protect them against junk pieces and meteorites. Suggestions have also come from scientists for the installation of detection devices in the space vehicles so that they could take evasive measures as and when necessary. However, all these measures may amount to putting lot or financial burden on the space mission.

There is no gainsaying that the problem of space debris has indeed become a source of worry for space agencies and satellite-owning countries. It has, therefore, become imperative that some international laws and regulations be made to control and regulate the debris formation in space. Otherwise, the space, which is regarded as the fourth environment, may indeed become so much polluted and congested that the possibility of the establishment of space settlement colonies in the foreseeable future would even lose its significance.

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*VP News contd. from page .....36*

assisted by a number of active ham radio operators in Delhi, namely Shri Surinder Kumar (VU2SUH), Shri Sanath Kumar (VU2YI), Shri Rahul Kapoor (VU2YK), Shri Venugopal (VU2LRL), Shri Kapil Tripathi (VU3POF). Dr. Abhay Kr. Shrivastava, Associate Professor & Head, Haryana Institute of Public Administration, who was present on the occasion as a distinguished guest, expressed his desire to organize a training programme for the IAS cadres. Colonel Pratap Singh expressed his desire to set up a ham radio club station in their school with the assistance from Vigyan Prasar.

*Volunteers of the Disaster Mitigation Training Programme*

A regional workshop on Ham Radio was also organised by Vigyan Prasar in collaboration with Science Trial Organisation, Silchar, Assam (A non governmental organization working for the popularization of science & technology) on September 22, 2002. The workshop was attended by 150 participants from different parts of Barak valley representing various schools and NGOs. A multimedia presentation on Ham Radio with an emphasis on the role of Ham Radio in disaster management was delivered by Shri Sandeep Baruah (Scientific Officer, Vigyan Prasar).

A number of new VHF ham radio stations have come up on-the-air through the Vigyan Prasar VHF repeater VU2DLR with the assistance from Shri Lokesh Khanna (VU2LO). The new ham radio operators with low cost modified equipment (now popular as the 'green birds' which have been modified from the junk surplus by Shri Khanna for VHF ham band) are: Mrs. Chandrima Roy (VU2CCT), Shri Tanmoy Dev (VU2TDV), Shri A.K. GhoshRoy (VU2GAK), Shri Yogesh Kataria (VU3PYF), Shri Gaurav Sharma (VU2GTI) and Shri Tirtha Prasad Sinha (VU2TPR). Incidentally, two of the new ham radio operators, namely Mrs. Chandrima Roy (VU2CCT) and Shri Tanmoy Deb (VU2TDV) were earlier trained by Vigyan Prasar.

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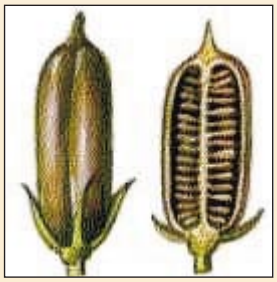
# Open Sesame!

T.V. Venkateswaran

Classic tale, 'Ali Baba and the Forty Thieves' from the *Arabian Nights* or *'The Thousand and One Nights'* is more than familiar to all of us. Ali, as you may recall was hiding for the fear of his life from the thieves, when he witnessed an amazing scene. The chief thieve standing before what appeared to be the face of a cliff shouted 'Open Sesame!' and the cliff wall opened to reveal a treasures filled cave. After the thieves left, Ali tried to open the cliff by shouting 'Open Sesame' and could slip inside the cave to amass a share of gold from the bounty the thieves had hidden away in the cave. Ali used to take little gold every now and then, adequate to revel but not to attract attention.

One day, wicked brother of Ali, Cassim, discovered the source of the new found riches of his brother and went to the cave himself. Once inside he closed the cave with the command, 'Close Sesame'. While he was greedily gathering the treasure to take them away, he heard the hoof sounds of forty horses. In his haste to get away, he forgot the password to open the gate.

He shouted 'Open barley!'. Nothing happened. He shouted 'Open wheat!'. Nothing. He shouted 'Open maize!' Nothing. He went through each grain that he could think of, but he could not remember sesame in time. The thieves found him and killed him.



Interesting as it is the story is, but intriguing questions are, of all things, why sesame as the password, and why in the world Cassim could not recall it in time. Some folklorists claim that this story is based on human psychology, often commonest tings slip out of our mind. Sesame was so well known and common to the Arabs, it was suggested that this phrase would quickly be forgotten because it was so common. Other interpretations suggest that, the sound produced when the trap door of the cave open up sound same when the sesame seeds 'pop' open from the ripe pod!

## Sesame in history

Whatever be the case with this familiar story, sesame has been in use for a very long time, for longer than many other herbs and spices. Sesame seeds are believed to be one of the first condiments as well as one of the first plants to be used for edible oil. There is reference to oil extracted from sesame in an ancient Sngam age Tamil literature (dated between 6 BC to 6 AD).

The earliest recorded use of a spice - sesame seed - comes from an Assyrian myth. In an archeological find dated circa 2300 BC, the ancient Assyrians made written reference to sesame on chiseled stone tablets. This narrated the story of how when the Gods were pondering the task of creating Earth and the universe, to fortify for this immense task, they had a mighty feast and drank sesame wine.

Sesame is listed in the Ebers Papyrus, a 65-feet-long scroll listing ancient herbs and spices discovered by the famous German Egyptologist, Ebers. Palace records of Egypt's King Nebuchadnezzar, 6th century BC, were carefully kept on clay tablets. One of the entries mentions a purchase of sesame oil. Records show that the Egyptians prescribed the sesame as medicine as caveres 1500 BC and used the oil as ceremonial purification. The English term *sesame* traces back to the Arabic *simsim,* Coptic *semsem,* and early Egyptian *semsent*. African slaves brought sesame seeds, which they called *benné seeds,* to America, where they became a popular ingredient. Through the ages, the seeds have been a source of food and oil. Sesame seed oil is still the main source of fat used in cooking in the China, Japan, and South East Asia as well as in some parts of South India.

Spices have been used not only for adding flavour to food, but also as home remedies, and as beauty aids. Sesame, though not deemed a rarity like saffron or black pepper, was considered to be having potent strength. Long before scientific ideas regarding growth and reproduction of plants developed, magic had assigned to the known species of vegetation supernatural properties; and subsequently, became an indispensable tool in every mystic ritual through the centuries. This practice continued to be active among the believers until the medieval times. Thus, Sesame was regarded as a spice that had miraculous properties. Priests employed them in worship, incantations, and rituals. In India, *Yamaha*, the Hindu god of death is regarded as responsible for the creation of sesame plant. The seeds are used in funeral ceremonies and sesame seeds along with water are offered to the departed soul on its long journey to the other world. Ancient Romans made special cakes with sesame seeds for funeral. But whereas in Africa, the seeds known as *benné*, is reckoned as a symbol of good luck!

## Sesame plant

*Sesamum indicum,* (*indicum* meaning from India) is claimed to be native to the Indian Subcontinent. The sesame plant is an annual herb of the *Pedaliacae* family. Now it is found growing in most tropical, subtropical, and southern temperate areas of the world. The reported life zone for sesame is from 11 to 29 degrees centigrade with an annual precipitation of 0.2 to 0.4 meters and a soil pH of 4.3 to 8.7. The crop does best in a warm temperature with a long growing season.

Sesame, a tropical herbaceous grows as high as 0.5 –

2.5 meter tall, though most plants range about 1 meter in height. The plant has an unpleasant odour. The leaves vary from ovate to lanceolate and are hairy on both sides. The white to lavendar-pink flowers, mature into pods, about 3 cm in length, containing numerous edible sesame seeds. The pods and seeds matures in 80 -180 days.

The pods 'pop' open dramatically, once the seeds are matured, with a 'popping' sound, and the seeds scatter and disperse on all directions. The seeds outer covering come in a variety of colors depending on the plant variety, including shades of brown, red, black, yellow, and most commonly, a pale grayish ivory. The darker seeds are said to be more flavorful. The seeds are tiny, flat ovals, measuring about 3 mm (1/8 in) long. In its raw form, it is frequently described as delicately sweet and nutty, and hotness scale is 0. When toasted it takes on the flavor of roasted peanuts with unique overtones. When the outer hull is removed, the inner seeds are creamy white.

Scattering of the seeds is a boon to the plant species, as the chances of survival of the progeny will be higher. However it is a bane for the farmer, who is interested in collecting the seeds inside the pod. Hence, farmers harvest the pod even while they are still green and dry them to extract the seeds. Alternatively, stems are cut and hung upside down for the ripe seeds to fall out to be collected on mats. Harvesting is a laborious task, involving high labour cost. It is mostly done by hand. Since the mature seedpods are quite fragile and will burst open easily, scattering the seeds to the ground, harvesting could not be mechanized until recently. In the middle of the 20th century, horticulturists developed a hybrid variety of sesame that does not scatter, and now some of the harvesting is a machine process, though too costly to be widely used.

**Chemistry of sesame**
**Sesamin molecule**

Antioxidative and lipid-soluble lignan compounds, such as sesamin, sesamolin, and sesangolin are found in sesame. Synergists, a type of chemical compound, are used with insecticides to synergize or enhance the activity of the insecticides, but are not in themselves considered toxic or insecticidal. A component of sesame oil, sesamin (methylenedioxyphenyl) is a synergist for pyrethrum insecticides such as piperonyl butoxide.

## Sesame- rich source of nutrient

No need to shout "Open sesame!" to get to the magical flavor of sesame seeds. Sesame seeds are 25 percent protein and are especially rich in methionine and tryptophan. One ounce of hulled seeds contains 6 grams of protein, 3.7 grams of fiber, and 14 grams of total fat. The fat in sesame seeds is 38% monounsaturated, and 44% polyunsaturated which equals 82% unsaturated fatty acids. When toasted they offer 4.8 grams of protein, 4.0 grams fiber, and 13.8 grams of total fat.

Sesame seeds have a high magnesium content to help steady nerves and are used in laxatives as an emollient. One-half cup of sesame seeds contains over three times the calcium of a comparable measure of whole milk. Sesame seed hulls are often removed since they contain 2 to 3 percent oxalic acid, which can interfere with the absorption of calcium and give a bitter flavor. Some studies show that sesamin, a lignan found only in sesame seeds, has remarkable antioxidant effect, which can inhibit the absorption of cholesterol and the production of cholesterol in the liver. Sesame seeds are highly nutritious. One ounce of seeds has as much protein as one cup of milk and in addition is abundant with Vitamin A. However the protein is incomplete and is low in lysine. Oil content of the seeds is an ample source of Vitamin E.

Both natural and hulled sesame seeds contain healthy amounts of the B vitamins riboflavin, thiamine, and niacin. With natural seeds scoring 8.7 mcg of folic acid for 1 tablespoon and plenty of vitamin B6, you can count on sesame seeds for excellent nourishment. One tablespoon of hulled seeds contains 0.62 mg of iron, 27.73 mg of magnesium, 32.53 mg potassium, and 0.82 mg of zinc. Figures for the natural, unhulled, are slightly higher. Sesame seeds also contain healthy amounts of phosphorous. If you are lacking iron, turn to the sesame seed. Its iron content is equal to that of liver.

The nutritious properties of sesame were well known even to ancient world. It is not for fun, that a drawing on an Egyptian tomb, 4,000 years ago, depicts a baker adding sesame seeds to dough. Ancient Greek soldiers carried sesame seeds as energy boosting emergency rations and the Romans made a kind of hummus from sesame and cumin- possibly the earliest army rations!

## Sesame Oil

Sesame has been used for thousands of years for extraction of oil and is still an oil seed of worldwide significance. Southern Indian cuisine depends on sesame oil for cooking, while in Japan it was the only cooking oil until quite recently. Till alternatives such as cotton oil and Soya oil replaced, sesame oil was staple in US too.

Sesame seeds are pressed and compressed a second and at times even third time to extract oil. Sesame oil comes in two varieties. One is cold-pressed with a color that is golden and flavor that leans toward bland. The other is the Asian variety made from roasted sesame seeds, darker in color with intense flavor. Known as either sesame, gingerly, or til oil, it is bland in taste and almost odorless. Constituents of the oil include olein, stearin, palmitin, myristin, linolein, sesamin, and sesamolin. The solid material that remains is a dense 'mush' that is rich in protein. It is usually used as cattle feed and in times of severe food scarcity, even as food supplement in certain parts of the country.

Sesame oil is non-drying oil, is remarkably stable and will keep for years without turning rancid, even in hot climates. Unlike the seeds the oil is not prone to rancidity (resistant to oxidation). Hence it is handy in preparation of pickles and preserves. It is very rich in protein, a polyunsaturated fat used in margarine production and cooking oils. Although sesame seeds contain no cholesterol, they are still 50 percent unsaturated fat, so those watching their fat consumption should exercise moderation. Luckily, a small amount goes a long way in flavoring foods.

## Medicinal, cosmetic and other uses

Non-culinary uses include its use as an ingredient in soap, cosmetics, lubricants and medicines. The Chinese used the sesame oil not only to light lamp but also to create soot from

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# Interview With Prof. M.S. Valiathan

Prof. Marthanda Varma Sankaran Valiathan, currently the President of Indian National Science Academy (INSA), needs no introduction. A cardiac surgeon by training, Prof. Valiathan has been the founder director of Sri Chitra Tirunal Institute of Medical Sciences and Technology, Thiruvananthapuram, for 20 years. By the time he passed on the mantle, this institute had not only established a place among India's most prestigious research institutions, but also transferred a number of biomedical technologies to the industry for commercial production. Low-cost Sri Chitra artificial heart valve and indigenously designed blood bags were prominent among them. A staunch campaigner for creation of indigenous technology base, Prof. Valiathan currently serves as Honorary Adviser to Manipal Academy of Higher Education and Chief Scientific Adviser to Kerala Government. Exceprts from an interview with Prof. Valiathan:

***Dream 2047:*** *As a child, how did you get interested in science?*

**Prof. M S Valiathan:** As a school boy I was fascinated by the lives of Ramanujan, JC Bose, Raman, Galileo, Newton and a few other greatmen of science. Some of these appeared in my school texts. Secondly, I was inquisitive on what was taught in the class and used to seek more information outside the classroom. These two traits got me really interested in science.

***Dream 2047:*** *After a degree in medicine, that too with specialisation in cardiac surgery, there was a promising career as doctor waiting. But why did you opt for medical research rather than practice?*

**Prof. Valiathan:** As a matter of fact I served as a Professor of cardiac Surgery for over twenty years when I performed surgery every morning and found time to do research in the areas of interest to me in the afternoon, weekends etc. These areas were a heart muscle disease which affects children in the tropics and the development of biomaterials and devices for cardiovascular applications.

***Dream 2047:*** *Can you please recount some memorable experiences during your research career spanning over 40 years?*

**Prof. Valiathan:** In shaping a surgeon's career, certain teachers have the greatest influence. Looking back, I was fortunate to come under the spell of two - Professor Charles Wells in the UK and Dr Charles Hugnagel in the US - who became my role models in surgery. They combined surgery, research and teaching in perfect proportions and made a surgeon's life an admirable goal for me.

***Dream 2047:*** *You have been consistently emphasising on biomedical technology (indigenous blood bags and Chitra valves) development in the country. What is the status of this emerging area in the country? Is it still in a nascent stage?*

**Prof. Valiathan:** India was importing perhaps Rs. 1000 crores worth of medical instruments and devices thirty years ago. Many of these items such as blood bags and disposable syringes are needed even in Taluk hospitals. The high import cost meant that hardly 5 - 10% of the Indian population had access to these technologies. The modest effort at the Chitra Institute was aimed at creating a nucleus of research and development in this field and setting up a model for the transfer of technology to industry. We had hoped that the Chitra experiment, if successful, would find echoes elsewhere in the country and usher in a new scenario when India would be producing at least 50% of its requirements of medical instruments and devices. The Chitra experiment did succeed in developing and transferring the technologies of several devices – blood bag, hydrocephalus shunt, oxygenator, heart valve, vascular graft etc., which are commercially produced today. But the Chitra experiment was not replicated elsewhere and its impact on the health sector in the country was negligible. We import perhaps Rs. 7000 crores worth of medical instruments and devices today with access to modern technologies even more limited for the common people. Unless the industry wakes up to the enormous market - estimated to exceed 100 billion dollars globally - and the Government recognises medical technology as a priority sector, we will continue to remain where we are.

*Prof. M S Valiathan*

***Dream 2047:*** *Does the lack of interest towards science and technology, particularly scientific research, among young generation, concern you? If yes, what can we do about it?*

**Prof. Valiathan:** The decreasing interest in science at the school and college level is a matter of global concern - not of India's alone. In India, the situation is more serious; what with science departments failing to attract good students or any students at all. To some extent, this could be explained by the pull of new technologies such as IT, BT and management which seem to offer far better job opportunities than a career in science. No less important is the decline of science in the scheme of things in schools and colleges. The neglect of science at these foundational levels in our education system is a costly folly. If science education in schools and colleges is made more appealing and interesting by introducing experiments, by field work in biodiversity, by better training and retraining of teachers, by the use of PCs and new educational technologies etc., we might reverse the present retreat from science. Secondly, the research and development expenditure of the private sector industries -miniscule today except in pharmaceuticals - must rise significantly and the Government allocation for Science and Technology should reach 2% of the GDP as

promised if a major expansion in the job market is to take place for scientists.

***Dream 2047:*** *Do you think our education system is at fault for such a sorry state of affairs?*

**Prof. Valiathan:** Yes, our educational system is far from healthy. This has been acknowledged repeatedly by educational experts and various UGC Committees in the last twenty years. Remedial measures too have been suggested - but they are not implemented at all or implemented half - heartedly. It is a case of motor paralysis - the patient knows it all but cannot act.

***Dream 2047:*** *There has been a lot of concern among the scientific community that the quality of Indian scientific research is falling. (Subbaiah Arunachalam's paper in Current Science, for example). As INSA president as well as a respectable member of the scientific society, do you think that this is a valid concern? If yes, how can this issue by addressed?*

**Prof. Valiathan:** Arunachalam's studies are important in so far as they highlight the decline in India's publications in science vis-a-vis the rapid increase in publications from China. This has many causes but the most important among them is the pathetic state of the science departments in our universities. The UGC and DST have introduced special schemes to strengthen these departments - but the supply is dwarfed by the enormous demand. We need to do much more to make our universities the powerhouses of new knowledge. We should remember that the allocation for education never reached 6% of the GDP in India as recommended by the Kothari Commission nearly forty years ago; paradoxically we are now told by 'experts' that higher education being a 'non-merit good' need not be supported by the Government. If the 'experts' have their way, what little remains of the science departments in our universities would disappear to the detriment of the next generation. This is far more serious than the widening gap between India and China in the number of publications.

**T.V. Jayan**

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which they made their superior stick ink over 5,000 years ago. Ancient Chinese calligraphic works of art using stick ink made from sesame oil are found in museums. The soot from burning sesame oil is used to decorate eyelashes in south India by women and children. It said to 'cool' the eyes. In south India it is being used to anoint the body and hair, form *Sangam* age. Before sesame seeds were appreciated for their ability to add rich nutty flavor or to garnish foods, they were used only for oil

or wine. Medicinally, sesame oil played an important role as an antidote to the bite of the spotted lizard. Sesame oil was the ideal base for making exotic perfumes, a practice that dates back to the Babylonians circa 2100 to 689 BC. They, too, made

wine from sesame and even perfected a brandy employing sesame seeds.

Sesame oil is mildly laxative, emollient and demulcent. Sesame seeds are administered to relieve constipation and to remove worms from the intestinal tract. They are an aid to digestion, stimulate blood circulation, and benefit the nervous system. Sesame oil makes ideal massage oil because of its excellent emollient properties. Applied topically, sesame oil is thought to aid in healing chronic diseases of the skin. An old folk remedy recommends thoroughly chewing and swallowing one tablespoon of sesame seeds per day to regulate the menses.

The seeds and fresh leaves may be used as a poultice. The oil has wide medical and pharmaceutical application. Paste made from ground sesame seeds mixed with water was an old remedy for wounds and bleeding sores. Indian physicians, as early as 4th century BC, seems to have used the poultice to help heal incision after surgery. Sesame oil is an emollient, often used in the winter. Even Cleopatra is supposed to have used sesame oil as a skin softener and moisturizer. Sesame oil rubbed on the skin may soothe a minor burn or sunburn as well as help in the healing process. Sesame seed oil is said to remove wrinkles when applied to the skin in a facial massage. Cologne is made from sesame flowers.

**Further reading**

1. Stuckey Maggie, The complete Spice Book, St Martin's Paper back, 1997.
2. www.exoticspice.co.uk
3. www.chaddsfordhistory.org
4. www.irl.cri.nz
5. www.osirisweb.com/egypt

# Recent Developments in Science and Technology

## Smallest Ozone hole since 1988

It has been discovered that this year Antarctic Ozone hole is the smallest one since 1988,but this has little to do with earthy activities and much to do with wired weather in stratosphere. The Ozone hole has also split into two pieces, a new wrinkle on a phenomenon that scientists first discovered in the 1970s and have tracked as one measure of the impact of pollution.

The 2002 edition of the ozone hole covers about 16 million sq km, well below the 24 million square kilometer seen for the last six years at this time of year. The ozone layer shields the Earth from the Sun's harmful ultraviolet radiation capable of causing skin cancer in human and potentially deadly to crops and animals. Without ozone layer there would be no life on this planet.

The small size of this years ozone hole is causes by unexpectedly large weather patterns in the stratosphere, the layer of the atmosphere some 10 km to 48 km above Earth's surface where the ozone layer is found.

The Ozone hole is caused by the chemicals like in chlorofluorocarbons and halons -- human made chemical once used in hairspray, refrigerators and air conditioners.

***Source : Nature, Oct 2002***

## Radar Can Probe Soil Structure

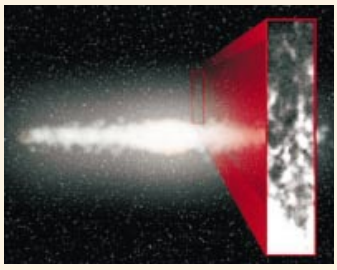
Soil testing is an important factor for good plantation. The methods which are used for testing generally disrupt the soil and can be time consuming. Now according to news published in Physical Review Letters microwave radar can be used for testing the soil. Researches have used microwave radar to determine the physical and mechanical properties of a section of earth without disturbing it.

Klaudia Oleschko of National Autonomous University of Mexico and her colleagues determined that although soil structure is extremely heterogeneous on the scale of one centimeter to one meter it is also a fractal -- patterns that can be described with relatively simple equation are repeated over varying size scale. The scientists exploited this property to identified the volume of empty space—a good indicator of density and water content—within a sample of dirt. Microwaves reflected by a soil sample, the team found, had the same fractal dimensions as the sample itself. When the researchers used microwave to scan a cube of earth with six very different layers the results obtained from radar technique agreed well with direct measurements taken from each of the sections .So ground penetrating radar is a prominent tool for nondestructive soil studies.

***Source: Scientific American ,Oct 2002***

## Hydrogen Cloud Spotted High above Milky Way

According to new report published in Astrophysical Journal Letter, huge hydrogen clouds that measure 100 light years across in the void between the Milky Way galaxy and intergalactic space. On the other hand previous research had reveled the presence of hydrogen gas floating above the plane of our galaxy. But where it came from or how it was distributed remained unclear due to instrument limitations. Now observations using the Robert C. Bred Green Bank Telescope have exposed the shape of neutral hydrogen masses.



F.Jay Lockman of National Radio Astronomy Observatory report in his publication that group of cloud is located towards the center of the milky way, 15000 light years from the earth and that each cloud contains between 50 and 100 solar masses of hydrogen. He further notes that the clouds which float about 5000 light years above the plane of our galaxy are coupled to the Milky Ways movements. One potential source is supernova explosions that continuously feed superheated hydrogen gas into the Milky Way which subsequently cool to from the clouds. Further radio telescope Observations are underway to gather more information about the intricacies of the hydrogen clouds, including their inner structure.

***Source: Scientific American, Oct 2002***

## Salt Tolerant Genes from Mangroves to Rice, Mustard

Indian Scientists have introduced the salt tolerance gene from mangroves, the plants that grow on the land near oceans in areas like Orissa, to rice and mustard and the varieties are undergoing test in labs, noted scientist Dr. M S Swaminathan said.

Dr. M S Swaminathan has said that his organization has mapped the genome of some mangroves and introduced the salt tolerant genes to rice and mustard under the project of Department of Biotechnology (DBT). He also emphasized that genetically modified plants are undergoing test in the green houses and would be available for farmers in about five years and this development will be significant in the scenario of climate change and possible rise in sea levels.

***Source: PTI News, November 2002***

Compiled by: Kapil Tripathi

## Letters to the Editor

I found "Dream 2047" enlightening as well as thought provoking. It not only provides us with the latest developments in the field of Science & Technology but also creates an interest among the children and teachers for science.

**Principal**

Mangalam D.A.V. Public School, P.O. Aditya Nagar-326 520, Morak, Distt. Kota (Raj.)

"Dream 2047" is undoubtedly a valuable source of scientific information.

**Dr. R.P. Purkayastha**

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