



# DREAM 2047

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## VP News

VIPNET News in Printed and Bigger form ....

VIPNET, the science clubs network of Vigyan Prasar, has been growing in strength and activities in a steady manner over the past six months of its existence. To cater to the demands of networking the clubs and publicising their programmes, a monthly newsletter titled "VIPNET News" is being published since December, 1998. The five issues, circulated among the member clubs and our well-wishers, so far, had been inhouse productions containing four pages of news, views, cartoons and quizzes. But looking at the ever increasing readership and contents contributed by the clubs, it has been decided to go for printing "VIPNET News" as an eight page monthly communication from June, 1999. Several new features, including a photo-section, have been planned for this new-look and bigger VP communication.

**Inside**

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You Too Can Make A Difference!

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1500 Years of Aryabhatiya

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### Marathi versions of two Vigyan Prasar books released

Marathi Vijnan Parishad, in association with National Book Trust and Sahitya Akademi, celebrated the International Book Day with an austere function at Mumbai on 23 April 1999. On this occasion, Marathi versions of Vigyan Prasar's two books titled "Meinbatticha Rasayanik Itihas" and "Sabanache Phuge Kase Banatat?" were released. Incidentally, these books, translated from English by Mrs. Sudha Gowariker, were the first two publications in the series "Science Classic Reprints" of Vigyan Prasar under the original titles of "Chemical History of a Candle" by Michael Faraday and "Soap Bubbles and the Forces Which Mould Them" by C.V. Boys. The function, presided over by Prof. G.P. Pradhan, was attended, among others, by Prof. V. G. Kulkarni, Mr. Kumar Ketkar, Dr. Vasant Gowariker, Dr. Narender K. Sehgal, Prof. M.V. Somani, Mr. Arvind Bhorkar, Mr. Prakash Bhatambrekar and the translator Mrs. Sudha Gowariker.



A section of the audience in the Marathi book release function in Mumbai



The Marathi titles of Vigyan Prasar

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

### You Too Can Make A Difference!

Determined individuals are capable of achieving unbelievable feats. Examples abound in every field in India as well as in other countries. Adversities, disabilities and handicaps of all kinds have not been able to prevent self-driven, highly motivated and determined individuals from becoming great achievers. Quite obviously, even under the worst of circumstances imaginable, individuals can make a difference, provided they continue to strive, never giving up. Moreover, in any case, struggles and movements for causes, revolutions, rebellions and the like are invariably conceived of, initiated and led to successful conclusions by only a handful of people or at best a small fraction of the total number of those who later help it, support it, join it and ultimately benefit from it. While population, or even large fractions of the same, rarely if ever come forward to initiate, or join a struggle or movement at the outset, it is their tacit, silent and indirect support which helps sustain, accelerate and eventually achieve its objectives.

The point to be made here is that even if the situation in our country is presently pretty bad and grim on several fronts -- and most people feel helpless -- determined individuals still ought to try and make a difference to their situation, even if it is only a very small difference. The question of giving up, of accepting the position that nothing can be done "to change things" should not at all arise.

What do we find all around us, everywhere, at every step, in every area, in whatever we try to do and no matter where we go in the country? Workers who get paid, but are shirkers, or reluctant to put in their full hours of work; people who respect or follow no rules -- whether on the road driving, or waiting their turn in queues; students who are not at all keen on their studies; teachers who would rather not take their classes or prepare their lessons when they have to; law makers and enforcers who regularly break law; those providing services doing so most reluctantly and as if they were doing you a favour; those selling something would like to fleece you to the maximum possible extent; after-sales service people would not like to be bothered with service complaints/calls; proof readers who leave behind many errors, because of carelessness; employees who would like to get overtime payment for work done during office hours; taxi drivers who wish to be paid for in excess of the fare meter readings; examinees who think nothing but of cheating, copying or using other unfair means of scoring in examinations; consumers who don't want to pay for the electricity or phones they use; publishers who never want to pay their authors royalties on actual sales; and I could go on and on for several more pages. I am sure each one of you readers can give me longer list, without repeating any of the foregoing examples.

Who is responsible for all this? If you ask me, all of us are; just about each one of us -- even if at each discussion on this subject, everyone talks as if all the others (except those discussing the subject) and not present, are responsible -- those who actually indulge in the abovementioned things; and all those who accept, put up with, silently condone, actively support, or go along with all this nonsense! The two together almost make up the whole universe. The small number of those who have managed to stay out of both the categories most of the time would have found themselves in constant conflict with someone or the other, struggling every centimetre of their way -- determined more than ever before to strive on and not to give in! We need to increase this tribe of individuals, who would not give up no matter what -- by joining them.

The fact that individuals have been and are making a difference to difficult and seemingly impossible situations ought to encourage and inspire others to stand up, fight for causes they believe in and ceaselessly carry on their struggle till objectives are achieved. Once an individual takes up cudgels for a cause and initiates some action, several others would be quick to join in and pursue it. But, for some reason, a good majority of the people everywhere are most reluctant when it comes to initiating something, or taking the first steps towards a goal, but once someone else does, many of them would gladly join hands.

So, next time you don't get a service you paid for, lodge a written complaint; don't let fleecers, cheaters, shirkers get away; let them know firmly what is expected of them. Remember, in our country, perfection, hundred percent performance, the promised quality of goods and services we pay for, and the like, have to be demanded and almost ferreted out of the providers/sellers; these things don't come in the normal course, as they should. One reason for this is that most people do not complain, and are willing to put up with low quality substandard things -- and the sellers know this and try to exploit this fully. All this would not do and must change. And the sooner the better. For that every person has to do his/her bit.

All the constant complaining we Indians do, in general, needs to be converted into action -- some conscious civilised action -- in specific terms, and as provided under our laws. So let us now stop talking and start acting, doing something about the problems, ills, and wrongs we have been complaining about.

Readers' views are solicited.

NKS



### SUBRAHMANYAN CHANDRASEKHAR

Subrahmanyan Chandrasekhar, one of the greatest scientists of the 20th century became a legend in his life time. Chandrasekhar's life as Kameshwar C. Wali wrote "stands out for its singular dedication to the pursuit of science, and for practicing the precepts of science and living up to its values to the closest possible limit in one's life." His prolific contributions spanned astrophysics, physics and applied mathematics. His life is the best example of the height one can achieve provided one has the will power, skill and patience. His journey was not smooth. He had to struggle against all odds. He was a product shaped by complexities of three widely different cultures—that of India (where he was born), England and USA. He believed in common heritage of human beings. He said: "The point is that human mind works in the same way. It's reassuring that things we find pleasurable are pleasurable to other people in every part of the world. And the fact that there is a common interest emphasises that there is a common heritage." He was a great scientist, an accomplished teacher and a formidable scholar.

Subrahmanyan Chandrasekhar was born in Lahore on October 19, 1910. His father C. Subrahmanyan Iyer was in Government Service. C.V. Raman, the first Indian to get Nobel Prize in science was the younger brother of Chandrasekhar's father. Chandrasekhar grew up in Madras (now Chennai). He went to a regular school when he was eleven. He joined the Madras Presidency College in 1925 where in the first two years he studied Physics, Chemistry, English and Sanskrit. On July 31, 1930 Chandrasekhar left for England for higher studies and thus began a long and outstanding scientific career which spanned 65 years. Except for the first six years he worked at the University of Chicago.

He is best known for his celebrated discovery of Chandrasekhar Limit. He showed that there is a maximum mass which can be supported against gravity by pressure made up of electrons and atomic nuclei. The value of this limit is about 1.44 times a solar mass. This was derived by Chandrasekhar in 1930, when he was a student. The Chandrasekhar Limit plays a crucial role in understanding the stellar evolution. If the mass of a star exceeded this limit, the star would not become a white dwarf. It would continue to collapse under the extreme pressure of gravitational forces. The formulation of the Chandrasekhar Limit led to the discovery of neutron stars and black holes. It may be noted that stars are stable, that is they do not collapse because internal pressures (due to the thermal motion of the atomic nuclei and electrons and also the pressure of the radiation generated by nuclear reactions) balance gravity. However, for every

star a time will come when nuclear reactions will cease and that means there will be no internal pressure to match the gravitational pull. Depending on the mass there are three possible final stages of a star - white dwarf, neutron star and black hole. Chandrasekhar was awarded (jointly with the nuclear astrophysicist William Alfred Fowler) the Nobel Prize in Physics in 1983.

While Chandrasekhar is best known for Chandrasekhar Limit, for him there was no limit. As mentioned earlier his work spanned physics, astrophysics and applied mathematics. In his own words: "There have been seven periods in my life. They are briefly : 1) Stellar structure, including the theory of white dwarfs (1929-39); 2) Stellar dynamics, including the theory of Brownian motions (1938-43); 3) The theory of radiative transfer, the theory of the illumination and the polarization of sunlit sky, the theories of planetary and stellar atmosphere, and the quantum theory of negative ion of hydrogen (1943-50); 4) Hydrodynamic and hydromagnetic stability (1952-61); 5) The equilibrium and the stability of ellipsoidal figures of equilibrium (1961-68); 6) The general theory of relativity and relativistic astrophysics (1962-71); and 7) The mathematical theory of black holes (1974-83)".

His research output is phenomenal and every monograph or book published by Chandrasekhar has become a classic. No serious student of the concerned fields can ignore Chandrasekhar's work. He was not motivated by a single problem but by a desire to acquire a perspective on an entire area. He was never concerned with the relative importance or unimportance of the subjects, he worked on. He was least concerned whether his work was going to bring him laurels and recognition. He said : "After the early preparatory years, my scientific work has followed a certain pattern motivated, principally, by quest after perspectives. In practice this quest has consisted in my choosing (after some trials and tribulations) a certain area which appears amenable to cultivation and compatible with my taste, abilities, and temperament. And when after some years of study, I feel that I have accumulated a sufficient body of knowledge and achieved a view of my own, I have the urge to present my point of view ab initio, in coherent account with order, form, and structure."

Once he finished a particular area he would be ready to start on a fresh one. The essence of Chandrasekhar's scientific life was 'attaining a complete understanding of an area, grasping and internalising it'.

Whatever he did, he did not only with a seemingly unmatched meticulousness but also with elegance. Lymnan Spitzer said: "It's a rewarding aesthetic experience to listen to Chandra's lecture and study the development of theoretical structures at his hands. The pleasure I get is the same as I get when I go to an art gallery and admire paintings".

Chandrasekhar consciously strived to develop style. He said: "I acquired my style from not only just reading, for instance, the essays of T.S. Eliot, Virginia Woolf, and Henry James, but also paying attention to how they write — how they construct sentences and divide them into paragraphs. Do they make them short or long? For example, the idea of just using one sentence for a paragraph, or of a concluding sentence without subject or object. Just a few words .... 'so it is' .... or some small phrases like that. I deliberately follow such devices ....."

Being so deeply involved in science, he had other interests as well. From the beginning he had developed interest in literature. He said: "My interest in literature began in a serious way in Cambridge around 1932. I used to devote most of the two to three weeks between terms to the study of literature. The real discovery for me at that time was the Russian authors. I read systematically, in Constance Garnett's translation, all the novels of Turgenev, Dostoevski's *Crime and Punishment*, *Brothers Karamazov* and *Possessed*. Chekov, I read of course all his stories and plays. Not all of Tolstoy's, but *Anna Karenina* certainly. Among the English writers I started reading Virginia Woolf, T.S. Eliot, Thomas Hardy, John Galsworthy, and Bernard Shaw. Henric Ibsen was also one of my favourite authors,...."

Chandrasekhar had the rare ability to inspire enthusiasm for hard work in others. More than 50 students did PhD work under his guidance. His relations with his students reminds us of the guru-sishya tradition of earlier times. While he evoked respect from his students, he also encouraged them to put their viewpoints without any fear. He said: "My students, students with whom I have worked closely, are respectful in a way, that is reminiscent of earlier times that we read of in books. At the same time they are not at all intimidated by what I say. They will react either positively or negatively, discuss and argue. If a person agrees with everything you say, then there is no point in the discussion."

Throughout his professional life he continued interacting with young people. Once he said: "I can easily imagine not having lost anything if I hadn't worked with Fermi or Von Neumann; but I cannot say the same thing with respect to my students".

He was the managing editor of the *Astrophysical Journal* from 1952 to 1971. He converted essentially a private journal of the University of Chicago into a national journal of the American Astronomical Society. For the first twelve years the *Journal* was managed by Chandrasekhar and a part-time secretary. "Between us we took care of all the routine work. We took care of scientific correspondence. We prepared the budget, advertisements, and page charges. We made the reprint orders and sent out the bills." When Chandrasekhar became the Editor, the *Journal* had six issues in a year totalling 950 pages but towards the end of Chandrasekhar's editorship, the journal became twenty four issues totalling over 12,000 pages a year. Under his

leadership the journal became financially independent of the University of Chicago. He left behind a reserve fund of US \$ 500,000 for the journal.

Chandrasekhar mostly lived and worked abroad. In 1953 he became a US citizen. However, he was deeply concerned with India's well-being. He had strong association with many scientific institutions and young scientists in India. In his childhood, he was inspired by Ramanujan's example - an example of total dedication to science. His interest in Ramanujan was life long. He played an instrumental role in establishing the Ramanujan Institute of Mathematics in Madras in the late 1940s and when the Institute was facing financial crisis he took up the matter with Nehru. He also managed to get increased pension for Ramanujan's widow who was living in abject poverty. He was also responsible for the busts of Ramanujan cast by Richard Askey.

What was the motivation for Chandrasekhar in pursuing science? As one of his students Yavuz Nutku said: "Forever learning, Chandra couldn't care one bit about the establishment. Everything he did was out of being curious in a productive way. He did it for one reason and one reason only — it would give him serenity and inner peace."

For those who are pursuing science or are planning to do, we would like to end by quoting Chandrasekhar. "The pursuit of science has often been compared to the scaling of mountains, high and not so high. But who amongst us can hope, even in imagination, to scale the Everest and reach its summit when the sky is blue and the air is still : and in the stillness of the air survey the entire Himalayan range in the dazzling white of snow stretching to infinity. None of us can hope for a comparable vision of nature and of the universe around us. But there is nothing mean or lowly in standing in the valley below and awaiting the sun to rise over the Kunchenjunga."

Chandrasekhar died on August 21, 1995.

Suggested reading:

- (1.) Subrahmanyan Chandrasekhar, Kameshwar C. Wali, *Current Science* pp. 477-479, 1998;
- (2.) *Chandrasekhar and His Limit* by G. Venkataraman, Universities Press, 1992;
- (3.) *Truth and Beauty : Aesthetics and Motivation in science* by S. Chandrasekhar, University of Chicago Press, 1987;
- (4.) *Chandra : A Biography of S. Chandrasekhar* by Kameshwar C. Wali, Penguin Books, 1990;
- (5.) *Eddington : The Most Distinguished Astrophysicist of His Time* by S. Chandrasekhar, Cambridge University Press, 1983;
- (6.) *Resonance* (a journal of science education published by the Indian Academy of Science, Bangalore) April 1997 Issue.

Subodh Mahanti

## 1500 Years of Aryabhata

India's first artificial satellite, Aryabhata, orbited in April 1975, has done a great service to our scientific heritage: it popularised the name of Aryabhata, one of the greatest scientists of ancient India. His name or his contributions were not as well-known as that of Varahamihira or Bhaskaracharya till recently. Even his name is not always spelled correctly!

It is not difficult to see why Aryabhata's name and contribution is not so well-known as that of Varahamihira or Bhaskaracharya. Varaha (6th century A.D.) was basically an astrologer; his books help keep the people bound to this age-old superstition. Bhaskara (1150 A.D.) was, no doubt, an original thinker, but he also supported astrology. And till the advent of modern education, his *Lilavati* was a sort of a text-book of arithmetic for several centuries.

Aryabhata did nothing of this sort. In style he was a *sutrakara*, a writer of compact statements of results. He did not support astrology; from some of his statements it appears he opposed it. His only available work, the *Aryabhata*, is entirely a scientific treatise. And yet, it was lost to us for long, like the *Arthashastra* of Kautilya. About 200 years ago, when modern researchers started investigating the development of mathematics and astronomy in ancient India, none of Aryabhata's work was available to them. Nearly a thousand years ago the great Central Asian savant Alberuni (1030 A.D.) had also failed to procure a copy of the *Aryabhata*. In modern India Aryabhata's work was discovered only in 1864 by the Maharashtrian Indologist Dr Bhau Daji. This is the *Aryabhata*, the only available work of Aryabhata today. All the manuscripts of this work have been found in South India.

The *Aryabhata* is a small work containing 121 stanzas, divided in four sections: *Gitikapada* (preliminaries), *Ganitapada* (mathematics), *Kalakriyapada* (reckoning of time) and *Golapada* (astronomy). Thus, it deals with both mathematics and astronomy. The *Gitikapada* is composed in *Gitika* metre and, barring its three *shlokas* of dedication and conclusion, consists of 10 *shlokas*. It is, therefore, known as *Dasha-Gitika*. The other three sections consisting of 108 *shlokas* are composed in *Arya* metre and are known as *Aryastashata*. But the author named his whole work as *Aryabhatiyam*.

Several mathematical-astronomical works written before Aryabhata (499 A.D.) are known, but we know almost nothing about their authors and their dates of composition. According to tradition, these pre-Aryabhata works, like the Vedas, are known as *a-paurusheya*, not composed by ordinary human beings. The *Aryabhata*

is ancient India's first *paurusheya* mathematical-astronomical work: it gives the name of the author and also its date of composition, a rare occurrence in the history of classical Sanskrit literature.

In one *shloka* (Kalakriya-10) Aryabhata tells us that he had completed the first 23 years of his life at the end of the year 3600 of the Kaliyuga. The Kaliyuga commenced in 3101 B.C. Therefore, the Kali year 3600 means 499 A.D., when Aryabhata was 23 year old. The author does not clearly indicate that he wrote his work in that year, as many scholars have assumed. However, the statement about the year of birth of the author is quite affirmative, 476 A.D. It may also be that at the age of 23, he did compose his work in 499 A.D., or completed it a little later by about the beginning of the sixth century.

In another *shloka* (Ganita 1) the author states that, "he (Aryabhata) sets forth in his work the science which is held in high esteem at Kusumpura". This does not mean that he was born at Kusumpura; it only indicates that the author may have taught or written it at Kusumpura. Where was Kusumpura? Many scholars identify it with Pataliputra, modern Patna. Possibly Kusumpura was a suburb of Pataliputra, modern Kumrar. But recent researches indicate that Aryabhata was a native of South India. Some of his commentators refer to him as *Ashmakacharya* and his work (the *Aryabhata*) is sometimes designated as *Ashmaka-Tantra*. According to all available sources, the Ashmaka Janapad was below the Vindhyas, in the Godavari valley of Maharashtra, and its capital was Pratihthana, modern Paithan. Not only were the manuscripts of the *Aryabhata* discovered in Kerala, in Malayalam script, but most of the commentaries and a majority of the astronomers belonging to the Aryabhata school came from South India. It is, thus, legitimate to assume that Aryabhata was born in or belonged to South India. Nothing more is known about Aryabhata's life. How long he lived or what other works he wrote is not known. In his extant work he does not refer to any earlier astronomer or to any contemporary ruler.

In the beginning and at the end of his work he pays homage to Brahma, the creator. In the concluding verse Aryabhata says: "The spotless jewel of true knowledge which lay so long sunk in the ocean of knowledge, both true and false, has been raised by me therefrom by using the boat of my own intelligence, by the grace of God whom I worship." This clearly shows that Aryabhata was not a borrower, but an originator of his *siddhanta* or system of astronomy. Named after Gods or mythical sages, there were several *siddhantas* known before Aryabhata's time. Varahamihira in his *Panchasiddhantika* has summarised the knowledge of five of these earlier *siddhantas*: Paitamaha, Vashishtha, Paulisha, Romaka

