



Vigyan Prasar

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Top Science Stories of 2007

- **Editorial: The Case of the Indian Monsoon**
- **Bires Chandra Guha: Pioneer of Modern Biochemistry in India**
- **All About Spinal Break and Slippage**
- **Travails of a Science Populariser**
- **The Promise of Giant Magnetoresistance**
- **How do Columns in RC Buildings Resist Earthquakes?**
- **Sky Map**
- **VP News**



The Case of the Indian Monsoon

There is magic in the word monsoon. There is romance in it and there is life in it. This is why the monsoon has inspired many of our art and cultural forms. In *Meghadoota*, the great poet Kalidasa used monsoon as a metaphor to convey love after separation with the cloud as the messenger. Again, in *Ritusamhara*, Kalidasa begins with the description of summer in which the dry weather and the extreme heat conditions make the lands extremely parched. Everyone yearns for a few drops of rain to soak the soil. Then come the much-awaited monsoons and the whole country gets drenched in the fresh monsoon rains. Everything looks full of life with black clouds and the rumbling thunder adding to the magic.

Monsoon in India is no ordinary affair, but is the lifeline of the country. Indeed, the Southwest monsoon accounts for about 80 per cent of the country's rainfall in a year. With only about 40 per cent of country's sown area irrigated, the monsoon becomes crucial in determining agricultural output. There is no gainsaying the fact that too much or too little rain can prove disastrous. Monsoon rain generates food and provides labour; and creates cash flow in the market. Bad rain could even result in dipping stock market and falling corporate investment. Further, a great deal of the country's electricity requirement is generated by water power provided by the monsoon rain. A severe drought could reduce gross domestic product (GDP) in a given year by about 2 to 5 per cent. This is why the progress of monsoon – its onset and performance – is followed with such a

keen interest in India. The ability to predict accurately the spatial and temporal distribution of rainfall well in advance can help farmers plan agricultural operations. Incidentally, the term *spatial* refers to distribution of monsoon over different areas or regions, while *temporal* refers to distribution over a period of time.

We must emphasize that monsoon is an extremely complex phenomenon governed by several global and regional factors. Despite intensive efforts for over

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A VERY HAPPY AND PROSPEROUS 2008
THE INTERNATIONAL YEAR OF THE PLANET EARTH

a hundred years we have not been able to understand the monsoon phenomenon completely. We understand monsoon only in bits and pieces. Indeed, it has remained a mystery! This is why we still cannot accurately predict onset and progress of monsoon – spatial or temporal. But, what are the prospects for predicting monsoon rainfall over India, anyway? Why has the accuracy of monsoon forecasts been so low? What are the projected impacts of global warming on the Asian summer monsoon? These are some of the questions we yet need to answer to understand the dynamics of monsoon.

Monsoon forecasting has a long history in India. The India Meteorological Department (IMD) was established by the colonial Government in 1875 with H. F. Blanford as its first head. After the subcontinent had experienced a devastating drought and famine in 1877, the Government asked

the recently established IMD to forecast monsoon rainfall. Blanford noticed an inverse relationship between the snow cover in the Himalayas during the preceding winter and monsoon rainfall over India. Tentative monsoon forecasts were issued on this basis in the initial period. In 1904, Sir Gilbert Walker became Director General of observatories in India. He discovered that when atmospheric pressure was low over South American coast, and high over the Indian Ocean region, rainfall was likely to be deficient. When the reverse happened, the monsoon was generally good. He devised a forecasting methodology using

a linear regression model using past data. However, even with this model droughts could not be successfully predicted. Indeed, prediction of droughts has remained elusive even today.

In 1969, it was established by J. Bjerkenes that the air pressure changes noted by Sir Gilbert Walker were in fact the atmospheric components associated with the unusual warming and cooling of the surface waters of the Pacific Ocean known as El Niño and La Nina respectively. The oceanic and atmospheric components of the system are now together termed El Niño Southern Oscillation (ENSO). It was shown that ENSO events strongly influenced the Indian monsoon, with poor rains in years when an El Niño occurred and a good monsoon when La Nina occurred. But the relationship between ENSO and the monsoon has appeared to

Contd. on page... 34

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Top Science Stories of 2007

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The year 2007 was another eventful year in the field of science and technology. For the first time, an international panel of climate experts came out with the irrefutable evidence that global warming is occurring and that it is “very likely” man-made. The year witnessed two remarkable comets and the discovery of the first Earth-like planet outside the solar system. The year also saw the success of the first reusable space capsule by Indian space scientists. In the area of health, significant breakthroughs were reported during the year, including the cracking of the genome of the common rhesus macaque, development of human embryonic stem cells from skin cells, a rice based oral vaccine against cholera, and much more.

Human role in global warming confirmed

Global warming has long remained a controversial subject with countries like the U.S. unwilling to accept that much of it is man-made and that the U.S. is a major contributor. But the fourth report of the Intergovernmental Panel on Climate Change (IPCC), a working group of some 3,000 delegates from 113 countries, in its final report released in February clearly stated that there can be no question that the increases in these greenhouse gases are dominated by human activity. According to the report, an increase of anywhere from 0.8 to 5.8° Celsius was likely by 2100. It says, “Warming could lead to some impacts that are abrupt or irreversible, depending upon the rate and magnitude of the climate change.” The contribution of IPCC in bringing about a change in the mindset regarding the human role in global warming was recognised by the award of the 2007 Nobel Peace Prize to the group, now headed by the renowned Indian environmentalist Rajendra Kumar Pachauri. The award is expected to help bring the processes and decisions that appear to be necessary to

protect the world’s future climate to a sharper focus, and thereby help reduce the threat to the security of mankind. Action is necessary now, before climate change moves beyond man’s control.

India tests reusable space capsule

In January, Indian space scientists attained a major success in their effort to develop a reusable space vehicle with the safe return of the capsule, *SRE-1*, earlier launched by Polar Satellite Launch Vehicle (PSLV-D7). With the success India became the fourth country after Russia, the USA, and China to achieve the feat of launching



Reusable Space Capsule

and retrieving a probe from orbit. The capsule, returning after 12 days in Earth’s orbit, survived a fiery re-entry into the atmosphere and parachuted down in the Bay of Bengal, about 140 kilometres from its launch site, from where it was picked up by a coast guard vessel to be ferried back to the Sriharikota in Andhra Pradesh.

The Space capsule Recovery Experiment (*SRE-1*) was intended to demonstrate the technology of an orbiting platform for performing experiments in microgravity conditions. It was also aimed at testing reusable thermal protection system, navigation, guidance and control, management of communication blackout, deceleration and floatation system, recovery operations, etc., required for successful return of an orbiting spacecraft. The lightweight heat-resistant tiles made from

pure silica that lined the outside of the 550-kg capsule to protect it from heat during re-entry were indigenously developed by scientists of Indian Space Research Organisation. (*Reusable space capsule image on Cover - Image courtesy: ISRO*)

Wonder comets

The year 2007 saw the appearance of two notable comets which kept astronomers busy. January 2007 saw one of the brightest comets in recent years. Astronomers and the general public had a rare opportunity to witness a bright comet more than a decade

after Comet Hale-Bopp put up a great show in 1996. Named Comet McNaught after its Australian discoverer Robert H. McNaught, the new comet is a non-periodic comet. According to the International Comet Quarterly at the Harvard-Smithsonian



Comet McNaught

Centre for Astrophysics, it was the brightest comet in 40 years after Comet Ikeya-Seki, which was seen in 1965. Comet McNaught attained its greatest brightness on 13 January after perihelion on 12 January when it could be seen even in broad daylight. Being in an orbit that brought it very close to the Sun, Comet McNaught could be seen mostly during twilight hours. After perihelion the comet could be seen only from the southern hemisphere.

In late October 2007 the appearance of another strange comet captured the attention of astronomers around the world. It was Comet Holmes – a comet without the customary ‘tail’ that characterises comets – which appeared the constellation of Perseus in the northern sky. But more than its unusual appearance was its strange behaviour – within a span of a few hours between 23 and 24 October 2007 it changed from being a faint, magnitude-17 object, visible only through large telescopes, to become a magnitude-2.5 object, making it similar in brightness to the stars that make up the famous Big Dipper – visible without optical aid. Then, yet another surprise came on 6 November 2007 when image of the



Image of Comet Holmes from the 3.6-metre Canada-France-Hawaii telescope on Mauna Kea showing the 1.4 million-km diameter coma (left). The white 'star' near the centre of the coma is the dust-shrouded nucleus. The Sun and planet Saturn are shown at the same scale for comparison (right). (Sun and Saturn images courtesy of NASA's SOHO and Voyager projects)

comet taken with the 3.6-metre Canada-France-Hawaii telescope on Mauna Kea, Hawaii showed its coma to have expanded to over 1.4 million kilometres in diameter, which made it larger than the Sun (dia. 1.39 million km)! But unlike the Sun, which is massive, the size of this comet was deceptive, as most of the coma is highly tenuous – made of mostly fine dust and gas ejected from the nucleus with relatively negligible mass through which the background stars could be seen. Astronomers are still trying to find out what caused the Comet Holmes to brighten up so suddenly – especially since it was at that time quite far away from the Sun's energetic influence.

Why Venus is so hot

The mystery of Venus's infernal atmosphere was partly cleared in November after analysis of data sent back by *Venus Express* spacecraft of the European Space Agency. The data showed that Venus is more Earth-like than previously thought – including lightning, which according to theory should not exist there. Venus is the planet closest to Earth in terms of size, mass, distance and chemical makeup, but while Earth is a haven for life, Venus is typically described as hellish, with a crushing atmosphere holding choking clouds of sulphuric acid over a rocky desert surface hot enough to melt lead. Venus's surface temperature hovers around a sweltering 465 degrees Celsius, its surface pressure is about 90 times that of Earth (which is akin to the pressure a kilometre below the ocean's surface), and there are no seasons there.

The *Venus Express* data shed light on not just how Venus became the intimidating world it is, but also how it still remains somewhat Earth-like. The spacecraft

intriguingly found evidence of lightning on the planet, even though none should exist because the clouds of Venus are like smog clouds on Earth, which do not generate lightning here. Just as lightning alters chemistry on Earth – creating ozone and smog components such as nitrogen oxides – so too do researchers expect lightning to have profound effects on Venus.

The space mission also shed light on how Earth-like Venus was. For instance, Venus may have had Earth-like oceans in its distant past, but its searing hot surface cannot sustain water now. Although vast volumes of water vapour are not now seen in Venus's atmosphere, new findings suggest how a great deal of water may have been lost (*Nature*, 29 November 2007).



Venus Express

Venus does not have a strong magnetic field as Earth does, meaning that sunlight could have broken up the water into hydrogen and oxygen that then easily escaped from the planet's atmosphere. Scientists had seen hydrogen leaving from Venus, but now they also have observed the escape of oxygen. According to the scientists, learning about the escape rates of hydrogen and oxygen will help them reconstruct how much water Venus had in the past.

Earth-like extra-solar planet discovered

In April, a team of astronomers announced they have discovered the smallest and potentially most Earth-like extra-solar planet yet. Five times as massive as Earth, it orbits a relatively cool red dwarf star called 'Gliese 581' at a distance that would provide earthly temperatures as well, signalling the possibility of liquid water. A team of Swiss, French and Portuguese scientists discovered the new planet using the 'HARP' instrument

on the European Southern Observatory 3.6-metre telescope in La Silla, Chile. They employed the so-called radial velocity, or "wobble," technique, in which the size and mass of a planet are determined based on small perturbations it induces in its parent star's orbit via gravity.

According Stéphane Udry, from the Geneva Observatory (Switzerland) and lead-author of the paper reporting the result, the mean temperature of the new planet lies between 0° and 40° Celsius, and water would thus be liquid. The radius of the new planet should be only 1.5 times the Earth's radius, and models predict that the planet should be either rocky – like our Earth – or fully covered with oceans (*Astronomy & Astrophysics*, 6 May 2007).

Gene therapy for Parkinson's disease

Success of the first-ever gene therapy trial for Parkinson's disease was reported in June. Parkinson's disease is a degenerative disorder of the central nervous system that often impairs the patient's motor skills and speech. Symptoms of Parkinson's disease have been known since ancient times, but it was not formally recognised and its symptoms were not documented until 1817 in 'An Essay on the Shaking Palsy' by the British physician James Parkinson, after whom the disease is named. At present, there is no cure for the disease, although medications or surgery can provide some relief from the symptoms.

In a study carried out at the Weill Medical College of Cornell University in New York City, most of the patients treated showed noticeable improvement in motor ability. No side effects related to the treatment were observed (*The Lancet*, 23 June 2007). The research team led by Michael Kaplitt and Matthew During added a gene called glutamic acid decarboxylase (GAD) to cells in the area of the brain called subthalamic nucleus, which is more active than normal in Parkinson's patients. The gene codes for the enzyme that makes gamma-aminobutyric acid (GABA), a neurotransmitter that inhibits neuron firing. The idea was that if the production of GABA could be stimulated, the activity in the subthalamic nucleus and other brain parts could be calmed. In patient trials it indeed seemed to work.

The macaque genome decoded

In March, the sequencing of the genome of the common rhesus monkey, rhesus macaque (*Macaca mulatta*) was announced. Rhesus macaque became the third primate (after humans and chimpanzees) of which the entire genome has been sequenced. The work, led by the Baylor College of Medicine in Houston, Texas, USA, involved an international team of more than 170 scientists from 35 institutions. The findings of the team show that the rhesus monkey, chimpanzees and humans share about 97.5% of the same genes (*Science*, 13 March 2007).



Rhesus macaque

Sequencing of the rhesus macaque genome is significant for the medical world because from the discovery of the Rh (Rhesus) factor, an important blood type determinant in 1940, to modern-day trials of AIDS vaccines, the rhesus macaque has played a vital role in biomedical research. In fact, it is the most commonly used nonhuman primate for studies on human health and disease. Their close genetic, physiological, and metabolic similarity to humans means that macaques offer invaluable insight into areas ranging from neuroscience, aging, and endocrinology to infectious diseases. So, information derived from the macaque genome has the potential to advance our understanding of the molecular mechanisms of aging and may offer insight into possible interventions into the human aging process. The macaque's genome sequence, and new genome-based tools (such as microarrays), would now enable researchers to perform more sophisticated experiments aimed at better understanding of genetic underpinnings of disease and behaviour in humans.

Embryonic stem cells without embryo

A significant breakthrough in stem cell research was reported in November. Stem cells are unspecialised human or animal cells that have the ability to self-replicate and give rise to specialised cells. Embryonic stem cells are 'pluripotent'; that is, they have the unique capability of being able to develop into almost any of the body's roughly 200 cell types. This property of stem cells has attracted researchers looking for a better way of repairing damaged organs. But it was believed that only embryonic stem cells had the capacity to grow into different kinds of tissue that could be used for organ repair; adult stem cells did not. Reprogramming adult human cells to repair damaged tissue or organs was considered to be almost impossible and use of stem cells from aborted embryos was considered unethical.

Two teams of researchers – Shinya Yamanaka of the University of Kyoto in Japan, and James Thomson of the University of Wisconsin, Madison, USA reported in November the creation of 'induced pluripotent cells' (iPCs) from human skin cells by using four genes (*Cell*, 16 November 2007, and *Science*, 23 November 2007). Both teams used viruses to insert four genes comprising the transcription factors into skin cells, and demonstrated that brain, heart and other tissues could be created from iPCs created this way.

The ability to create pluripotent stem cells from adult human tissue, rather than embryos, will not only mean that the supply of pluripotent stem cells will be potentially unlimited, but will also allow this vital medical research to proceed without religious or ethical impediment. According to the researchers, using the new technique it should be possible to generate patient- and disease-specific stem cells, without using human eggs or embryos. These cells should also be useful in understanding disease mechanisms, searching for effective and safe drugs, and treating patients with cell therapy.

Vaccinating with rice

Success of a test cholera vaccine that can be taken by mouth was reported in June. Conventional vaccination against cholera always involved the painful jab of a needle.

The new vaccine developed by Japanese researchers at the University of Tokyo is a genetically modified variety of rice that can be administered by mouth (*Proceedings of the National Academy of Sciences*, 26 June 2007). Since the rice-based vaccine comes from an edible plant, it is safe and inexpensive to produce in large quantities. What is more, the genetically modified rice can be stored at room temperature for at least a year and a half; so there is no problem of maintaining the cold chain, as is necessary with many of today's vaccines at enormous cost. Rice also has greater protein content than some of the starch-based edible vaccines currently under experimentation for a variety of infectious diseases. Abolishing the painful use of needles and syringes would also prevent pathogens from accidentally appearing in the vaccines and then spreading throughout the population, especially in underdeveloped countries where supplies are limited.

To create the rice-based cholera vaccine, the Japanese researchers isolated the genetic material from the cholera bacterium and inserted it into the sequenced genome of two local varieties of rice plant. Once the rice plants produced the toxins, the modified rice in a powder form suspended in water was fed to mice. The rice-based vaccine produced antibodies in the mice's bodies, especially in the mucosal layers of the intestine, which are most prone to damage by the cholera bacterium. As a result, the mice became immune to the diarrhoea-causing bacterium. The researchers plan to prepare the rice-based vaccine in the form of a capsule or tablet for applications in humans.

Drug-resistant bacteria tamed

In July, American researchers reported a technique of controlling antibiotic-resistant bacteria by gene swapping that could make antibiotics more effective. Indiscriminate and unrestricted use of antibiotics is a major factor in development of resistance in pathogenic bacteria, which become immune to common antibiotics and require more powerful antibiotics to control. A team of researchers at the University of North Carolina, USA, exploited the tendency of bacteria to spontaneously transfer to each

other strands of DNA – a process known as ‘conjugation’ – by which they pass on survival advantage, including resistance to antibiotics. An enzyme called relaxase helps them do this. The researchers discovered that the action of relaxase can be blocked by drugs called bisphosphonates, which are already approved as a treatment for bone loss. Once the enzyme is blocked antibiotic resistance genes cannot spread (*Proceedings of the National Academy of Sciences*, 9 July 2007).

The researchers had worked only with *Escherichia coli* so far, but would be testing to see if bisphosphates have the same effect on other species such as *Acinetobacter baumannii* (hospital-acquired pneumonia), *Staphylococcus aureus* (staph infections) and *Burkholderia* (lung infections).

New hope for asthma patients

In October, American medical scientists achieved a breakthrough that may make the control of asthma easier. Asthma is a chronic disease that affects the airways that carry air in and out of the lungs. In asthma patients, the inside walls of the airways are inflamed (swollen), which makes them very sensitive, and they tend to react strongly to allergens. When the airways react, they get narrower, and less air flows through to the lung tissue. During an asthma attack, muscles around the airways tighten up, making the airways narrower so less air flows through. Inflammation increases, and the airways become more swollen and even narrower. Asthma cannot be cured, but most people with asthma can control it so that they have few and infrequent symptoms and can live active lives.

Doctors and medical scientists have believed for more than two decades that cytokines (protein molecules secreted by cells of the immune system that serve to regulate the immune system) such as interleukin-4 (IL-4) or interleukin-13 (IL-13) play a vital role in the onset and development of clinical asthma. However, there has been no scientific evidence that this might be so. The American study, reported in *The Lancet* (20 October 2007), not only confirms the role of interleukins in asthma but also offers hope for a new line of treatment.

For the study, Malinda Longphre of Aerovance Inc, Berkeley, California, USA

and colleagues did two separate phase-II clinical trials, in which patients with asthma were given a new drug called pitrakinra. Pitrakinra is a recombinant variant of human IL-4 and is an IL-4 inhibitor. In the first study, 12 patients were given pitrakinra by subcutaneous injection once daily, while a further 12 were given placebo. In the second study, 16 patients received pitrakinra twice daily by nebulisation, while a further 16 were given placebo. The patients in each study were also made to inhale allergens before and four weeks after treatment (known as ‘allergen challenge’, which induces an asthma attack).

After analysis of the data the researchers concluded that the effects of pitrakinra on asthmatic attacks are promising when compared with similar studies with other successful anti-inflammatory asthma therapies such as inhalers and tablets. Pitrakinra users reported up to three and a half times less breathlessness when compared to those using placebo. Pitrakinra appears to block the activity of two key cytokines – IL-4 and IL-13 – which are immune system molecules believed to cause allergic inflammation. However, the new drug is still under clinical trial and is not likely to come in the market before 3 to 5 years.

Chimp outperform humans in memory test

The year end brought the news of a unique skill of chimpanzees – known to be the closest neighbours of humans in the evolutionary tree. In a study by Japanese researchers, chimpanzees – and young ones at that – outperformed humans at cognitive task for the first time. It was known that humans share 98.77 per cent of their genes with chimpanzees, which separated from a common ancestor about 6 million years ago. It is not surprising therefore that there is increasing evidence of similarities in chimp behaviour and skills. But no one had known that chimp memory is so sharp.

Chimpanzees display a remarkable range of behaviour and talent. They make and use simple tools, hunt in groups and engage in aggressive, violent acts. They are



Chimp memory test

social creatures that appear to be capable of empathy, altruism, self-awareness, cooperation in problem solving and learning through example and experience.

Tetsuro Matsuzawa, of the Primate Research Institute at Kyoto University, Japan, tested three adult female chimpanzees, their three 5-year-old offspring and 12 university students for their ability to memorise the location of the numbers 1 to 9, which appeared at random locations on a computer touch screen (*Current Biology*, 4 December 2007). During the test, all the numerals simultaneously appeared on the screen for very short durations – 650, 430, or 210 milliseconds, and were then replaced by blank white squares. The chimpanzees then casually but swiftly pressed the squares, calling back the numbers in the correct ascending order – 1, 2, 3, etc. The human subjects were also required to the same, but surprisingly, the young chimpanzees remembered the location of the numerals more accurately than humans performing the same task. The test was repeated several times, with the numbers and squares in different places and every time the same result was repeated. What was most astonishing was the fact the young chimpanzees performed better even at the shortest duration, which does not leave enough time for the eye to move and scan the screen. When the numbers were displayed for just 210 milliseconds of a second, the young chimpanzees scored about 80 percent, while human volunteers could score only 40 percent; apparently the young chimpanzees were using some kind of photographic memory. Adult chimpanzees remembered the location of the numbers with the same or worse ability as humans. Matsuzawa suggests that some human children too have a kind of photographic memory, but this faculty is lost as they grow up and is replaced by

Editorial (Contd. from page 39)

diminish in recent decades. In 1997 the rainfall was slightly above average despite a strong El Niño event while 2002 saw one of the worst droughts in a century despite only a weak El Niño.

The seasonal mean monsoon rainfall is influenced by the slowly varying boundary conditions of sea surface temperature, soil wetness and snow cover. There is also a study describing a phenomenon called Indian Ocean Dipole (IOD). During the positive phase of the dipole, when the eastern Indian Ocean near Indonesia becomes colder than normal and the western part of the ocean near the Somali coast warms up, it is associated with a good monsoon. In recent analyses, however, it has been shown that while the IOD does not correlate as well with the Indian summer monsoon rainfall, the Equatorial Indian Ocean Oscillation (EQUINOO) correlates much better. EQUINOO refers to the pressure and wind pattern changes over similar areas of the Indian Ocean as the dipole. It is suggested that ENSO and EQUINOO could together account for the droughts and years of excess monsoon rain that India has experienced.

Forecasting the weather is a huge undertaking. Dynamical models that simulate how the ocean and atmosphere interact are important for scientific studies and predicting the monsoon. The computer programmes that provide the raw material for modern weather forecasts employ complex arrays of equations take a set of initial conditions – variables such as air pressure, temperature, ocean current speeds, humidity and so on – and use theories such as fluid dynamics and thermodynamics to work out what sort of weather those initial conditions will evolve into after a given time. To make accurate predictions, the information has to be gathered from as many points on above, and below the surface of the Earth as possible. However, a tiny air movement in one part of the globe can turn into a storm thousands of kilometres away! Minuscule errors or omissions in the initial conditions can blow up into hugely erroneous forecasts. Such 'dynamic' models are useful for forecasts two or three days in advance or

for indications of how the monsoon might progress over the following week or so, but not for long-range forecasts. This is one reason IMD uses a forecasting methodology using a linear regression models with past data.

The IMD began its operational forecasts in 1988 using a 16-parameter 'power regression model' that used six regional and 10 global land, atmosphere and ocean variables chosen for observed correlations between the Indian summer monsoon rainfall and the data available from the past. It had a successful run for 12 consecutive years as regards prediction of 'normal' monsoon, but, it had problems predicting the quantity of rain. In 2000, IMD replaced four parameters that had declining correlations with the rainfall. After the drought of 2002, when 19 per cent of the rain never fell, IMD was forced to develop a new model that used 8 parameter set for April and 10 parameter set for June for forecast in 2003. It proved successful in 2003, but 2004 forecast was off the mark by a long way. What was forecast as a normal monsoon turned out to be a drought. The new model with a new methodology for the year 2007 used 8 parameters, the interesting aspect being doing away with regional parameters altogether. The year's monsoon was bountiful, but the new model failed to predict the total seasonal rainfall for the country as a whole accurately. We may note that for past four years, IMD forecasts are issued in two stages. The first is given in April based on March values of the parameters of the model, and the second, an updated one is issued in June based on the May-June data taking into account the development of key forcing meteorological conditions such as El Niño / La Nina.

Predicting monsoon may get even more difficult as a result of the climate change. True, no one is sure about what the effects would be, but it is likely that extreme weather events like storms and hurricanes could become more common in many parts of the world. Surely, such events have far-reaching effects on the distant weather systems that would make forecasting even harder. Further, the predictability of the monsoon is limited by

the fact that the mean monsoon circulation may be governed by an intrinsically unpredictable component. Our models are getting better and satellite data more comprehensive and accurate. But, even with such phenomenal developments, shall we still continue to be like Alice and the Red Queen who remained under the same tree howsoever fast they ran and for whatever time?

Under the circumstances, it is imperative that we keep fine-tuning the statistical models for monsoon forecasts and not worry much about the real mechanisms that drive the monsoon and predict monsoon accurately most of the times. Finally, an ambitious programme to understand and model monsoon would imply attracting, nurturing and retaining young scientific talent. This may be the biggest challenge in the years ahead. Then, perhaps monsoon may not remain a mystery for ever.

□ Vinay B. Kamble

Letters to the Editor

Informative editorial

The editorial in the November 2007 issue of *DREAM 2047* has brought us very important and useful information on human space flight for which I shall remain grateful to you.

Ananga Tripathy,
PO. Kushang, Dist. Balangir 767065 Orissa

I am really very interested in space science and your editorial in the November 2007 issue has helped me in clearing my confusions about space programmes.

George Cornal

Cooking oil

In the article "Cooking Practices, Food Beliefs and Good Health Recipes" (*DREAM 2047*, November 2007), there is no mention of the use of linseed oil for cooking. I would like to know if it is a healthy cooking oil.

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Bires Chandra Guha

Pioneer of Modern Biochemistry in India

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"B. C. Guha lived through biochemistry, and biochemistry in India, especially modern biochemistry, could be equated to Guha. It will, however, be wrong to judge the personality of this unusual biochemist through biochemistry alone. Considering his humanitarian, social and political activities, the understanding of his character through his biochemical activities alone will be a complete failure."

I.B. Chatterjee and D. P. Burma in Current Science

He (B. C. Guha) was far from being a timid, quite, passive and a non-interfering individual like many of his other colleagues at the University. He had the quality of a torrential stream gushing through gorges and not a placid, smooth current of water with gentle ripple on its surface...He believed in the dictum of the great Japanese Philosopher and Nation-builder, Yoshida Torajiro and often used to say "It is better to be crystal and be broken, rather than remain for ever as tile on a house top."

B. Mukerji in Biographical Memoirs of Fellows of the National Institute of Sciences of India.

Bires Chandra Guha played a pioneering role in shaping the discipline of modern biochemistry in India. He spent most of his research career working on vitamins and nutrition and carried out research on the nutritive value of different Indian fishes, Indian tea and hydrogenated fats. His research covered a wide range, including fermentation studies on citric acid, acetone and butanol production, microbial jute retting, and microbial spoilage of stored cereal grains. He also worked in the area of designing anti-folic acid compounds and nucleic acid base analogues for their probable application in the chemotherapy of cancer. Guha realised the importance of multi-disciplinary research much ahead of many others. He believed that basic research was essential for the uplift of the country. But it did not mean that he undermined the importance of applied research. Guha himself did both basic and applied research.

Guha's interest was not confined to science alone. He had a great command over Sanskrit, English and Bengali literature. He could recite passages from Kalidasa, Shakespeare and Rabindranath with equal ease. He had mastered the art of public speaking. He was not a so-called ivory tower scientist; he applied his scientific knowledge for the betterment of the society.

Bires Chandra belonged to the well-known Guha Thakurata family of Banaripara in the district of Barisal (now in Bangladesh). He was born on 8 June 1904 at Mymensingh (now in Bangladesh), where his father, Shri Rash Bihari Guha was posted at the time. Young Bires Chandra



Bires Chandra Guha

was very much influenced by his maternal uncle Shri Aswini Kumar Dutta, an eminent educationist and a well-known freedom fighter. At the age of eleven, Bires Chandra was inducted in the revolutionary Jugantar Party. For many it may be hard to believe that at such a young age one could join a revolutionary party.

Till 1917, Guha studied in Brajamohan School at Barishal. In 1918,

he came to Kolkata (then Calcutta) and joined the Sri Krishna Pathshala. He passed the Matriculation Examination of the Calcutta University in 1919. His initial interest was to study arts in the Intermediate Course. However, being persuaded by his elder brothers he decided to study science. He got himself admitted in the ISc class in City College, Kolkata. After passing the ISc examination in 1921, Guha joined the BSc Honours course in chemistry. However, because of his political affiliation Guha was compelled to leave Presidency College. This was because of his involvement in the non-cooperation movement led by Mahatma Gandhi against the British rule. He managed to get admission in St Xavier's College and from where he passed the BSc examination in first class, standing first in order of merit. He also passed his MSc examination in chemistry in first class in order of merit.

After obtaining his MSc degree he started doing research under the guidance of his famous teacher Acharya Prafulla Chandra Ray. During his one year research under Ray, Guha published three research papers. Two of his research papers were on the varying valency of platinum with respect to mercaptonic radicals and the third one concerned synthesis of condensed heterocyclic system. After working for one year under Ray, Guha proceeded to England with a Tata Memorial Scholarship. It should



P.C. Ray

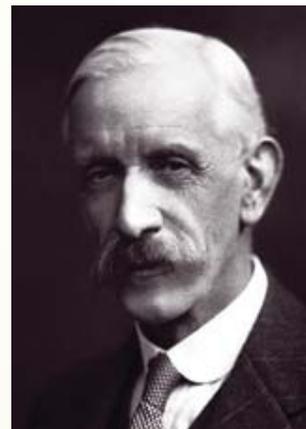
be noted that his trip to England was not a smooth affair. Due to an adverse report by the police his application for passport was rejected. He was finally given a passport because of the efforts made by Sir Edward Greaves, the then Vice Chancellor of Calcutta University and Acharya Ray. His passport was issued subject to the condition that Surendranath Mullick, Member of the Indian Council in England would keep a strict vigil on his activities during his stay in England.

Guha spent five years in England and where he first worked with Sir Jack Drummond of the London University and then with Sir Frederick Gowland Hopkins (1861-1947) at Cambridge, who is regarded as father of biochemistry in England. At Drummond's laboratory Guha was assigned the task of isolating and identifying the water soluble vitamins present in the polishing of rice. Christian Eijkman had shown that the addition of rice polishing to the diet would ameliorate the beriberi. However, before Guha could purify the factor, Jansen and Donath obtained the vitamin, which was identified to be thiamine or vitamin B₁. Guha then attempted to isolate and identify a heat-stable protein present in rice polishing. A. D. Emmet and G. O. Luros had observed in 1920 that autoclaved yeast no longer contained the anti-beriberi factor that is vitamin B₁ but it contained a substance that promoted growth of rats on certain synthetic diets. This substance was later identified to be riboflavin or vitamin B₂. Guha worked extensively on vitamin B₂ but he could not isolate this vitamin in pure form during his stay in Drummond's laboratory. R. Kuhn and his co-workers isolated pure riboflavin from milk in 1933.

Guha published ten research papers on vitamin B₁ and vitamin B₂.

From Drummond's laboratory at London, Guha moved to Cambridge to work in the laboratory of Hopkins. At Hopkins' laboratory, Guha came in contact with Albert Szent-Gyorgyi, the discoverer of vitamin C or ascorbic acid. It is interesting to note here, even at the cost of a little diversion, that Szent-Gyorgyi's discovery of vitamin C was purely accidental. During his short stay at Hopkins' laboratory Szent-Gyorgyi undertook the task of extraction and concentration of a redox substance present in animal and plant tissues. During the process of extraction and concentration of some redox substance from ox adrenal glands he obtained some sugar-like crystals. He had no idea about the nature of this substance except that it was a carbohydrate derivative. He named the new compound 'ignose' ('ign' for ignorance and 'ose' for sugar) and later he changed it to godnose (to indicate God Knows!). Such naming indicated how ignorant Szent-Gyorgyi was about his new discovery. The editor of the *Biochemical Journal*, to which the paper was sent for publication did not agree with the name given by Szent-Gyorgyi. The structure of the new compound was soon worked out in collaboration with Haworth an alternative name hexuronic acid was given. In the mean time Charles Glen King isolated vitamin C from lemon juice and which was found to be identical with hexuronic acid. Chatterjee and Burma has stated: "It is worth mentioning that Guha with his expertise in bioassay, which he learnt in Drummond's laboratory, helped Szent-Gyorgyi quite a lot in understanding the nature of the anti-scorbutic property of hexuronic acid." Guha's interaction with Szent-Gyorgyi made him interested in vitamin C.

Guha returned to India in 1932 after obtaining PhD and DSc degrees of the London University. His peers in England recommended him for the newly created post of Professor of Biochemistry at the All India Institute of Hygiene and Public Health. However, the appointment did not materialise. It was true that Guha was not a medical biochemist but the main reason



Sir Frederick Gowland Hopkins

for not giving him the post was his political affiliations. Guha then joined Bengal Chemical and Pharmaceutical Works founded by Acharya Ray. He established a nutritional research laboratory. He spent about three years (1932-35) there and during this short period he could publish 38 research papers. Out of these 38 research papers six were published in the well-known international science journal *Nature*. During his work at Bengal Chemical he fought for better remuneration for its workers and this made him unpopular with its management. On the advice of Acharya Ray, Guha left Bengal Chemical and taught at the Vidyasagar College for a brief period before being selected for the Chair of Applied Chemistry at the University College of Science.

After joining the University College of Science, Guha started building up an active and vibrant school of biochemistry. The Ghosh Travel Fellowship of the Calcutta University enabled him to visit England and other European countries for studying the organisation and development of biochemistry in these countries. Guha persuaded the University Grants Commission to appoint a Review Committee to prepare a report on biochemistry in India. With the efforts made by the Review Committee a nucleus for biochemistry was established in many universities. Before the advent of the reviewing committee, facilities for training in biochemistry were only available at Bangalore, Chennai and Kolkata. Commenting on the important role played by the Committee, Chatterjee and Burma wrote: "The report on Biochemistry in Indian Universities by the Review

Committee appointed by the University Grants Commission in 1959 under his chairmanship is practically a bible for the biochemist community depicting the past, present and future of not only biochemical education but also its research activities. There were only a few biochemistry departments in the country at that stage, but evaluation was done for the past as well as their future activities. On the recommendation of the committee, biochemical education definitely got a boost in the country."

Guha did his best to find ways and means for realising the objectives of the Scientific Policy Resolution 1958 adopted by the Government of India under the leadership of Pt. Jawaharlal Nehru. He believed that strengthening science teaching in schools and colleges was very crucial towards achieving this goal. He wrote: "In implementing the resolution, Government would have to pay attention to science teaching in schools, colleges and universities. Schools are, by and large, ill-equipped and ill-staffed for science teaching. It is there that the foundation should be laid. If proper salary scales are not provided



Christiaan Eijkman

for school teachers and money is lacking for experiments and demonstrations, it is idle to expect a radical improvement in the situation regarding scientific personnel. Besides it is at the school stage that special efforts should be made to spot the most creative minds and give them special opportunities for development by way of high class merit scholarships, special arrangements for teaching and

accommodations, etc. What applied to schools, applies also to colleges and universities. Here also the career of a teacher should be made sufficiently attractive, both materially and psychologically, and special opportunities should be for development of the most original and vigorous minds among the students. The science departments of the colleges and universities should have adequate annual block grants, so that the teachers engaged in research may concentrate on their work without worrying about research expenses and without begging for funds from sundry organisations. Nothing is more depressing than this constant anxiety for funds for research."

The devastating Bengal famine of 1943 resulted severe scarcity of milk and protein food. Guha left his normal research and took up the problem of protein malnutrition. Guha developed vegetable milk for infants. This artificial milk, which consisted of malted barley and groundnut powder, had almost same nutritive value as cow milk. He also prepared soybean milk. For adults he prepared protein substitutes by isolating proteins from grasses and leaves. He demonstrated different ways of blending such proteins with human diet.

In 1948, Guha joined the Ministry of Food, Government of India as Chief Technical Adviser. He came on deputation from the Calcutta University. He organised in the Food Department a Technical Wing for inspection, analysis and standardisation of foods. He also prepared plans for the development of food processing industries and for an integrated programme of nutrition surveys for the whole country.

From the Food Ministry, Guha went to Paris to serve the UNESCO as India's representative and counsellor in agricultural sciences. After returning from Paris, Guha joined Calcutta University. But after a year he joined the newly constituted Damodar Valley Corporation as a member from West Bengal. He agreed to take this administrative assignment after being persuaded by Shyama Prasad Mookerjee and Dr. B. C. Roy, the then chief Minister of West Bengal. He demonstrated his considerable skill in the administration and



Albert Szent-Györgyi

organisation of this multi-purpose project of river valley development.

In 1953, Guha rejoined Calcutta University. During his last phase at the University, Guha actively spearheaded the cause of teaching and research in biochemistry in the country. He was associated with a number of organisations namely, Council of Scientific and Industrial Research, National Institute of Sciences of India (now Indian National Science Academy), Indian Council of Medical Research, University Grants Commission, and Indian Science Congress Association. He played an important role in the establishment of the Indian Institute of Medical Research, which later became Indian Institute of Chemical Biology, a premier laboratory of the Council of Scientific and Industrial Research. The Guha Research Conference, a unique conference which has played an important role in the development of biological sciences in the country, is named after Bires Chandra Guha. Calcutta University has created the Dr. B. C. Guha Centre for Genetic Engineering and Biotechnology in honour of this pioneer.

Guha died on 20 March 1962 in Lucknow, Uttar Pradesh.

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All about Spinal Break and Slippage

You may find this hard to believe, but many people hide a break in their backbone. The ring-like arch of a vertebral body is split open. This break is either due to a birth defect; a fracture suffered in the growing years; or less often, a part of the ageing process. This condition is called spondylolysis. It usually affects the fifth lumbar vertebra

the problem is born out of such sports as gymnastics, weight lifting and football, which put a great deal of stress on the bones in the lower back. These sports also require that the athlete constantly over-stretch (hyperextend) the spine. In either case, the result is a stress fracture on one or both sides of the vertebra.

significant, the bones may narrow the spinal canal and begin to compress the spinal nerve roots. This causes pain and/or weakness in one or both thighs and legs, and may reduce ability to control bowel and bladder functions.

Diagnostic tests

The defect or break in the vertebral arch can be diagnosed on the X-rays of the lower back (lumbo-sacral spine). The *pars interarticularis*, or the portion between the upper and lower articular processes of a lumbar vertebra shows a crack or fracture. This condition is called spondylolysis. The X-ray confirms the bony abnormality.

Some people may also acquire the defect following a back injury, such as the impact of falling off a ladder and landing on the feet. Others suffer due to the wear-and-tear of daily life, and a few due to a tumour that eats away this part of the vertebral bone.

If the gap at the pars widens, the lumbar vertebra tends to shift forward in relation to the rest of the spine. The condition is called spondylolisthesis. The doctor measures the displacement of the vertebra on a standing side (lateral) view X-ray of the spine. This way the extent of forward slippage is verified. If the vertebra is pressing on nerves, a CT scan or MRI may be needed to further assess the abnormality, and see the actual extent of pressure on the spinal nerve roots.

Symptoms

Many people with spondylolysis and spondylolisthesis have no symptoms, and only come to know of the problem when it is revealed on an X-ray done for a different problem. In others, life may be plagued with several difficulties. They may suffer from pain in the lower back, especially after exercise, an increased swayback, and tight hamstrings, resulting in changes in posture and walk. If the slippage is



in the lower back, and much less commonly, the fourth lumbar vertebra.

A person who has this defect can suffer further damage. The vertebra, unable to maintain its proper position, can start to shift out of place. This condition is called spondylolisthesis. If too much slippage occurs, the bones may begin to press on nerves and surgery may be necessary to correct the condition.

Risk factors

Some people are born with a break or gap in a vertebral ring. This vertebra is therefore vulnerable to slip forward in relation to the rest of the bones of the spinal column. Significant periods of rapid skeletal growth may encourage this slippage. Yet, in many young people,





Treatment

Treating spondylolysis

The initial treatment for spondylolysis is generally conservative. The individual should take a break from all vigorous activities until the symptoms go away, as they often do. Non-steroidal anti-inflammatory medications (NSAIDs) such as ibuprofen may help reduce back pain. Occasionally, the doctor may recommend a back brace and physical therapy. In most cases, activities can be resumed gradually and there are few complications. Stretching and strengthening exercises for the back can help prevent future recurrences of pain.

However, surgery may be needed if the back pain does not respond to conservative treatment and begins to interfere with activities of daily living. In that case, a spinal fusion surgery is performed to plug the defect. Sometimes, an internal brace of screws and rods is used to hold together the fused vertebrae so as the fusion may become strong.

Treating spondylolisthesis

The decision about the type of treatment is made on the basis of the severity of slip and the symptoms. If you have a spondylolisthesis, which is

stable and non-progressive, you may do well without any treatment. Just so, it may be best to stay under a doctor's supervision, so that if the defect begins to widen, then proper treatment can be instituted in quick time.

If you have been diagnosed with spondylolisthesis, you should avoid activities that might cause more stress to the lumbar spine, such as sports activities like gymnastics, football, competitive swimming, and diving. Restrictions also apply on heavy lifting, excessive bending, twisting or stooping. You should discuss with a rehabilitation medicine physician about the necessary safeguards. You should also take advice about daily activities, which can be significant to your long-term physical and emotional well-being. Thus, you may find out that you can participate in swimming, walking in water, and regular walking, in addition to your back-strengthening physical therapy programme.

If you feel pain, your doctor may suggest non-steroidal anti-inflammatory pills like ibuprofen and muscle relaxants. You may also be asked to wear a corset or brace to provide additional support to the spine. This support may decrease muscle spasm and pain. Normally a corset is worn when you are up and about, but is often not necessary when you are lying in bed.

If you start wearing a corset, watch out for skin irritation (some

redness is expected under the brace). If any sores on the skin are noted, remove your brace and contact your physician immediately for further skin-care instructions. The brace will be uncomfortable at first. It will take several days for you to begin to like your brace and the support that it gives your spine. Your brace should be worn under your clothing. Wearing your brace over clothing will cause increased pressure where waistbands, buckles, snaps and buttons can cause skin irritation and sores. You will need to wear a cotton undershirt that is snug fitting under your brace to absorb moisture and prevent skin chaffing. You may need to change the T-shirt a couple of times per day to remain comfortable. As soon as your back becomes stronger, your physician may restrict the use of the brace.

You may be advised surgery if your condition does not improve with these non-surgical measures. If the slippage is considerable at the time of the diagnosis, also then surgery may be suggested as the first course of treatment. The goals of surgery are to remove pressure on spinal nerve roots, and to provide stability to the lumbar spine. In most cases of spondylolisthesis, lumbar decompression would need to be accompanied by uniting one spinal vertebra to the next (i.e., spinal fusion) with spinal implants that are often used to help aid the healing process.



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Travails of a Science Populariser

□ Rakesh Popli

The astrologer said, with a grim face, “I am afraid your days are counted.” The patient smiled and said, “Don’t worry, panditji, I can count very large numbers!”

This article presents some personal reminiscences about how scientific outlook in life comes to be challenged by superstitions. It also raises some questions about limitations of science and technology as presently available to us, and about its usefulness in some life situations vis-à-vis alternative knowledge-systems. Let me say at the very beginning that I am a science populariser: at least that is my self-image. I have been active in this field for several decades, writing articles and books on science, carrying on science popularisation campaigns in rural and urban areas, and so on. Moreover, I have been consistent in taking a scientific attitude in personal and social life as well, a value considered very important in science popularisation circles. During the last two years, some upheavals took place, which raised many challenges and questions.

Sickness invites superstition

In May 2004, I fell ill. After being given medical treatment for many suspected diseases at various places, I landed in AIIMS. After detailed investigations, my case was diagnosed as NHL (Non-Hodgkin’s Lymphoma), a form of cancer that affects the lymphatic system of body. It may be added that NHL, particularly of the T-cell, is considered rather tricky and hard to cure. Any way, my doctors started chemotherapy. This was followed by radiation therapy. All the while, treatment for TB was also given as a precaution. After some time, my heart got badly affected due to one of the medicines, and I was given treatment for that too.

These sudden developments naturally caused serious concerns among my family and friends. Amidst their unstinted support and loving care, there was also quite a bit of anxiety. There was no knowing whether a complete cure was possible at all, or how long I might live. Many pieces of well-meaning advice came from various quarters, some of which appeared to militate against the scientific temper. Let me mention a few.

The ring and the bangle

There was a strong and well-considered astrological recommendation that I wear a ring with blue stone. I never wear any rings and certainly have no faith in astrology or rings. So I declined. Considering the bad condition in which I was, they didn’t argue with me or press me. However, they managed to persuade my daughter, a fresh engineering student then, to wear such a ring, citing astrological advice that it could possibly bring good health to her father. And guess what happened: it ‘worked!’ Against all odds, I apparently recovered from nearly every malaise by March 2005. My daughter was naturally very happy and highly valued the ring she had worn. It is another matter that she got rid of it (and her new-found faith in it) when my NHL problem resurfaced later that year.

Similarly, I was advised repeatedly and affectionately to wear a bangle made of an eight-metal alloy (*ashtadhatu*), which was supposed to bring me health and happiness in general. My response was the same as before every time. Many other similar suggestions came from well-wishers in all sincerity, e.g., burning red chilies and waving them around me.

The panic hangover

However, the most weird and unexpected suggestion came from another quarter, and it was related to my past actions in the course of science popularisation work. I had been deeply involved in a nationwide programme of education of children in remote tribal areas. Some years ago, I was attending a three-day meeting of the national training them in New Delhi. A lady, who was a family friend of one of us, sent word that she would like to introduce us to “*pranic vidya*” It was claimed to be a potent and inexpensive way to ward off ill-health, and would be very useful for village-level workers functioning under severe limitation of resources. Then she proceeded to demonstrate it off his body and “freeing” *pranic* energy into his body. The details of the procedure I do not remember now. But I do remember feeling uneasy: after all, was it not similar to the kind of *jhad-phook* practised

by witch doctors in our villages? And did our people need to learn this from this disciple of a Korean *guru*?

Having “cured” the volunteer, the lady “captured” the ailment and consigned it ceremonially into some saline water already prepared for the purpose kept in a jar. She warned that the saline water, thus “contaminated” must be disposed of very carefully (e.g. buried in a pit). It would be harmful for anybody, even a plant, that came in contact with it. I felt she was introducing irrational fears among us. I went up to the front, poured some saline into my palm and drank it a couple of times, asking, “Is it so bad?” The lady was aghast. She muttered in an attempt to “ward off the ill effect that might come upon me.”

After she had left, we briefly discussed the matter and decided that no further sessions on “*pranic vidya*” were needed. However, my friends were concerned about me and kept inquiring about my well-being for the next two days. Nothing happened, of course, but some of them could not help wondering, half-jokingly, whether I was hiding some discomfort! Anyway, the whole matter was laughed off and forgotten by and by.

Well, after 3 or 4 years, on my sick-bed in the hospital, I received a funny message from that lady. She had heard of my condition and was feeling guilty that somehow *she* had been instrumental in bringing the curse on me. So, it was all due to that salt water, you see! She now wanted to do something to “take it off” me. I had a hearty (and health-giving) laugh. But, surprisingly, when I mentioned the “joke” to my well-wishers, some of them took it seriously. Pressed over the next several months, I pointed out it that it was not the only thing I had done “to invite a curse”. There had been occasions in the course of my education/science popularisation work when I felt called upon to show “irreverence” as in tearing of chain letters from “god men” promising rewards and issuing threats, demonstrating the natural phenomena involved in “Ganesh’s milk drinking”, encouraging people to see eclipses against astrological inhibitions, etc., in order to rid

my co-workers and other people of irrational fears. Should I now chase all of those acts and try to undo them? My ultimate weapon was, "all right, I will agree to the 'pranic treatment', but then discontinue the medical treatment".

In trying to persuade me to undergo all such treatments, which I considered superstitions, several arguments were offered. One "unanswerable" argument that came up every now and then was, "What is the harm in trying?" I leave it to the readers to answer it in their own way.

The status of alternative therapies

Now I would like to discuss something, which is not a superstition, although it is not science either. I mean alternative therapies like *Ayurveda*, homeopathy, *yoga* and naturopathy. In my case, there were several minor problems which were solved by recourse to some of these therapies. For example, in the beginning, when my general condition was very bad, one of the problems was a kind of dysentery: frequent and loose motions. It was cured in a gentle, complete and lasting way by a simple *Ayurvedic* remedy:

the powder of *bel* fruit taken with water. A different kind of situation arose later. A stage came during my treatment when diagnostic tests revealed no disease or infection; nevertheless, several problems remained. What should be done about, say, daily fevers with no scientifically diagnosable cause? There was no answer and no medical advice other than taking anti-pyretic pills continuously for relief. The question was whether to go in for alternative therapies.

The problem with all alternative therapies, more or less, is that tall, all-inclusive claims are made; even case studies are sometimes presented, but no detailed data are available on how many people got cured of a particular disease by a particular treatment and how many did not by following the therapy. There has been no scientific verification in most cases. In my case, I did practise *yoga* (mostly *pranayama*) prescribed for treatment of my major ailments. But it is not clear how much of my recovery could be attributed to it.

Of course, apart from the 'canonical' therapeutic systems (fairly well-documented and studied systematically by students) of the kind mentioned above, there is a large range

of folk remedies and household remedies (housewives' cures). I hardly need to present my own experience in this regard because just about everyone has benefited from these treatments. The attitude of people belonging to the world of medical science towards all alternative therapies often ranges from hostility to indifference.

Whither scientific community?

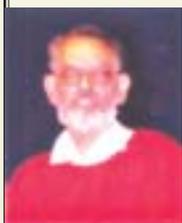
I cannot help wondering why the scientific community is not taking adequate interest in investigating the claims of these knowledge-systems. Just note the glaring contrast between this indifference and the enthusiastic challenges thrown at god men like Sai Baba to have their "miracles" investigated. Here the situation is the opposite. Many proponents and practitioners of alternative therapies are more than willing to have their cures investigated and validated scientifically, but the scientific community is not taking any notable interest (unless, of course, American scientists take the initiative).

Several other questions have arisen during this episode. For example, every one of my acquaintances expresses surprise at my being afflicted with cancer. "Why you of all the people?" they ask. I have been a non-drinker, non-smoker, physically active and taking nutritious food. As a science populariser and teacher, I have often discouraged students and others from consuming things like bottled drinks, canned food and commercial ice-creams, as these contain many harmful chemicals (anti-oxidants, anti-coagulants, stabilizers, emulsifiers, colours, preservatives, etc.). Many of them may even prove to be carcinogenic. Now the situation is this: I have run into cancer though those around me routinely consuming such foods have not! So, how can I say such things now? Of course, the statistical argument is there, that it is the statistics that proves a correlation and not individual cases, and it does make sense, but people are more impressed by the immediate example before them. So, it appears that science popularisers have to be healthy in order to preach health science. I leave the readers to ponder over these matters.

Obituary

Dr. Rakesh Popli

(27 October 1952 – 15 September 2007)



Dr. Rakesh Popli, educationist and well-known science populariser breathed his last on 15 September 2007 in Jaipur. Dr. Popli's association with Vigyan Prasar began with its inception and took keen interest in Vigyan

Prasar's activities. In 1995, Dr. Popli wrote three popular astronomy books in Hindi for children. These were *Akash Darshan Ka Anand*, *Khoya Hua Janmadin* and *Rahu-Ketu Ki Khoj*. It was with Dr. Popli's initiative that Vigyan Prasar could bring out in 1998 the Hindi version of George Gamow's famous book, *One, Two, Three... Infinity*. Dr. Popli not only translated the book but also updated it. His popular account of Einstein's Theory of Relativity was brought out under the title *A Stroll Through Space-Time: A Leisurely Discourse on Einstein's Relativity Theory* in 2003 by Vigyan Prasar. The Hindi translation

of the book, done by Dr. Popli himself, will be published by Vigyan Prasar shortly.

Dr. Popli was a brilliant student. He stood first in Higher Secondary Examination (1968) in Delhi Board and was a recipient of a scholarship under the National Talent Search Scheme. After obtaining his MSc degree in physics from the Delhi University (1974), he went Purdue University, USA for further studies and from where he obtained MS (1977) and PhD degrees. His PhD thesis was on experimental nuclear physics. He started his academic career as a lecturer in the Indian Institute of Technology, Kanpur from where he moved to Birla Institute of Technology (BIT), Ranchi.

Besides his teaching responsibilities, Dr. Popli was also engaged in activities like concept learning in physics; science literacy, popular science writing and non-formal education (curriculum and training) on which he has a number of publications. His publication *Minimum Science for Everybody* (jointly with Ashok Sinha) evoked a lot of interest among science communicators and educationists. He had founded an NGO for spreading education among the disadvantaged. Spreading science and education was Dr. Popli's life's mission.

The Promise of Giant Magnetoresistance

□ Biman Basu

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The 2007 Nobel Prize in Physics has been jointly awarded to Albert Fert of France and Peter Grünberg of Germany for their discovery of giant magnetoresistance, which has already revolutionised techniques for retrieving data from computer hard disks. The hard disc drive (HDD) is one of the most important components of the modern PC; no application will run reasonably without the hard drive. Originally, induction coils were used in read-out heads of computer hard drives; they exploited the fact that a changing magnetic field induces a current through an electric coil. But this technology is totally unsuitable for reading today's shrinking hard disks. Today's magnetic head typically consists of a magnetoresistive or giant magnetoresistive reading head and a thin-film inductive write head. The discovery of giant magnetoresistance has also given a boost to the development of better magnetic sensors as well as to the development of a new generation of electronics.

What is magnetoresistance?

In a metal conductor, electricity is transported in the form of electrons which can move freely through the material. The current flows because the electrons move in a specific direction – the straighter the path of the electrons, the greater would be the conductance of the material. Electric resistance arises when electrons diverge from their straight path and scatter on hitting irregularities and impurities in the material. The more the electrons scatter, the higher is the resistance.

If the conductor is placed in a magnetic field a change in resistance is observed, which is known as

magnetoresistance (MR). The effect is attributed to a larger probability of scattering of electrons in the direction of magnetic field. If the conducting material is ferromagnetic like iron, cobalt and nickel, this property would also depend on the direction of the external field relative to the direction of the current through the conductor.

Magnetoresistance was first observed by the British physicist William Thomson (Lord Kelvin) in 1857. He



Albert Fert (left), and Peter Grünberg

discovered that the electrical resistance of iron and nickel changed in the presence of a magnetic field. He wrote: "I found that iron, when subjected to a magnetic force, acquires an increase of resistance to the conduction of electricity along, and a diminution of resistance to the conduction of electricity across, the lines of magnetisation". This difference in resistance depending on the direction of the magnetic field is called 'anisotropic magnetoresistance.'

In general, MR effects are very small, at most of the order of a few per cent. Still, the MR effect has been of substantial importance technologically, especially in the construction of read-out heads for magnetic disks and as sensors

of magnetic fields. The most useful material has been an alloy with about 20% iron and 80% nickel content called Permalloy. However, there was hardly any improvement of the performance of magnetoresistive materials since Kelvin's time and it was almost accepted that the performance of magnetic sensors based on MR cannot be improved further.

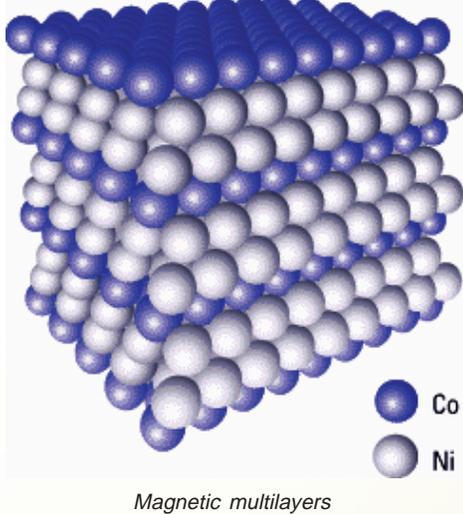
Magnetic sandwich

Then came a big surprise; in 1988 two research groups independently discovered materials that showed a very large MR, now known as 'giant magnetoresistance' (GMR). These materials, called 'magnetic multilayers', are made up of layers of ferromagnetic and non-magnetic metals stacked on each other, much like a giant multi-decker club sandwich in which individual layers are only a few atomic layers thick. In the original experiments leading to the discovery of GMR, one group, led by Peter Grünberg, used a tri-layer system Fe/Cr/Fe, while the other group, led by Albert Fert, used multilayers of the form (Fe/Cr) n where n could be as high as 60.

It is now known that MR originates from the electron spin-orbit coupling. In a magnetic material the scattering of electrons is influenced by the direction of magnetisation. The very strong connection between magnetisation and resistance that one finds in GMR arises because of the intrinsic rotation of the electron that induces a magnetic moment – the quantum mechanical property called spin – which is directed in either one of two opposite directions. In a magnetic material, most of the spins point in the same direction (in parallel).

Nano-sized structures

The stage was set for the discovery of the GMR-effect in the 1970s by the new possibilities of producing fine layers of metals on the nanometre scale. A nanometre is a billionth (10^{-9}) of a metre, and nanotechnology is concerned with layers consisting of only a few individual



Magnetic multilayers

strata of atoms. It was known that at atomic level, matter behaves differently and therefore it was expected that nanometre-sized structures would exhibit totally new material properties. And this is true not only for magnetism and electrical conductivity, but also for properties like strength or the chemical and optical qualities of a material.

It was in the mid-1980s that scientists working in the field of magnetism realised what new possibilities nanometre-sized layers might offer. Albert Fert, professor at Université Paris-Sud in Orsay and scientific director of a joint laboratory between the National Scientific Research Centre and Thales Group, and his colleagues created some 30 alternating layers of iron and chromium – composed of just a few strata of atoms each. But it was not an easy task; they had to work under near vacuum conditions and use vapours of iron and chromium at very low pressure to produce the layers by a process known as ‘epitaxy’. At almost the same time, Peter Grünberg and his group at the Jülich Research Centre in Jülich, Germany, using almost a similar technique, created a somewhat simpler system composed of just two or three layers of iron with a layer of chromium sandwiched in between.

Fert’s group registered a greater MR than Grünberg’s group, probably because the former used many more layers. The French group saw a magnetisation-dependent change of resistance of up to 50 per cent, whereas the German group was able to get only a 10 per cent difference at the most. Nonetheless the observed effects were similar and both groups realised that they had observed a totally

new phenomenon, because with traditional MR the increase was never more than one per cent. They named it ‘giant magnetoresistance’.

Better heads to read hard discs

Both the researchers were quick to realise the tremendous potential of the new discovery. Fert was the one who coined the actual concept of giant magnetoresistance to describe the new effect, and in his first publication on the topic he pointed out that the discovery could lead to important applications. Grünberg even went to the extent of filing a patent at the same time as he was writing a first scientific publication. Their optimism was not unfounded.

The discovery of GMR immediately opened the door to a wealth of new scientific and technological possibilities, including advanced techniques of data storage and magnetic sensors. Soon an industrial process using the technique of ‘sputtering’ for producing multi-layers was developed.

The first commercial GMR-head had been produced in 1997 and GMR reading-heads became standard in hard disks very soon after. A computer hard disk stores information in the form of microscopically small areas magnetised in different directions. The information is retrieved by a read-out head that scans the disk and registers the magnetic changes. But as a result of miniaturisation, hard disks have become smaller and more compact and the individual magnetic areas smaller and weaker. So more sensitive read-out heads are necessary to retrieve information packed densely on a hard disk. This is where GMR has come to the rescue. A read-out head based on the GMR effect can convert very small magnetic changes into large differences in electrical resistance and therefore into changes in the current emitted by the read-out head.

Towards a universal memory

GMR meant not only a breakthrough for reading tightly packed information from hard disks; it also paved the way for a completely new type of electronics, dubbed ‘spintronics’, which makes use of not only the electron’s electrical charge, as in traditional electronics, but also the electron’s spin. A novel application of spintronics, which has already begun to emerge, is a magnetic working memory called MRAM. Today’s computers use random access memory, or RAM, as a faster working memory to supplement the hard disk, where information is stored permanently. In its RAM the computer stores all the information it needs to be able to process information while it is

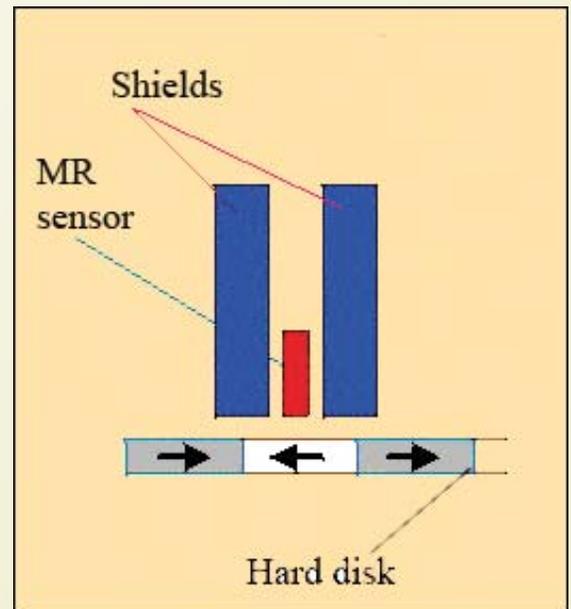


Diagram of MR reading-head of hard disks

working. But if there is a power loss or somebody switches off the computer without saving, all data stored in RAM is lost. Only by pressing the ‘save’-button can the working data be safely stored on the hard disk. In contrast, MRAM could not only be used as a working memory, as opposed to the slower hard disk, but it would also be a permanent memory, which does not depend on electric power. This means that MRAM could develop into a universal memory which would replace both the traditional RAM and the hard disk. ■

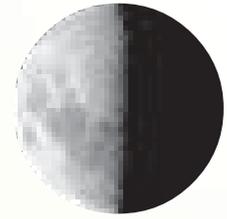
Sky Map for January 2008

Full Moon



22 January

Moon - Last Quarter



30 January

North

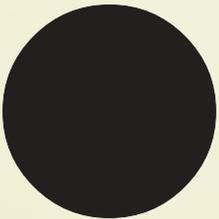
East

West



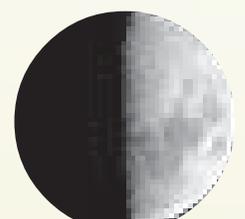
South

New Moon



8 January

Moon - First Quarter



15 January

The sky map is prepared for viewers in Nagpur (21.09° N, 79.09° E). It includes bright constellations and planets. 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 northern horizon. Similarly, for viewers 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 01 January, at 9:00 PM on 15 January and at 8 PM on 31 January.

Tips for watching the night sky :

- (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 constellations as shown in the map one by one.

Planet/Dwarf Planet Round Up:

- Mars** : In the constellation Gemini (*Meethun Rashi*) up in the zenith sky.
- Saturn** : In the constellation Leo (*Simha Rashi*) near eastern horizon.

Prominent Constellations: Given below are prominent constellations with brightest star therein (in the parenthesis). Also given are their Indian names.

Eastern Sky : Cancer, Canis Minor (Procyon), Gemini (Castor, Pollux)/*Meethun Rashi*, Hydra, Leo (Regulus)/ *Simha Rashi (Magha)*, Leo Minor, Lynx, Monoceros.

Western Sky : Andromeda, Cetus (Deneb Kaitos), Lacerta, Pegasus, Pisces / *Meen Rashi*.

Southern Sky : Canis Major (Sirius), Columba, Dorado, Eridanus, Fornax, Horologium, Lepus, Phoenix, Pictor, Puppis, Pyxis, Reticulum.

Northern Sky: Camelopardalis, Cassiopeia, Cepheus (Alderamin), Ursa Major/ *Saptarishi*, Ursa Minor (Polaris) / *Dhurva Matsya (Dhurva Tara)*.

Zenith : Aries / *Mesha Rashi*, Auriga (Capella), Orion (Betelgeuse, Rigel, Saiph), Perseus, Taurus (Aldebaran) / *Vrishabh Rashi*, Triangulum.

□ Arvind C. Ranade

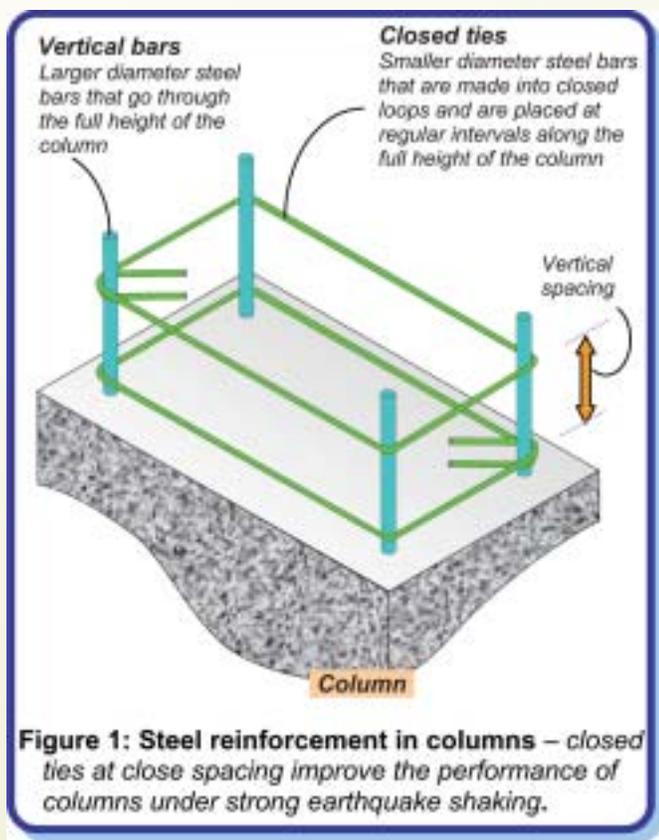
E-mail : rac@vigyanprasar.gov.in

Earthquake Tip-19

How do Columns in RC Buildings Resist Earthquakes?

Possible Earthquake Damage

Columns, the vertical members in RC buildings, contain two types of steel reinforcement, namely: (a) long straight bars (called 'longitudinal bars') placed vertically along the length, and (b) closed loops of smaller diameter steel bars (called transverse 'ties') placed horizontally at regular intervals along its full length (Figure 1). Columns can sustain two types of damage, namely 'axial-flexural' (or combined compression-bending) failure and 'shear failure'. Shear damage is brittle and must be avoided in columns by providing transverse ties at close spacing (Figure 2b).

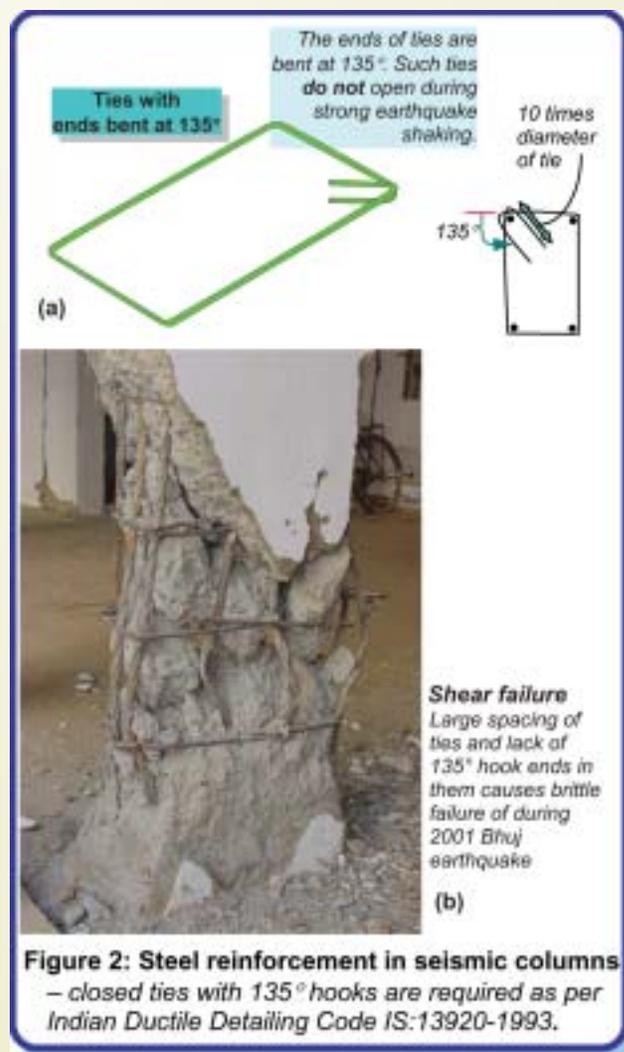


Design Strategy

Designing a column involves selection of materials to be used (*i.e.*, grades of concrete and steel bars), choosing shape and size of the cross-section, and calculating amount and distribution of steel reinforcement. The first two aspects are part of the overall design strategy of the whole building. The Indian Ductile Detailing Code IS:13920-1993 requires columns to be at least 300mm wide. A column width of up to 200mm is allowed if unsupported length is less than 4m and beam length is less than 5m. Columns that are required to resist earthquake forces must be designed to prevent shear failure by a skillful selection of reinforcement.

Vertical Bars tied together with Closed Ties

Closely spaced horizontal closed ties help in three ways, namely (i) they carry the horizontal shear forces induced by earthquakes, and thereby resist diagonal shear cracks, (ii) they hold together the vertical bars and prevent them from excessively bending outwards (in technical terms, this bending phenomenon is called buckling), and (iii) they contain the concrete in the column within the closed loops. The ends of the ties must be bent as 135° hooks (Figure 2). Such hook ends prevent opening of loops and consequently buckling of concrete and buckling of vertical bars.

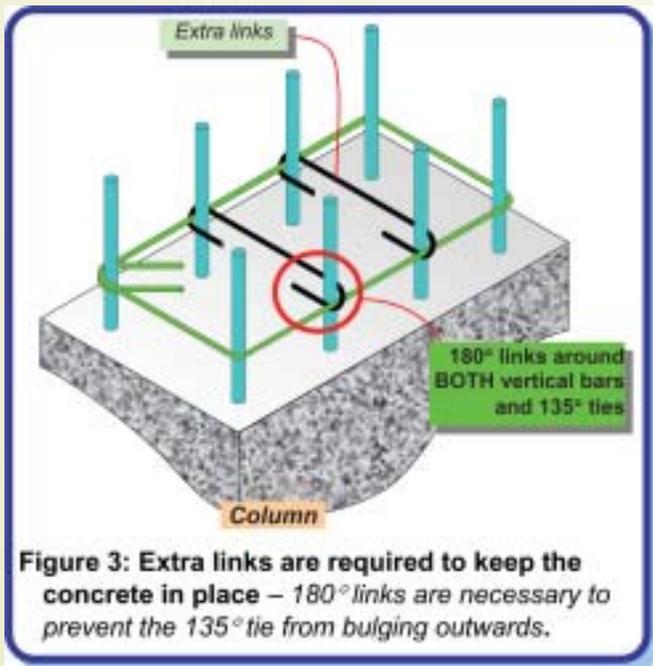


The Indian Standard IS13920-1993 prescribes following details for earthquake-resistant columns:

- (a) Closely spaced ties must be provided at the two ends of the column over a length not less than larger dimension of the column, one-sixth the column height or 450mm.

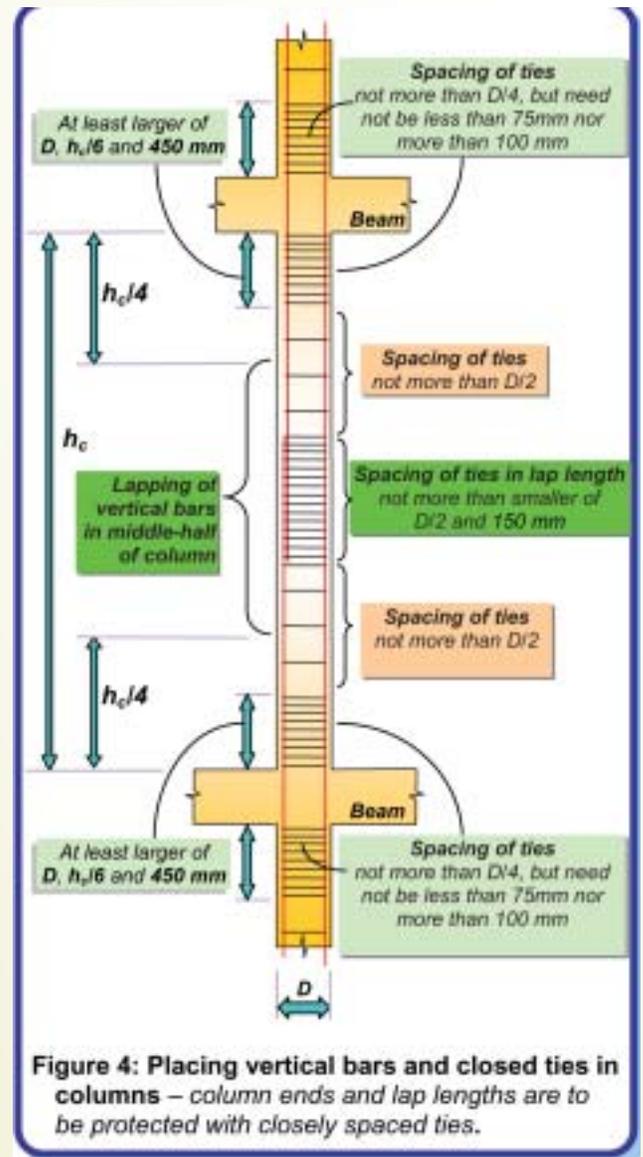
- (b) Over the distance specified in item (a) above and below a beam-column junction, the vertical spacing of ties in columns should not exceed $D/4$ for where D is the smallest dimension of the column (e.g., in a rectangular column, D is the length of the small side). This spacing need not be less than 75mm nor more than 100mm. At other locations, ties are spaced as per calculations but not more than $D/2$.
- (c) The length of tie beyond the 135° bends must be at least 10 times diameter of steel bar used to make the closed tie; this extension beyond the bend should not be less than 75mm.

Construction drawings with clear details of closed ties are helpful in the effective implementation at construction site. In columns where the spacing between the corner bars exceeds 300mm, the Indian Standard prescribes additional links with 180° hook ends for ties to be effective in holding the concrete in its place and to prevent the buckling of vertical bars. These links need to go around both vertical bars and horizontal closed ties (Figure 3); special care is required to implement this properly at site.



Lapping Vertical Bars

In the construction of RC buildings, due to the limitations in available length of bars and due to constraints in construction, there are numerous occasions when column bars have to be joined. A simple way of achieving this is by overlapping the two bars over at least a minimum specified length, called 'lap length'. The lap length depends on types of reinforcement and concrete. For ordinary situations, it is about 50 times bar diameter. Further, IS:13920-1993 prescribes that the lap length be provided ONLY in the middle half of column and not near its top or bottom ends (Figure 4). Also, only half the vertical bars in the column are to be lapped at a time in any storey. Further, when laps are provided, ties must be provided along the length of the lap at a spacing not more than 150mm.



Related IITK-bMTPC Earthquake Tip

Tip17: How do Earthquakes Affect Reinforced Concrete Buildings?

Tip18: How do Beams in RC Buildings Resist Earthquakes?

Resource Material

1. IS 13920, (1993), *Indian Standard Code of Practice for Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces*, Bureau of Indian Standards, New Delhi.
2. Paulay, T., and Priestley, M.J.N., *Seismic Design of Masonry and Reinforced Concrete Buildings*, John Wiley & Sons, USA, 1992.

Acknowledgement :

Authored by : C.V.R.Murty, Indian Institute of Technology Kanpur, Kanpur, India.

Sponsored by : Building Materials and Technology, Promotion Council, New Delhi, India

Documenting Science Writing in Oriya in the past

An initiative of Vigyan Prasar for the compilation of science writings in Oriya language during 1850 to 1950 has been launched with a preliminary

Kumar Panda, and Dr. Subodh Mahanti from Vigyan Prasar was present on the occasion. Dr. Mahanti spoke about the need for and importance of this work

academic group working with science and education, which would execute the Oriya documentation project – outlined the background information already collected, approaches proposed to be followed and the difficulties likely to be encountered. It is anticipated that locating old Oriya publications and getting copies of the relevant articles would be the main problem. It was proposed that attempt should be made to prepare a digitised public archive of all available material using the facilities and experience of Srujanika.

The participants in the meeting discussed various aspects of the work and suggested possible contacts and material sources. It was decided that the libraries/archives in Bhubaneswar and Cuttack be covered in the first phase and then materials available at other places within and outside the state would be look for. The National Library, Kolkata, and Visva Bharati have important collections of Oriya publications and need be covered for this work. After the first phase of the work a larger meeting with writes/researchers from all parts of the state would be organised to broad base the effort and to ensure greater coverage.



(From R to L) Prof. Gokulananda Mohapatra, Dr. Subodh Mahanti, Prof. Gouranga Charan Dash, Prof. Amulya Kumar Panda, Dr. Nityananda Swain, Mrs. Puspashree Pattnaik, Prof. Surya Narayan Behera, and Dr. Nikhil Mohan Pattnaik

meeting on 18 November 2007. The meeting held at Cuttack was attended by senior science writers and communicators and literary researchers, including Prof. Gokulananda Mohapatra, former Professor of Chemistry and ex-Principal, Ravenshaw College and President, Bigyan Prachar Samiti, Prof. Surya Narayan Behera, former Director Institute of Physics and ex-VC Brahmapur University, Prof. Amulya Kumar Panda, ex-Principal, Ravenshaw College, Prof. Basudev Kar, former Professor of Biochemistry, SCB Medical College and President Orissa Bigyan Academy, Dr. Nityananda Swain, former Professor of Biochemistry, SCB Medical College, Prof. Gouranga Charan Dash, Reader in Oriya, Sri Nachieketa Khamari Sharma, Senior lecturer in Physics, science communicators from 'Srujanika' – Dr. Nikhil Mohan Pattnaik, Mrs. Puspashree Pattnaik and Sri Jeeban

and displayed the books already published from such work in Hindi and Bengali languages.

Dr. Pattnaik, co-ordinator of Srujanika – a Bhubaneswar-based



Dr. Subodh Mahanti, Scientist "F", Vigyan Prasar receiving the Maghnad Saha Puraskar (Second) for his manuscript "Bhautiki Ka Itihas - Ek Jhalak" (Hindi) from Dr. T. Ramasami, Secretary, DST at Technology Bhavan on 3 December, 2007. Also seen (from L to R) Shri Anuj Sinha, Head, NCSTC and Shri K.N. Napolian, Director, (Administration), DST