R.N. 70269/98
ISSN : 0972-169X

Postal Registration No.: DL-SW-1/4082/09-11
Date of posting: 26-27 of advance month

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DREAM 2047

March 2009 | Vol. 11 | No.6 | Rs. 5.00

Green Revolution in Bioscience

Inside

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

Preserving Astronomical Heritage

The World Heritage List of UNESCO includes 878 sites forming part of the cultural and natural heritage, and considered as having 'outstanding universal value'. The Angkor Wat temples in Cambodia, the Acropolis in Athens, Ajanta and Ellora caves in India, and the archaeological ruins of Mohenjo-daro are among the 679 *cultural* sites protected by UNESCO. The List also includes 174 *natural* sites, such as the Great Barrier Reef in Australia, Kaziranga National Park in Assam, Yellowstone National Park in the USA, and the Serengeti National Park in Tanzania, to name a few. The remaining 25 sites are *mixed* sites that are considered outstanding from both cultural and natural standpoint, such as the historic sanctuary of Machu Picchu in Peru.

Sites like the monuments of Mahabalipuram, the monuments at Hampi - the last capital of the last great Hindu kingdom of Vijayanagara, or Fatehpur Sikri are some of the extraordinary creative masterpieces of the lost cultural traditions. These are the places where human communities lived and flourished for thousands of years, and died. What is more, each site stands out as a window to the past and a source of inspiration for people across the world to peep into the ancient civilizations that existed there, and the beliefs and practices followed by those people.

However, one aspect of our cultural heritage - astronomy - is woefully under-represented in the World Heritage List. In fact, several beliefs and practices in the ancient days had their origins in the astronomical phenomena - the motion of the Sun and the Moon through the zodiac, stars and constellations seen during different seasons, equinoxes, eclipses; and so on. Indeed, the cosmos has captivated the imagination of civilisations through the ages. The efforts of those cultures to understand or interpret what they saw in the sky are often reflected in their architecture, petroglyphs (carvings on rock made by prehistoric people), and other cultural representations. This is how astronomy has had a significant influence on the architecture of ancient temples and tombs. Needless to say, we cannot ignore the relationship of these monuments to the sky if we want to learn and appreciate the beliefs and practices reflected in their architecture.

No doubt, a few ancient sites and monuments with link to the sky do figure into the World Heritage List, but the criterion used for their selection was their architectural and cultural significance - not their relation to astronomy. One such example is the Stonehenge in Wiltshire, United Kingdom. The main axis of the monument faces the direction over the horizon where the Sun rises on the morning of the summer solstice, the longest day of the year, and sets on the day of the winter solstice, the shortest day of the year. Then, there is the Neolithic passage tomb of Newgrange in Ireland. It is so aligned that the Sun shines in only for a few minutes after sunrise on the day of the winter solstice. At Chaco Canyon in New Mexico, southwestern USA, at noon on the summer solstice, a single sliver of sunlight - dubbed as "Sun dagger" - appears near the top of a spiral carved on a rock and slices its way down through the very centre, cutting the spiral in half before leaving it in shadow once again. On the winter solstice, two daggers of light appear during which they exactly frame the spiral! The Konark Sun Temple in Orissa featuring in the World Heritage List is one such site. The magnificent temple is in the form of the Sun's chariot drawn by seven horses marking the seven days of the week. The 24 huge wheels, magnificently carved and decorated, mark the hours of the day. The idol of the Sun God no longer exists today. It is, however, claimed that on days close to the equinoxes the Sun would shine at dawn or sunset on the Sun God in the temple.

It is a matter of grave concern that there have never been any guidelines for nominating World Heritage Sites based on their relationship to astronomy. As a result, many such sites could be susceptible to neglect and damage. It is with this concern that UNESCO is now encouraging the member countries to put forward nominations for astronomical sites. The objective of this Astronomy and World Heritage thematic initiative is to establish a link between science and culture on the basis of research aimed at acknowledging the cultural and scientific values of the sites connected with astronomy. The identification, safeguarding and promotion of these sites are the three lines of action for the implementation of this programme. What is important is the fact that during 2009, the International Astronomical Union would be working with UNESCO to come up with specific criteria for judging the merit of the proposed sites. This initiative would provide us with an opportunity to identify sites related to astronomy located around the world, and to save them from progressive deterioration. Surely, it is a fitting task for the International Year of Astronomy 2009, celebrating the 400 years of the first use of the telescope by Galileo

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Published and Printed by Dr. Subodh Mahanti on behalf of Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi - 110 016 and Printed at Aravali Printers & Publishers Pvt. Ltd., W-30, Okhla Industrial Area, Phase-II, New Delhi-110 020 **Editor : Dr. V. B. Kamble**

Hipparchus of Rhodes

The Greatest Astronomer of the Antiquity

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"…it seems highly probable that Hipparchus was the first to construct a table of chords and thus provide a general solution for trigonometrical problems. A corollary of this is that, before Hipparchus, astronomical tables based on Greek geometrical methods did not exist. If this is so, Hipparchus was not only the founder of trigonometry but also the man who transformed Greek astronomy from a purely theoretical into a practical productive science."

G. J. Toomer in *Dictionary of Scientific Biography*, New York, 1870-1990

"As a theorist Hipparchus worked on the orbits of the Sun and the Moon. He established more accurate lengths of both the year and the month and was able to produce more accurate eclipse predictions. One of his lasting achievements was the construction of a table of chords, which virtually began the discipline of trigonometry."

***A Dictionary of Scientists*, Oxford University Press, 1999**

"He (Hipparchus of Rhodes) put Greek astronomy on a more scientific footing, introducing arithmetic and early trigonometric methods. His many accurate astronomical observations resulted in a catalogue of 850 stars, giving their co-ordinates and dividing them into six magnitudes."

***Dictionary of Astronomy*, Oxford University Press, 1997**

Hipparchus of Rhodes is also often referred to as Hipparchus of Nicaea or Hipparchus of Bithynia. He made phenomenal contributions to the development of astronomy and mathematics. As an astronomer his most famous discovery was the precession of the equinoxes, a slow conical motion of the Earth's axis about the vertical to the plane of the ecliptic. He discovered this while attempting to calculate the length of the year with high degree of precision. He determined the length of a year to within 6.5 minutes. After observing a new star around 134 BC, he formulated the astronomical principle that "the stars are not eternally fixed in the heavens." It is believed that Hipparchus prepared the first star catalogue around 134 BC.

Perhaps he was the first to predict solar and lunar eclipses. He observed the annual motion of the Sun, developed a theory of its eccentric motion and measured the unequal durations of four seasons. He made similar observations of the Moon's more complex motion. He retained the Aristotelian view that the Earth and not the Sun was the centre of the universe. However, he found that his observations did not agree with Aristotle's belief that the celestial bodies revolved around the Earth in perfect circles. To

Hipparchus of Rhodes

explain this he proposed that the Sun and the Moon moved in circular orbits but they did not move around the Earth's centre. Further he proposed that the planets made small loop-like movements as they moved in the bigger circle around the Earth. These circles superimposed upon the larger ones he called epicycles. His ideas were taken up by Ptolemy two centuries later to develop a system that though incorrect, lasted for centuries. Greek astronomer Aristarchus (c.320-c.250 BC) first proposed the heliocentric view of the universe

Hipparchus is regarded by many as the father of plane and spherical trigonometry because it was he who first organised measurements in relation to angles in trigonometric tables. He also introduced the division of a circle into 360 degrees in Greece.

Almost nothing is known about Hipparchus' life. What is known is that he was born in Nicacea (now Iznik) in Bythynia (now in Turkey) around 190 BC, and that he made astronomical observations in Rhodes, Bythynia, and Alexandria. Most of what we know about Hipparchus comes from the writings of the Greek astronomer Ptolemy

We do not have definite details of his works because all his works except one were lost when the Library of Alexandria

was burned down. Among the works that were lost include: *Catalogue of Stars*, *On Constellations, On the Arrangement of Fixed Stars*, *On the Treatise on Simultaneous Risings*, *On the Rising of the 12 Constellations of the Zodiac*, *On the Precession of the Equinoxes, On the Parallax* (2 books), *On the Size and Distance of the Sun and the Moon*, *On the Eclipses of the Sun and the Seven Climates, On the Lunar Year*, *On the Intercalary Months and Days*, *On the Length of the Year*, *Investigations of the Chords of a Circle* (12 books), *On Gravity, Against the Geography of Eratosthenes*, and *To the Noblest*.

The only surviving work, *Commentary on Aratus and Eudoxus* is not one of his major works. However, this has assumed importance because it is the only source of Hipparchus' own writings. This work, written in three books, was a commentary on three different works, viz., a treatise by Eudoxus, in which he named and described constellations; a poem called 'Phaenomena' by Aratus, based on Eudoxus' treatise; and a commentary on Aratus by Attalus of Rhodes. In this work Hipparchus also included his own account of the rising and setting of the constellations. Commenting on this only surviving work of Hipparchus, Toomer writes, "Far from being a 'work of his youth', as it is frequently described, the commentary of Aratus reveals Hipparchus as one who had already compiled a large number of observations, invented methods for solving problems in spherical astronomy, and developed the highly significant idea of mathematically fixing the positions of the stars."

Today the available details of Hipparchus' works come from the Alexandrian astronomer, mathematician, and geographer Ptolemy's (2nd century AD) commentaries in *Almagest*, which served as the most important book on astronomy for 1500 years. One should remember that Ptolemy's aim was not to preserve Hipparchus' work for posterity. As Toomer writes "…although Ptolemy obviously had studied

Ptolemy

Hipparchus' writings thoroughly and had a deep respect for his work, his main concern was not to transmit it to posterity but to use it and, where possible, improve upon it in constructing his own astronomical system." There are two other

Pliny the Elder

commentaries of Hipparchus' work namely by Theon of Alexandria and by Greek mathematician Pappus of Alexandria (4th century AD) but they do not always surpass the details given by Ptolemy in any way. Extracts of Hippachus's works are also found in the works of Roman scholar Pliny the Elder (AD 23-79), Greek geographer and stoic Strabo of Amaseia (c.60BC - c.21AD), Thyon of Smyrna and Plutarch. We do not have the original works of Hipparchus, but from the extensive extracts given by the abovementioned authors one can largely reconstruct his methods and results.

Hipparchus invented an improved version of astrolabe for accurately determining the co-ordinates of the stars. He constructed the first globe. He devised an improved version of dioptra, a devise used for estimating the apparent diameter, distance and size of the Sun and the Moon. According to Ptolemy, Hipparchus invented an improved version of theodolite for measuring angles. He improved many other instruments, which were in use in his time, like the plumb (a lead weight called plumb bob hung at the end of a line called plumb line used to determine how deep water is or whether a wall, etc., is vertical), the gnomon (a column or pin on sundial that casts a shadow indicating the time of day), the sundial, the clepsydra (water clock), and the fixed sphere.

Hipparchus calculated the length of the year. Here it may be noted that there are two definitions of a "year" namely, sidereal year and tropical (solar) year. He first measured the length of a tropical year, a unit of time equal to the period of one revolution of the Earth about the Sun measured between successive vernal equinoxes. The length of the year derived by Hipparchus was 365.24667 mean solar days while the true value is 365.242217 mean solar days or 365 days 5 hours 48 minutes and 46 seconds. It has been suggested that for calculating the length of the tropical year Hipparchus used old Babylonian data and checked the resulting value against his observations of equinoxes and solstices and those of the Aristarchus (made in 230 BC) and Meton (made in 432 BC). He also calculated the length of the sidereal year, the time period relative to the stars of one revolution of the Earth around the Sun and for this also he used old Babylonian data. He found that the

Plutarch

sidereal year was 1/144 day longer than the tropical year. It was a highly accurate value. Sidereal year is about 365.2564 mean solar days. He calculated the length of the synodic (lunar) month as 29 days, 11 hours, 44 minutes and 3.33 seconds – only less than one second from the correct value. This was a highly accurate value. Synodic month is the mean period between successive occurrences of identical lunar phases for example from new Moon to new Moon, or full Moon to full Moon.

Hipparchus also determined the average distance of the Moon from the Earth based on observations of eclipses. According to him the average distance of the Moon from the Earth was 33.66 times the diameter of the Moon. The actual value is 30.20 times. He also calculated the diameter of the Moon at 0.33 that of the Earth against the actual value of 0.27. He also undertook a systematic study of the motion of the Moon and developed a theory of the Moon's motions based on epicycles.

It is said that in 134 BC Hipparchus observed a new star in the constellation of Scorpio, which led him to construct a catalogue of 850 stars. Perhaps this was the first star catalogue because there is no record of any star catalogue prepared earlier than this. He listed the stars with their celestial latitude and longitude; that is, their celestial co-ordinates. The catalogue was of high precision. It appears that Ptolemy included Hipparchus' catalogue in his own work three centuries later. Edmond Halley also used the Hipparchus' catalogue.

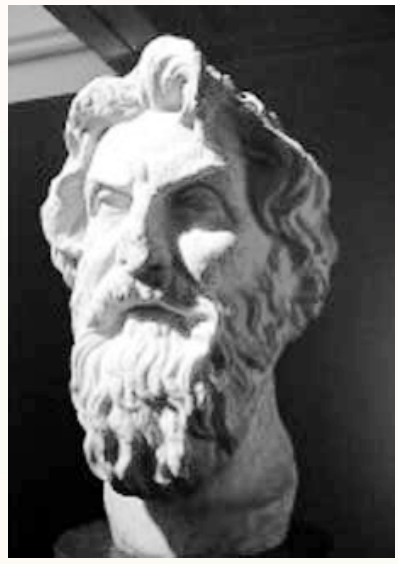
Hipparchus introduced the practice of dividing the stars into different classes of magnitudes based on their brightness. He was the first to assign a scale of magnitude. He developed a system of six magnitudes. He classed the brightest stars as the first magnitude and the faintest visible stars to the naked eye he classed as sixth magnitude. His scale, much refined, is still in use.

While comparing the position of the stars of his day with those given 150 years earlier he observed that the star Spica had moved 2° relative to the autumnal equinox. To explain this he proposed precession (motion) of the equinoxes. The equinoxes are the twice-yearly events when day and night are of equal length. They denote the points where the ecliptic – the apparent path of the Sun – crosses the celestial equator. He calculated the rate of precession at about 45 seconds of arc a year, which is close to the now accepted value of 50.27 seconds. Sometimes it is claimed that Chaldeans are the true discoverer of the precession of equinoxes. The reason for this kind of belief is that Chaldeans in their tables adopted different longitudes as zero at different times. However, it was Hipparchus who recognised it as a continuous regular progress.

Hipparchus tabulated a table of chords; that is, length of the line joining two points on a circle corresponding to the given angle at the centre. The table was based on a circle divided into 360 degrees and each degree was further divided into 60 minutes. The table of chords was a precursor of the sine table. He made weather forecasts based on his studies of weather patterns through observations. This impressed many of his contemporaries. He divided the then known inhabited world into climatic zones.

The year 127 BC is usually cited as the last year known for Hipparchus' actual work. In that year he made some observations on the star Eta Canis Majoris. He died around 120 BC in Rhodes.

A crater near the centre of the Moon has been named after Hipparchus. A crater on Mars surface has also been named after him.



Aristarchus

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

The Scientific Temper

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Introduction

A few years ago I attended an international and inter-disciplinary conference dealing with the issues man has to face in the twenty-first century. Naturally issues such as global environment, population control, food-availability, communications, education, science and technology, etc., featured prominently. As speaker after speaker covered a variety of topics of great relevance to the theme of the conference, I increasingly began to feel like a diner at a sumptuous meal searching desperately for that tiny but vital item, viz., the salt shaker. That pinch of salt is the scientific temper that is such an essential component of man's mental framework in his struggles to face the challenges of the present and the future.

What is scientific temper? Why is its relevance being felt *now* rather than in the past? Is it an individual trait or does it also extend to societies, cultures, civilizations? To what extent is it prevalent today? What can be done to make it more widespread? These are the questions I shall try to answer. But the bottom line has been stated much more effectively by Pandit Jawaharlal Nehru:

> …The impact of science and the modern world have brought a greater appreciation of facts, a more critical faculty, a weighing of evidence, a refusal to accept tradition merely because it is tradition…
>
> But even today it is strange how we suddenly become overwhelmed by tradition, and the critical faculties of even intelligent men cease to function… Only when we are politically and economically free will the mind function normally and critically.
>
> *…(Discovery of India)*

This was written during the British Raj. Today we live in a free India which is feeling its way towards economic prosperity. Yet we are still a long way away from achieving that scientific outlook which Nehru considered so essential for our future well-being. To appreciate what the scientific outlook is all about, let us first see how science itself works.

The method of science

There are three steps in the progressive march of science: experiment and observation/ theoretical interpretation/ prediction of new results. This sequence is endless. One performs experiments in the laboratory, or observes some natural phenomenon and then tries to interpret it in terms of a theoretical framework. If the attempt succeeds, then one tries to make new predictions that future experiments or observations will verify. If the success of the theory continues, one keeps believing in the theory. *However, one never accords the theory a blank cheque for being correct.* There is always a possibility that a future experiment may disagree with the predictions of the theory, in which case it may have to be abandoned or modified or replaced by a new and better theoretical framework. Thus Newton's law of gravitation continued successfully until some sophisticated tests in the solar system showed its inadequacies and it was replaced by Einstein's theory of relativity. It was in this connection that Sir Hermann Bondi, the well-known astronomer, remarked:

> …The essential thing in science is for the scientist to think up a theory. There is no way of mechanizing this process; there is no way of breaking it down into a science factory. It always requires human imagination, and indeed in science we pay the highest respect to creativity, to originality. It is, of course clear that since every theory must live dangerously, the casualty rate is pretty high. So we do not honour scientists for being right; it is never given to anybody to be always right. We honour scientists for being original, for being stimulating, for having started a whole line of work. Science is the most human of endeavours because it depends on co-operation, it depends on people testing each other's work and it depends on people taking notice of each other.
>
> *(Cosmology Now,* ed. L. John, 1973, B.B.C. Publications*)*

Bondi's comment needs one clarification. It does not mean that any Tom, Dick or Harry can propose 'new ideas', claiming to be better than Newton or Einstein. I get such ideas from dozens of people in the post, which are vague flights of imagination with no backing of quantitative facts. Bondi here means ideas carefully worked out with rigorous mathematics and having the benefit of confirmation by physical facts. In fact there is no simple way to the truth, whatever it may be. One needs patience in putting together whatever understanding of nature our society has acquired and build on it towards a greater understanding.

The scientific outlook has evolved from this practice of science: it relies on factual evidence and statements that can be checked against established truth. It allows for pragmatism; that is, willingness to drop a paradigm if it fails the test of facts and to adopt a better one if it meets all factual checks. However, the scientific outlook need not be the prerogative of the scientist alone. After all, it owes its origin to human curiosity about Nature and as such every one of us, whether a scientist or not, is entitled to it. Indeed, just as in the case of science, progress could be achieved only when the scientific outlook prevailed over innate conservatism. So, in the case of a society of human beings this outlook acts as an antidote to the evils of prejudice and superstitions.

Science and astrology

Superstitions are born out of ignorance of how Nature functions. Science is dedicated to the unravelling of the mysteries of Nature. As one particular mystery is solved, we should expect the superstitions based on it to disappear. Yet, this does not always happen in practice because of the lack of scientific outlook in the typical human being. I give below one example.

The early human societies ascribed occult powers to planets. This assumption arose from ignorance of what planets are and how they move. Now that astronomy has answered all of the questions raised about planets by the primitive man, we should expect this assumption to be regarded as groundless. Yet this has not happened. Even in the technologically

advanced countries this belief persists among sections of educated classes. In the mid-1970s a group of leading scientists including several Nobel Laureates in the West signed a circular denouncing the very basis of this belief. I give below an extract from their statement:

> ….It is simply a mistake to imagine that the forces exerted by stars and planets at the moment of birth can in any way shape our futures. Neither is it true that the positions of distant heavenly bodies make certain days or periods more favourable to particular kinds of action, or that the sign under which one was born determines one's compatibility or incompatibility with other people ... In these uncertain times many long for the comfort of having guidance in making decisions. They would like to believe in a destiny predetermined by astral forces beyond their control. However, we must all face the world, and we must realize that our futures lie in ourselves, and not in the stars…
>
> *(The Humanist,* Sept./Oct. 1975*).*

Do planets influence human destiny? The subject of astrology is based on the answer to this question being 'yes'. How will a scientist go about testing the hypothesis that the answer is 'Yes?' He will not be satisfied by the prediction by a single person based on a single horoscope. First he will require a set of well-defined rules on which such predictions are based. The rules should be unambiguous so that different persons make the same prediction from the same horoscope. Next he will need to be convinced that these rules work in a statistically significant manner to discount the possibility of the prediction being right purely by chance. This will require a systematic study of a large number of such trials under different conditions.

It is necessary for this purpose, to cast the prediction in a well-focussed form where it can be tested. Such tests as have been conducted so far by scientists have yielded negative results. But again, it is not always necessary to call upon a professional scientist to perform such tests. The educated common man can himself sift the evidence provided he adopts an objective outlook. Let me give one illustrative example of experiments of this kind conducted recently in India to test the scientific predictivity of astrology.

For this test I was associated with the Andhashraddha-Nirmulan Samiti headed by Dr Narendra Dabholkar, Prakash Ghatpande (who had been an astrologer earlier but had now become a critic of astrology), and Sudhakar Kunte from the Statistics Department of Pune University. The test was a simple one, staying away from many grey areas common in astrology. Date, time and place of 200 subject children were collected so that horoscopes could be cast for them. Of the 200, half (i.e., 100) were bright gifted children whereas half were mentally retarded. In a double blind experiment, several sets of 40 randomly chosen horoscopes were made. Thus a typical set would have, say, N horoscopes of gifted kids and 40-N of retarded ones. We then invited astrologers to participate in the test. 51 agreed to do so while some major astrological organisations boycotted the test sensing it to be some kind of 'trap'. Each participant was sent a typical set and asked to label each horoscope as belonging to class I of bright children or class II of retarded children. Neither we nor the participants, knew the value of N for his set, although our records carried full information. Our statistician had announced before the test that for any significant claim of predictive power, the astrologer must get at least 28 out of 40 right. Of the 51 only 27 responded and the average rate of success of their predictions was around 17 out of 40. If they had used the method of calling head/tail after tossing a coin, they would have registered a greater success! In addition, a professional astrologers' institution also participated in the test. To the institution we gave all 200 horoscopes. They got 102 right, again statistically no different from pure 50-50 chance! Obviously, this test revealed that astrological predictive power in such cases is non-existent.

I could go on with other examples in the USA and Europe, to illustrate that astrology has been tested for the scientific criterion of predictability in numerous ways by numerous research workers on numerous occasions – and has always been found wanting.

Conflict with traditions

Individually or as part of a larger group man has always lived by certain traditional beliefs. These beliefs are inextricably mixed with his cultural and religious heritage. Inevitably conflicts arise whenever the critical appraisal inherent in the scientific temper is applied to these beliefs. Some conflicts arise because the beliefs or the rituals they imply had a rational basis in the olden days but which they no longer possess today. Some rituals may have had a symbolic or even a practical meaning in the social ambience of several centuries ago: today they have become irrelevant. The question arises: what should one do in case such a conflict arises?

On the 'traditional' side we have the traditional virtues of the individual's responsibility to the society, the society's commitment to ensure the well-being of its members and the individual, and social commitment to preserve the natural habitat around us. Armed with these virtues man can assess what science has to offer: he can take judicious decision on what to accept and what to reject. This is where the scientific temper comes to the help of the society as a whole.

The technologically advanced nations of the West have been experiencing the ill effects of uncontrolled impact of science and technology on society. The destructive nuclear arsenal, the excessive industrial pollution, the enforced idleness brought about by automation and the consequent psychological problems of mechanisation, etc., are there to see. Does this mean that we must put a stop to all scientific and technological development? Such a response, already advocated by a few in the developing nations, indicates a panic reaction. Given the traditional virtues mentioned above as guiding principles it should be possible to identify a rational path that skirts around the above pitfalls.

The present status

Let me review briefly how we Indians stand today vis-à-vis Nehru's expectation that

> "… Only when we are politically and economically free will the mind function normally and critically".

A dispassionate survey presents a somewhat mixed picture.

On the one hand, as I had mentioned earlier, we have several NGOs devoting their efforts to spreading rationalism and to eradicating superstitions. There are

organisations which conduct public awareness programmes through lecture demonstrations, street plays, experiments debunking the so-called miracles, articles and books on the importance of the scientific temper, and so on. The National Council for Science and Technology Communication (NCSTC) in New Delhi has been supporting such programmes in an imaginative fashion.

The NCSTC had been responsible for launching the National Science Day to be celebrated on February 28, commemorating the discovery (on that date in 1928) by C.V. Raman that fetched him the Nobel Prize in physics. On this day (and indeed in the week covering that date) there are several public awareness programmes involving scientific concepts and scientific outlook, organised throughout the country. Scientific institutions keep an open house for the general public, with audio-visuals on their work, exhibitions and lectures, etc. Some institutions organise special quiz programmes and competitions for schoolchildren.

While there are several such efforts in an organised manner both in and out of the government, what is the mindset of the 'person in the street'? Can we confidently assert that in the half century since independence, we have made a significant dent in the wall of superstitions that have steadily thickened over the centuries? We remember, for example, the great social reformer Raja Ram Mohan Roy and his crusade against the *Suttee*-ritual. But there still take place isolated incidents of this ritual and they attract crowds of believers.

Nor is superstition confined to villages only. The episode of the idols of Lord Ganesha drinking milk drew large crowds in Delhi, Mumbai and other cities in India with some ministers also expressing their wonder and joy at the sight. It did not take long to debunk the phenomenon in terms of known science, but the spontaneity of belief was a give-away that the veneer of science of technology on the society is very thin indeed.

But perhaps of greater concern is the *rising trend* towards superstitions. Several symptoms can be cited of this trend.

1. More marriages are being decided by the criterion of matching of horoscopes than a generation ago. Thus I know of parents whose marriages were not passed through the 'horoscope filter', but whose children feel it necessary to apply this criterion for their marriage.
2. With new technology, new superstitions are getting hold of the society. A recent rage is Vastushastra and its Chinese counterpart, the Feng Shui. Influential politicians and leaders of society have been swayed by this new cult. None of the claims of these subjects have passed scientific scrutiny.
3. Despite debunking of Godmen's miracles by science, a large section even of the educated urbanites continues to believe in the 'Baba's who demonstrate their superhuman powers through miracles. In fact this is an area where science journalism could bring its investigative aspects to bear. So far it has registered moderate success but much more needs to be done.
4. The legitimisation of astrology as a 'science' by the University Grants Commission is another symptom of this unfortunate trend. The UGC used the word 'Vedic Astrology' implying that the subject is of Vedic origin. All historical evidence, however, shows that planetary astrology using horoscopes came from the west, from Greece, Babylon, etc.

Miracles of science benefit all

One could easily enlarge this list. Granted, there are problems with excessive reliance on automation, there are dangers of pollution with indiscriminate uses of technology, there may be serious dangers for the society from continuing certain areas of scientific research, but this does not mean that we turn away from the scientific path and re-grasp the age-old superstitions which have been proven to be invalid.

Indeed, at first sight these problems before us appear to be formidable if not insurmountable. Yet, we have only to look at the remarkable progress of science over the last few decades to see that a properly channelled scientific approach holds out hope for the future. The achievements of space technology with such highlights as the manned trips to the Moon, the landing on Mars and the SITE programme in our country, the rapid growth of communications which has dramatically brought the far corners near, the advances in medicine, biology, agriculture – are they not scientific miracles happening before our own eyes and achieved during less than the span of a generation? Unlike the so-called miracles of the so-called godmen, *the miracles of science benefit not one single individual, but a whole class of humanity*. They benefit the poor as well as the rich. The invention of electric power not only runs the gadgets of the rich, it also provides light to the remote villages.

The developed nations have recognised these facts and they not only support science in general but also continue to encourage basic research, which at first may appear 'useless' but may lead to useful applications like those just mentioned. For us to ignore basic research at this stage would mean that we will have to keep on importing new ideas from abroad. This would be contrary to our policy of self-reliance. India has plenty of talent for basic research, most of which is untapped. Suitable support for basic research will unearth this talent and bring in its own rewards in the long term if not immediately. Right now I can think of one analogy to illustrate my point of view. Imagine a country which has vast untapped resources of oil, but which will not search for these for reasons of heavy financial outlay. Such a country will forever be dependent on oil imported from abroad. And, finally let me emphasise that basic research does not require heavy financial outlay when compared to its rich potential. We must, however, ensure with adequate safeguards that the research produced is of first class quality.

When Lord Krishna finished telling the *Gita* to Arjuna, he ended by saying: *"Reflect over what I have said, fully and then do what you wish."* In a sense this is what the scientific temper calls upon us to do: to weigh in all the evidence and then decide what is best. I am confident that if, and only if, we are not blinded by traditions and dazzled by science but keep our visors open and our minds alert, our country will make a triumphant march towards progress in this century.

Prof. Jayant Vishnu Narlikar is an eminent theoretical astrophysicist and winner of the Kalinga Prize for science popularization. He is a former Director of Inter-University Centre for Astronomy and Astrophysics, Pune

Green Revolution in Bioscience

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When scientists develop methods to help them see things that were once invisible, research always takes a great leap forward. For example, when Anton van Leeuwenhoek invented the microscope in the 17th century a new world opened up. Scientists could suddenly see bacteria, sperm and blood cells; things they previously did not know even existed. During the 20th century the foundations of biochemistry were laid and used to explore the basic principles of metabolic processes inside living cells. It also witnessed a revolution in our understanding of enzyme function and, through crystallography and nuclear magnetic resonance, of structure of proteins. Later, genetics revolution, supported by bioinformatics and other auxiliary techniques, revolutionised many areas of the biological sciences, with practical consequences for medicine, pharmacy and ecology. However, none of these provided the experimental tools that would allow for quantitative and experimentally well-defined monitoring at the molecular level of the inter-cellular processes that define the dynamic behaviour of all living systems.

The beginning of the 21st century saw the rapid development of such tools based on the green fluorescent protein (GFP) from the jellyfish *Aequorea victoria* and other similar proteins that are helping researchers to watch processes such as the development of nerve cells in the brain or study spread of cancer cells that were previously invisible. In fact, today, GFP is a standard tool for thousands of researchers all over the world and the 2008 Nobel Prize for Chemistry has been awarded jointly to three scientists – Osamu Shimomura of Marine Biological Laboratory Woods Hole, and Boston University Medical School Massachusetts, USA, Martin Chalfie of Columbia University, New York, USA, and Roger Tsien of University of California, San Diego, USA for the discovery and development of this versatile green fluorescent protein (*Dream2047* January 2009).

Green fluorescent protein (GFP) is a brightly glowing substance found in the beautiful jellyfish *A. victoria* the outer edge of which glows green when the jellyfish is agitated. After its discovery in 1962, GFP has become one of the most important tools used in contemporary bioscience research. What is revolutionary about GFP is that the protein does not need any additives to glow, in contrast to aequorin and other bioluminescent proteins, which require a continuous supply of energy-rich molecules. It is enough to radiate GFP with UV light or blue light. The light enters the cells and meets GFP, which glows green. If the researchers had needed to add a chemical, as they do with other bioluminescent proteins, they would have had to inject it into the cell – a process which can disturb the cell and is difficult to carry out at such microscopic scales.

The technical revolution resulting from the discovery of GFP relates to a miraculous property of the chromophore (an atom or group whose presence is responsible for the colour of a compound) that is responsible for its fluorescence. This chromophore is formed spontaneously from a tri-peptide entity in the primary structure of GFP, so that its fluorescence is "automatically" turned on in every organism where it is expressed. In other words, the maturation of the tri-peptide-based chromophore in GFP only requires oxygen and does not depend on the presence of enzymes or other auxiliary factors. GFP and its related variants thus provide universal genetic tags that can be used to visualise a virtually unlimited number of processes in virtually all living systems. This GFP revolution in the bio-

Jellyfish Aequorea victoria

logical sciences has been greatly accelerated by a rapid parallel development of quantitative light microscopy, electronics, computational power and molecular modelling of intra- and intercellular processes.

An even more interesting use of GFP is that researchers can actually follow processes inside individual cells. We know the body consists of billions of cells, from pumping heart muscle cells and insulin-producing beta cells to macrophages that destroy unwelcome bacteria. The more researchers know about a cell type – how it develops and functions – the greater the chance that they can develop effective drugs with minimal side-effects.

Further, we know that the chemical processes of cells are usually regulated by proteins. There are tens of thousands of different proteins, each with different functions. By connecting GFP to one of these proteins, researchers can obtain vital information. They can see which cells a particular protein inhabits, so they can follow its movements and watch its interactions with other proteins. Thanks to GFP's green light scientists can now track a single protein under the microscope.

The three Nobel laureates contributed equally to the study and development of GFP as a research tool. Shimomura first isolated GFP from the jellyfish *A. victoria*, which drifts with the currents off the west coast of North America, in 1962. He discovered that this protein glowed bright green under ultraviolet light. In the 1960s, when Shimomura began to study *A. victoria*, he had no idea what a scientific revolution it would lead to. In the 1970s, he looked more closely at GFP's fluorescence and showed that GFP contains a special chromophore, a chemical group that absorbs and emits light. When UV light or blue light hits the GFP chromophore, it sucks up the energy in the light, and gets excited. In the next phase, the chromophore gets rid of the energy, emitting light, which is now in the green wavelength.

Chalfie heard about GFP for the first time in 1988 at a seminar dealing with bioluminescent organisms at Columbia University in New York. He was quick to realise that its ability for independent fluorescence could perhaps make it an ideal cellular beacon for the model organisms he studied. Using molecular biological techniques, Chalfie succeeded in introducing the gene for GFP into the DNA of the small, almost transparent, millimetre-long roundworm *Caenorhabditis elegans* and demonstrated the value of GFP as a luminous genetic tag for various biological phenomena. GFP was produced by the *C. elegans* cells, giving off its green glow without any indication of causing damage to the worms. Subsequent work showed that it was possible to fuse the gene for GFP to genes for other proteins, opening-up a world of possibilities for tracking the localisation of specific proteins in living organisms.

The tertiary structure of GFP, displaying its can-like shape with the α-helix, containing the chromophore, threading up through the can (Brejc et al.*, 1997).*

Tsien contributed to our general understanding of how GFP fluoresces. He charted how the GFP chromophore is formed chemically in the 238-aminoacid-long GFP protein. Researchers had previously shown that three amino acids in position 65–67 react chemically with each other to form the chromophore. Tsien showed that this chemical reaction requires oxygen and explained how it can happen without the help of other proteins. He then used this knowledge to modify the structure to produce molecules that emit light at slightly different wavelengths, which gave tags of different colours. In time, his group added further fluorescent molecules from other natural sources to the tag collection, which continues to expand. Complex biological networks can now be labelled in an array of different colours, allowing visualisation of a multitude of processes previously hidden from view. Thus Tsien's work extended the colour palette beyond green allowing researchers to give various proteins and cells different colours. This enables scientists to follow several different biological processes at the same time. Today, scientists are able to study biological processes that were previously invisible with the aid of Tsien's proteins, which glow in all colours of the rainbow.

Tobacco: Accursed Leaf, Infernal Smoke

Dr. Yatish Agarwal
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A custom loathsome to the eye, hateful to the nose, harmful to the brain, dangerous to the lungs, and in the black, stinking fume thereof nearest resembling the horrible Stygian smoke…

King James I of England,
A Counter-blast to Tobacco

Just a few hundred years ago, tobacco was the favourite of royalty, physicians and commoners in large part of the world. Even though King James I had prophesied that it was dangerous to the lungs, the realisation that tobacco was a serious hazard to health dawned only towards the later part of the 20th century. Today, the ills of tobacco are well recognised. A slow poison, tobacco can knock out the heart, brain, lungs, arteries, and several other vital organs. Its smoke contains a number of chemicals, out of which many are carcinogenic (having the potential to cause cancer). Still, the megabuck tobacco industry continues to bamboozle people into believing that it is socially respectable and desirable, manly, and a necessary part of a rich, full life. Prudence, however, lies in staying away from all forms of tobacco. If you are determined, quitting tobacco is not difficult.

Tobacco's colourful history

The use of tobacco dates back to thousands of years. The first people to puff at the infernal smoke of cured tobacco were probably those living in tropical America and the neighbouring Caribbean islands, where tobacco grew in the wild as a native crop. They experimented and found several uses for it. They used tobacco as a medicine, as a hallucinogen in religious ceremonies, and as offerings to the spirits they worshiped.

When the Spanish armada of Christopher Columbus set sail in 1492 to find a new sea route to India, their voyage took them to the New World.

Tobacco has more than 70 species. Each mature plant yields about 20 broad leaves, which are dried, cured, fermented, and aged before being used to fill cigarettes, cigars and pipe, and being sold as snuff and chewing tobacco.

Sent ashore by their Captain, two of Columbus's lieutenants, Luis de Torres and Rodrigo de Jerez, reported seeing natives who 'drank smoke'. This is the first recorded reference to smoking of tobacco. Since the Caribbean people smoked tobacco through a tube they called *tobago,* the name stuck, even though the Spanish tongue twisted it to *tabaco*.

On completing their voyage, Columbus and his men returned to a royal reception. With them they brought several exotic objects, including the seeds of the tobacco plant. Soon tobacco was introduced as a crop in Spain, and the harvest was made use of by the people. During the next 50 years, the accursed plant took roots throughout Europe. Sailors, explorers, monks, and diplomats taken by the 'sublime' numbing effect of the tobacco smoke, promoted pipe and cigar smoking among the nobles and the royalty. In 1561, the Queen Mother of France, Catherine de Medici received an offering of the seeds and powdered leaves of the tobacco plant from her favourite ambassador in Lisbon, Jean Nicot. Nearly two and a half centuries later, a French chemist Louis Nicolas Vauquelin identified the active principle in tobacco, and gave it the name nicotine, and the plant the botanical name of *Nicotiana rustica* after Jean Nicot's name.

The French physicians found several uses for tobacco. They declared it a panacea for several serious illnesses, and used it to treat bubonic plague, asthma, cancer, migraine, and also for pain relief during childbirth. The French were so convinced of its medicinal uses that they passed a new law in 1635, which restricted the sale of tobacco to apothecaries on a prescription from a physician.

Meanwhile, in other parts of Europe, the first reaction to tobacco was not very cordial. The Church and the State of England forbade its use, but it was soon realised that tobacco was habit-forming and could be a major source of revenue for the state. Tobacco began to sell in London for its weight in silver shillings and became a popular extravagance among the dandies. The demand for tobacco grew, and tobacco farming became lucrative. In 1610, when the first English settlers moved from Britain to set up a colony in Jamestown, Virginia, in America, tobacco turned out to be their lifeline. The settlers took to growing tobacco and began shipping the produce to England. The profitability of these exports helped them survive the hostility of the natives, the famines and the killer malaria. The cash flow encouraged them to take more and more land for tobacco farming. Ships would sail for England with tobacco on board, and return with British prisoners and debtors. The tobacco growers simply bought them out or 'nabbed' the 'kids' (hence 'kidnap') to work the fields. Since they were also British, these indentured servants were allowed a reprieve. If they worked hard enough on the fields, they could earn their freedom after five to twelve years of toil. Still, human greed knew no end.

Tobacco growers quickly realised the profitability of bringing in African slaves, who could be flogged and made to work like animals for life. The ships began to set sail for slave markets in Africa. The arrival of the slaves enabled growers to farm larger areas, making giant plantations possible. After 1776 tobacco farming expanded from Virginia in the south to North Carolina and in the west as far as Missouri. Even today, despite strict anti-smoking regulations in place, the United States continues to be one of the world's largest producers and exporters of tobacco.

The invention of cigarettes happened through no mean ingenuity. The year was 1614. Some beggars, who lived by a cigar production centre in Seville, Spain, collected scrap tobacco and rolled it in paper. After lighting the stick, they took turns at taking drags from it to numb their sorrows. Still, cigarettes did not win popularity for the next two and a half centuries. Cigars, pipes and snuff continued to be the most popular means of tobacco use. It was also around this time that tobacco found its way to India. The Portuguese sailors introduced it to the Mughals.

The Crimean War in the mid 19th century was responsible for the rise in the popularity of cigarettes. The British soldiers found the cigarettes of their Turkish allies to be more convenient than pipes or cigars. The high price of the cigarettes, however, was a big stumbling block in the way of their popularity. In those days, each cigarette had to be rolled by hand. In 1880, American inventor James A Bonsack found a way out. He devised and patented a machine to roll cigarettes. The machine could produce more than 10,000 cigarettes in one hour. Cigarette prices fell and they became more popular than cigars.

Today, despite a worldwide campaign against the use of tobacco, several tobacco products continue to be in use. While people smoke cigarettes, cigars, and pipe tobacco, they inhale tobacco and chew powdered tobacco in several forms—as *khaini*, *paan masala*, and bundled in a betel leaf.

A Chemical Parade

When a person inhales tobacco smoke, he lets loose a chemical parade that marches through the most vital organs of his body. The smoke delivers more than 4,000 chemical compounds, tiny amounts of poisons such as arsenic and cyanide, and at least 43 cancer-causing chemicals to his lungs, blood vessels, heart, brain, and other key organs. Each one of these chemicals has far-reaching effects, but the most notorious and most powerful among them is nicotine.

Nicotine is the *culpa prima*. It is the chemical that keeps a person hooked on tobacco. Through a complex chemical action, it promotes abnormally high levels of dopamine in the brain. Dopamine is a natural chemical associated with a feel good factor. Researchers believe that the abnormally high levels of dopamine induced by tobacco encourage the smoker to increasingly seek pleasure in tobacco smoke.

Few smokers may accept this fact, but the dependence on tobacco is to a large extent psychological. It does not produce a physical craving like some other addictive substances. Some people, however, may complain of physical symptoms at first when they try to give up smoking. The withdrawal symptoms may include restlessness, lack of concentration, irritability, headaches, and impaired psychomotor performance. But these effects are transient and should not deter a person from his resolve to stop smoking.

What Draws People towards Tobacco ?

The reasons people get drawn to tobacco are probably complex, but social environment does play a major part. Commercials that present smoking and chewing tobacco as socially acceptable and desirable, manly, and as a necessary part of a rich full life, encourage many young people to fall in the tobacco trap. For many, smoking is linked with self-esteem and status needs, while others mistakenly believe that tobacco can heighten mental concentration and stimulate creativity. Still others get drawn to it because they see a role model or an elder smoke or chew tobacco.

The Innate Factor

Researchers trying to determine if there is any innate factor that drives a person to become a smoker have found no substantial personality difference between smokers and non-smokers; though some studies suggest that cigarette-smokers tend to be more extroverted and less rigid than non-smokers, and pipe-smokers are more introverted. Some psychoanalysts believe that smoking a cigarette, pipe, or cigar is on the whole a libidinous act. It is in line with getting something into the mouth, beginning in infancy with the breast, then the bottle, then the comforter, then food, and finally the cigarette. The common sight, a smoker with an unlit cigarette or pipe, lends some credence to this idea. Oral sex practices also lend some credence to this theory.

Some people smoke to relieve pressure while others feel that a cigarette and a matchstick in hand alleviates their stress. Some find themselves better equipped to handle stress if they have a cigarette stick in their mouth.

Editorial (Contd. from page 39)

for observing the sky; and the publication of Johannes Kepler's *Astronomia Nova* describing the first and the second law of the planetary motions.

Astronomy and World Heritage initiative of UNESCO will include sites related to history of modern astronomy in addition to the prehistoric sites. It will also include observatories, instruments and places where astronomical discoveries were made. No doubt, this is an important part of science heritage in general, and astronomy in particular, which is not adequately represented on the World Heritage List. The 15th century observatory of Ulugh Beg in Samarkand, Uzbekistan, the 18th century observatory of St. Petersburg in Russia, and the old Royal observatory in Greenwich are a few examples that do appear on the World Heritage List, but they are only parts of sites with broader significance.

Two of the five surviving astronomical observatories built by Maharaja Jai Singh II at Delhi and Jaipur consisting of fourteen major geometric devices for measuring time, predicting eclipses, tracking stars, ascertaining the declinations of planets, and determining the celestial altitudes and related ephemeris, could be strong candidates for the nomination of the Astronomy World Heritage sites. Other potential candidates may include the ruins of the Vijayanagara Empire, Sun temple at Modhera, Gujarat, the Gavi Gangadhareshwara temple at Bangalore, and so on.

Hopefully, the initiative of UNESCO to identify Astronomy World Heritage sites would provide impetus for research in a not so well-known field of archaeoastronomy in India. Incidentally, archaeoastronomy is the study of how people in the past understood the phenomena in the sky, how they made use of those phenomena, and what role the sky played in their culture. For example, in North Karnataka and Hyderabad regions, there are some 40 sites of stone alignments suggesting their use as sight-lines for monitoring the sunrises and sunsets over the horizon to estimate and predict the seasons and the passage of years. In particular, at Hanamsagar in Belgaum district of Karnataka, a typical stone arrangement shows direction of summer and winter solstices. Already, in a first, a team from the Tata Institute of Fundamental Research, Mumbai, has undertaken an archaeoastronomical project to study India's ancient Indus Valley Civilization sites from a purely astronomical perspective.

The sky is our common and universal heritage, and it forms an integral part of the total environment that is perceived by mankind. Hence, interpretation of the sky as a theme in World Heritage is a logical step towards taking into consideration the relationship between mankind and his environment. Needless to say, sites relating to astronomy are a tribute to the complexity and diversity of ways in which people rationalised the cosmos and framed their actions in accordance with that understanding. This includes - but is by no means restricted to - the development of modern scientific astronomy. Astronomical knowledge and its role within human culture define the outstanding universal value of these sites. These material testimonies of astronomy, found in all geographical regions, span all periods from prehistory to today.

"Every human culture has a sky, and strives to interpret what people perceive there", says Clive Ruggles, emeritus professor of archaeoastronomy at the University of Leicester, UK, and chair of the IAU's working group on astronomy and world heritage, in a recent issue of *New Scientist* (17 January 2009). The understanding people develop by observing the sky forms a vital part of their knowledge concerning the cosmos and their place within it. Seen from this standpoint, astronomy is not just a modern science, rather it is a reflection of how all peoples - past and present, see themselves in relation to the universe. In today's world, where globalisation of human culture moves at breakneck pace, safeguarding our astronomical heritage is vital for saving the fragile aspects of our common cultural heritage - before they are lost forever.

Vinay B. Kamble

Letters to the Editor

A magazine of quality

I am a regular reader of *DREAM 2047* since 2004 and I have found it to be very informative, educative and much useful for the young student community. The quality and the standard of the contents of this magazine cannot be matched easily. The presentation and lay-out of articles make it even more beautiful. The article "Living with Cancer" (January 2009) was fascinating.

Rais Ahmed Dar
Secretary, Veshev Science Clab,
Ashnaji (Kulgam)

Brilliant articles

The articles published in *DREAM 2047* are exceptionally brilliant, giving readers the latest knowledge in various fields of science. We have assured the availability of the copies to friends and students desirous of sharing your scientific knowledge.

Dr. C.B. Kapoor
Ex. Professor & Head,
Department of English & Modern
European Languages,
Mahatma Gandhi Kashi Vidyapith

Informative articles

I am a student of M.Sc. Physics in Kurukshetra University. I read your article on 'Broken Symmetries' in January 2009 issue of *DREAM 2047* magazine. The article is very informative for physics students like me. I thank you for such a nice article. I will display this article on our department's science wall magazine. I hope you will publish such informative articles on physics in future too.

Shammi Verma,
Kaithal, Haryana

Recent Developments in Science and Technology

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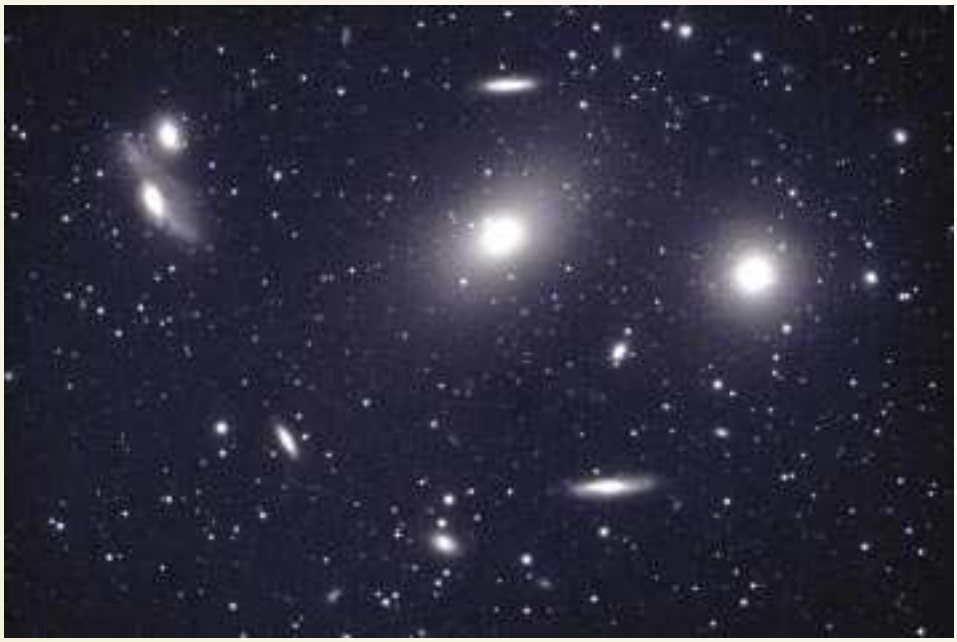
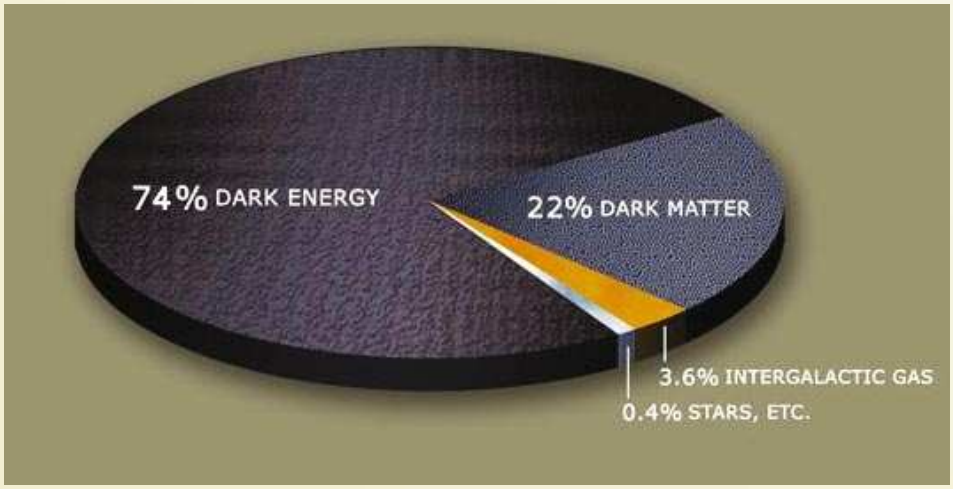
Dark energy and galaxy clusters

Ever since the American astronomer Edwin Hubble discovered in the 1920s that the universe is expanding, with galaxies moving away from each other at velocities proportional to their mutual distances, cosmologists had believed that the rate of expansion will slow down in the distant future. But in 1998, two teams of researchers discovered just the opposite – the universe was not slowing down in its expansion as expected, but was in fact accelerating.



The galaxy cluster in the constellation of Virgo



Dark energy makes up nearly three quarters of the universe, dark matter comprises another 20 to 25 percent, and ordinary matter constitutes a mere 4 percent.

By observing distant, ancient exploding stars, physicists and astronomers at the U.S. Department of Energy's Lawrence Berkeley National Laboratory led by Saul Perlmutter, and a team of scientists from around the world led by Australian astronomer Brian Schmidt announced that the universe is not just expanding, which they knew, but it is expanding at an ever-faster pace. The two teams found that a distant supernova was fainter than expected, indicating that the expansion of the universe was speeding up rather than slowing down. The causative factor was supposed to be dark energy – a hypothetical form of energy that permeates all of space and causes the universe to expand at an ever-accelerating pace. Also known as the energy density of the vacuum, dark energy is a property of space itself. By current estimates, dark energy makes up nearly three quarters of the universe, dark matter comprises another 20 to 25 percent, and ordinary matter – everything that we can see and touch – constitutes a mere 4 percent.

A new study, using a new, independent line of evidence, has now confirmed the presence of dark energy. After examining the growth of galaxy clusters rather than the movement of individual stars, astrophysicist Alexey Vikhlinin and his colleagues at the Harvard-Smithsonian Center for Astrophysics in USA has now confirmed the existence of this mysterious, repulsive force. Vikhlinin and his colleagues charted galaxy clusters as they grew over thousands of millions of years. These massive collections of dust and gas are bound together by gravity in the near and distant universe. After analysing x-ray

images from NASA's Chandra X-ray Observatory, they found that the growth of these structures began to slow down about 5,500 million years ago (*The Astrophysical Journal*, 10 February 2009).

According to the researchers, it was at this point that the repulsive force of dark energy may have prevented galaxy clusters from pulling more matter in from far away and growing larger. Besides, dark energy not only slowed down the growth of existing galaxy clusters, but also reduced the rate at which new clusters were formed. The inference of the researchers is further corroborated by the timing of the event; it coincides with findings by supernovae researchers that show that the expansion of the universe had been slowing down before it began to accelerate 5,500 million years ago.

The findings of Vikhlinin's team also corroborate Einstein's theory of general relativity, which describes gravity as a property of space and time. The new results reinforce the validity of the 'cosmological constant,' a correction factor that Albert Einstein had introduced into his equations to balance the force of gravity.

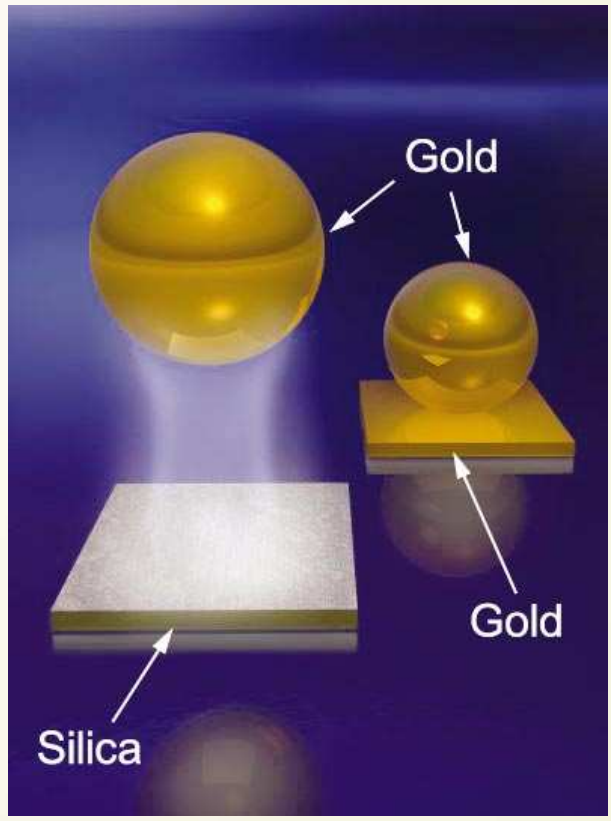
Levitation at microscopic scale

According to Newton's universal law of gravitation, every object should attract another with a force that varies inversely with the square of the distance between them. But no two objects are known to repel each other unless, of course, they happen to have similar electrostatic charge or the same magnetic polarity. Although claims have been made of yogis performing levitation through yoga power, there is no scientific evidence that it is possible. But a recent experiment shows that levitation is possible under certain circumstances, but only at nano-scale. Researchers from Harvard University and the National Institutes of Health in USA have actually levitated an object, suspending it without the need for external support (*Nature*, 8 January 2009). Working at the molecular level, the researchers relied on the tendency of certain combinations of molecules to repel each other at close contact, effectively suspending one surface above another separated by a microscopic distance.

The newly discovered effect is related to what is known as the 'Casimir force'. It is named after the Dutch theoretical physicist Hendrik Casimir who in 1948 had predicted that two uncharged, perfectly conducting plates in a vacuum would be attracted to each other because of quantum fluctuations in the vacuum's electromagnetic field between the plates. The Casimir force arises from one of those unlikely sounding real world manifestations of quantum field theory. In the classical everyday sense we think of a vacuum as what is left after we have removed all of the stuff – molecules, atoms, etc. But that still leaves photons. If we remove those as well – including all the thermal energy – then surely we should have an absolute vacuum which contains precisely nothing. But theoretically, that is not possible according to Heisenberg's uncertainty principle, which forbids the precise independent knowledge of energy and time simultaneously at quantum level. The absolute energy of a system is thus unknowable as a single parameter. So we cannot have a vacuum of absolute zero energy because it violates the uncertainty principle.

The simplest way to imagine the Casimir force (also known as Casimir-Lifshitz force) in action is to place two parallel metal plates separated by a few nanometres in a vacuum. But, theoretically, even a vacuum is not empty – it is actually bubbling with a quantum field of particles, constantly popping in and out of existence, which can even fleetingly interact with and push on the plates. But the small space between the two plates restricts the kind of particles that can appear, so the pressure from behind the plates overwhelms that from between them. The result is that when two surfaces of the same material, such as gold, are separated by vacuum, air, or a fluid, the resulting force is always attractive.

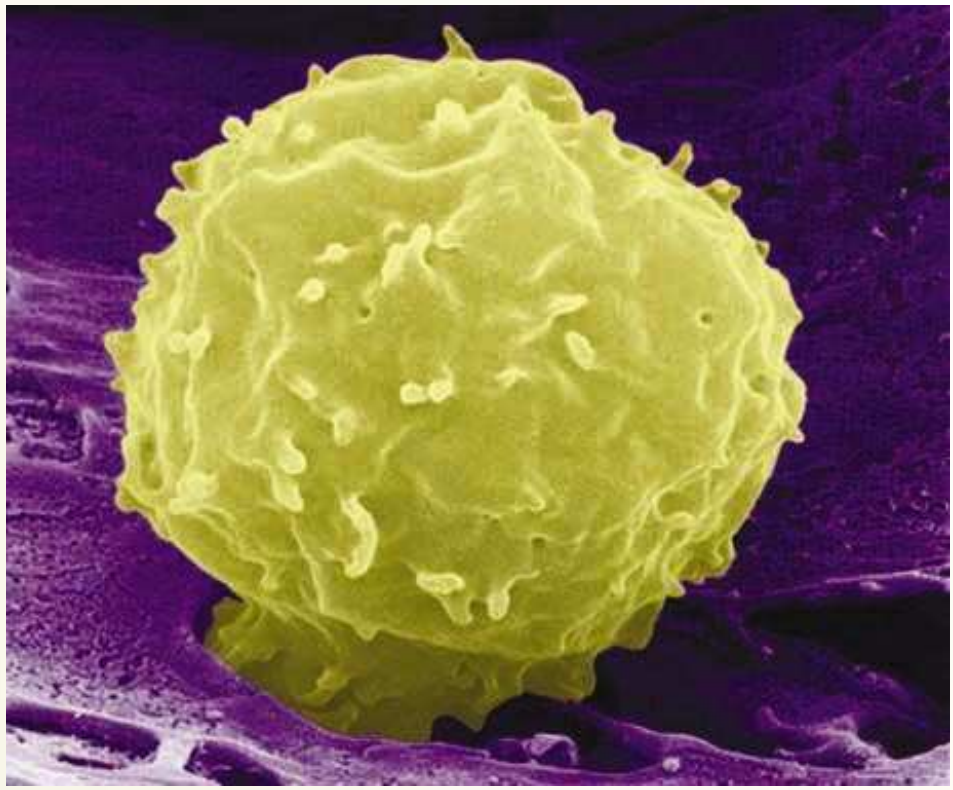
The recent discovery of repulsion at microscale was made when the scientists replaced one of the two metallic surfaces in the form of a gold-coated microsphere, about 40 micrometres in diameter, immersed in liquid bromobenzene and suspended it over a plate made of silica. They observed the attractive



*An artist's rendition of the repulsive Casimir force. A gold sphere, immersed in bromobenzene (*left*), levitates above a silica plate. When the plate is replaced by one of gold (*right*), levitation is impossible because the Casimir force is always attractive between identical materials.*
(Credit: Federico Capasso, Harvard School of Engineering and Applied Sciences)

force changed to repulsive. For the first time, they could measure what they considered is a repulsive Casimir force, which made the gold-coated microsphere levitate over the silica plate. But when the silica plate was replaced by one of gold no levitation occurred because the Casimir force is always attractive between identical materials.

Repulsive Casimir forces are of great interest to scientists because they can be used in new ultra-sensitive force and torque sensors to levitate an object immersed in a fluid at nanometric distances above a surface. Potential applications of the new finding include the development of nanoscale-bearings based on quantum levitation suitable for situations when ultra-low static friction among micro- or nano-fabricated mechanical parts is necessary. Specifically, the researchers envision new types of nanoscale compasses, accelerometers, and gyroscopes.



A stem cell emerging from rat bone marrow. By stimulating the release of stem cells after a heart attack, the healing process could be accelerated.

(Photograph: Imperial College, London)

Stem cell therapy makes healing faster

A team of British researchers has developed a new technique of using stem cells to enhance the body's ability to repair itself, especially after an injury. The therapy, which makes the body release a flood of stem cells into the bloodstream, is designed to heal serious tissue damage caused by heart attacks and even repair broken bones. Normally, when the body is injured, bone marrow releases stem cells that move to the damaged area through the bloodstream. On reaching the target area, they start to grow into new tissues, such as heart cells, blood vessels, bone and cartilage and repair the damage.

In fact, the body repairs itself all the time. We know that when we cut ourselves the skin heals over by itself. Within our body, too, there are stem cells patrolling around and carrying out repair where it is needed. But when the damage is severe, such as in a heart attack or bone fracture, there is a limit to what the body can do. The amount of stem cells released normally is not sufficient to speed up the healing process.

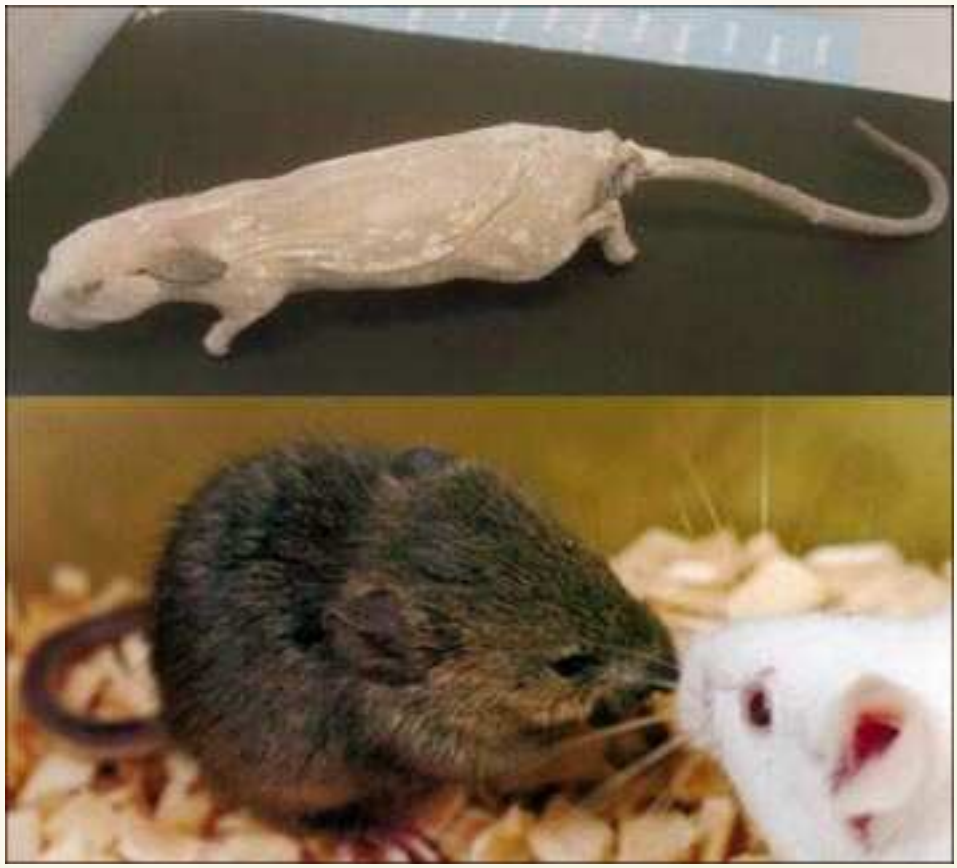
In the past, scientists had known how to make bone marrow release a type of stem cell that can only make fresh blood cells. They used the technique to collect cells from bone marrow donors to treat people with the leukaemia. Now a team led by Sara Rankin at Imperial College, London has discovered a way to boost stem cell production – by stimulating bone marrow to release other types of stem cell, which can repair bone, blood vessels and cartilage (*Cell Stem Cell*, 9 January 2009).

What the researchers did was to give mice a drug called Mozobil and a naturally-occurring growth factor called vascular endothelial growth factor (VEGF) and they found that stem cell counts in their bloodstream shot up more than 100-fold. The finding has huge and broad implications for future health care strategies. For example, if a person comes to hospital having had a heart attack or a broken bone, then, by giving him these drugs their bone marrow can be made to release stem cells quickly and in large numbers into the bloodstream, which will carry them to the affected areas and thereby speed up the repair process.

The researchers hope to begin trials of the therapy in rodents later this year to investigate how effective it is at repairing tissue damage in the animals. If successful it will mark a major step towards the ultimate goal of using patients' own stem cells to regenerate damaged and diseased organs. The therapy might also prove useful in treating patients with immune disorders, such as rheumatoid arthritis. One of the stem cell types released from bone marrow weakens the immune system, and so could help keep so-called autoimmune diseases under control.

Mice cloned from dead, frozen mouse

Can you bring an animal that has been dead and frozen for 16 years back to life? No, that is not possible yet, but a team of Japanese researchers have been able to clone healthy mice from cells taken from dead mice that had been frozen for 16 years at a temperature of -20°C. The team led by Teruhiko Wakayama of the RIKEN Center for Developmental Biology in Kobe, Japan, used a modified version of a cloning technique in which the nucleus of a mouse cell – in this case a cell from dead tissue that has been frozen and then thawed – is injected into a mouse egg that has had its nucleus removed. The resulting embryo was then used to create embryonic stem cells the nuclei of which were injected into other eggs to produce clones (*Proceedings of the National Academy of Sciences*, 11 November 2008).



*Dead mouse frozen for 16 years (*top*) and its clone (*bottom*). (Wakayama et al.)*

One of the surprising discoveries made by the Japanese researchers was that it was easiest to create clones from brain tissue, probably because freezing and thawing the tissue somehow makes it easier to 'reprogram' the brain cell nucleus. Another reason may be that brain tissue has high sugar content, which can protect cells when they freeze, protecting the DNA from damage. Cloned mice had been produced earlier from previously frozen dead cells. But this is the first time animals have been cloned from tissue frozen without the use of chemicals that might protect the cells from damage.

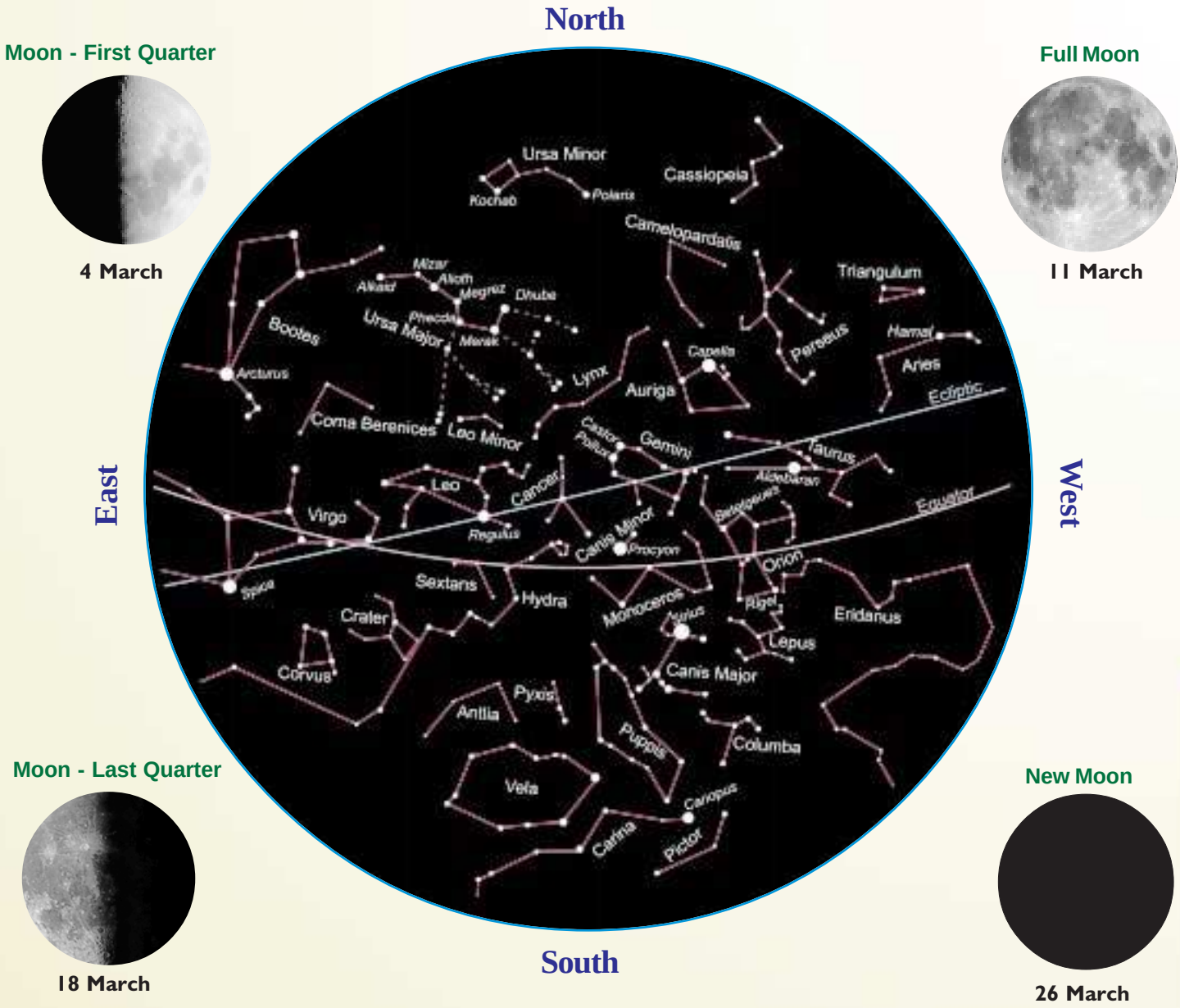
The Japanese success has raised the possibility that endangered species could be cloned from old, frozen carcasses, rather than from living cells frozen using elaborate techniques. The finding also raises hopes of one day being able to resurrect extinct animals frozen in permafrost, such as the woolly mammoth. Already, there are several cloning programmes around the world that aim at increasing the size of rapidly-dwindling populations of endangered species such as African wild cats. These programs depend on the animal cells being treated with specialised chemical before being frozen so that they can be brought to life when thawed.

Car parts from coconut husk

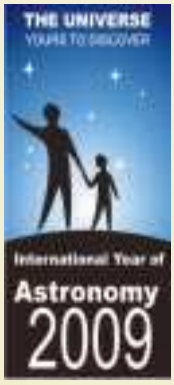
Coconut husk has many uses – coir rope and mats, and rubberised coir mattresses are common. Now a team of researchers at Baylor University, Texas, USA has developed a way to use coconut husks in automotive interiors. The researchers have developed a technology to use coconut fibre in place of synthetic polyester fibres in compression moulded composites. Coconut fibres can also be used to make liners for car dickey, floorboards and interior door covers. The mechanical properties of coconut fibres are just as good, if not better, than synthetic and polyester fibres when used in automotive parts. Moreover coconut fibres are less expensive than other fibres and are better for the environment because their manufacture does not cause pollution. Coconut husk also does not burn very well or give off toxic fumes; so they are safe for actual application in commercial automotive parts.

Coconut is a tropical crop and is an abundant, renewable resource in all countries near the equator, including the Philippines, Indonesia and India. With an estimated 11 million coconut farmers in the world making an average annual income of just about Rs.20,000, the researchers hope to triple the poor coconut farmer's annual income by creating a viable market for coconut husk.

Sky Map for March 2009



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



Tips to use sky map:

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

Visibility of Planets[a]

	Rising	Setting	In the Zodiac
Mercury	05:46	17:22	Capricorns- Pisces
Venus	06:58	19:41	Pisces
Mars	05:09	16:35	Capricorns- Aquarius
Jupiter	04:20	15:31	Capricorns
Saturn	17:46	06:15	Leo
Uranus*	06:20	18:12	Aquarius- Pisces
Neptune*	04:51	16:12	Capricorns

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

Sky Event

Date	IST	Event
07	20:36	Moon at perigee
09	00:45	Saturn at opposition
19	18:46	Moon at apogee
20	17:14	Spring equinox
23	03:01	Moon-Jupiter
24	19:35	Moon-Mars
28	01:01	Venus Inf. Conj.
31	08:54	Mercury Sup. Conj.

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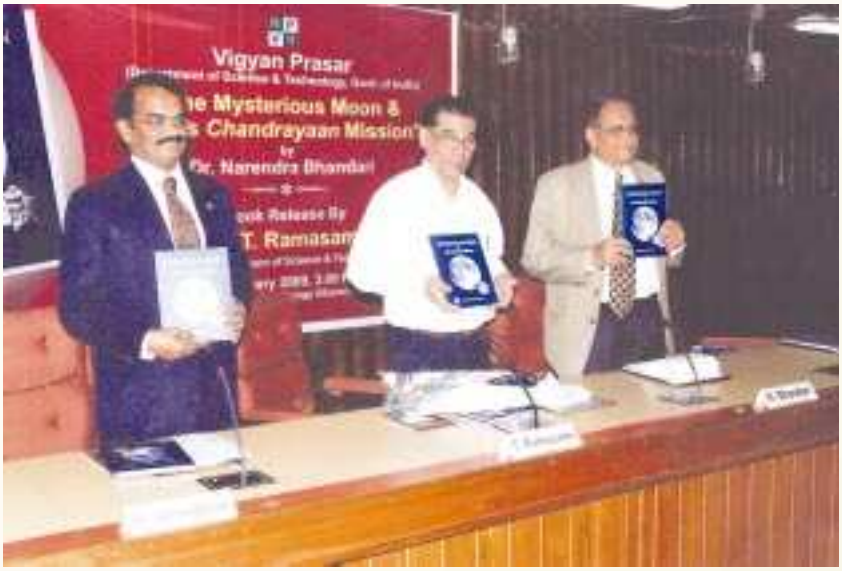
Astronomy

Book Release Function

Vigyan Prasar's publication *The Mysterious Moon & India's Chandrayaan Mission* was released by Dr. T Ramasami, Secretary, Department of Science & Technology, Government of India on 27 January 2009 at a function held in Technology Bhawan, New Delhi. Among others present on the occasion were Dr. Narendra Bhandari, the author of the book, Shri M Annadurai, Project Director, *Chandrayaan*-1 Mission, ISRO and Dr. V B Kamble, Director, Vigyan Prasar.



(From L to R) Shri M Annadurai, Project Director, *Chandrayaan*-1 Mission, ISRO; Dr. T Ramasami, Secretary, Department of Science & Technology, Government of India, and Dr. Narendra Bhandari, author of the book.

Dr. Kamble welcomed the gathering and introduced the author of the book, Dr. Narendra Bhandari, who is a renowned planetary scientist, associated with the *Chandrayaan*-1 mission since its inception and was part of the Moon mission task force constituted by ISRO. He said the book has been brought out on the occasion of the launching of *Chandrayaan*-1, the first Indian lunar mission in October 2008. He said that the book is meant mainly for inquisitive students and deals with the subject to highlight the science aspects and is different from the information available in other publications or on the web.

Addressing the gathering, Dr. Bhandari said that the book brings out the importance of studying the Moon for better understanding the Moon-Earth relationship. The book is divided into two parts. The first part deals with what is known about the Moon, its chemical and mineral composition, surface and internal characteristics, environment and surface processes, the formation of the Moon and its early evolution. The gaps in our understanding of various aspects of the Moon are brought out at every stage. The second part deals with the past and future missions to the Moon and *Chandrayaan*-1. Various payloads and mission requirements are described in the context of science objectives and various remote sensing techniques. The book gives, in a simple way, the motivation for this mission to Moon in the framework of the unresolved problems in lunar science. He thanked Shri Biman Basu for editing and providing inputs for images in the book.

Shri M Annadurai informed the gathering that *Chandrayaan*-1 met all the deadlines with precision. He also shared the latest findings and images collected by the lunar probe. He then gave a presentation on the *Chandrayaan*-1 mission and its present status.

Dr. Ramasami released the book and addressed the gathering. He appreciated the entire *Chandrayaan*-1 team and congratulated Shri Madhavan Nair on being honoured with the Padma Vibhushan. He said the success of the mission is mainly due to three factors; the team work, the precision, and the system. He said the book is neither too popular nor too technocal and believed that the book would keep its readers engaged. He congratulated Vigyan Prasar for bringing out the book and appreciated the content and the layout.

The function ended with a screening of a film titled "Passage to Moon" produced by DECU.

YOUR OPINION

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

This month's topic:

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

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

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