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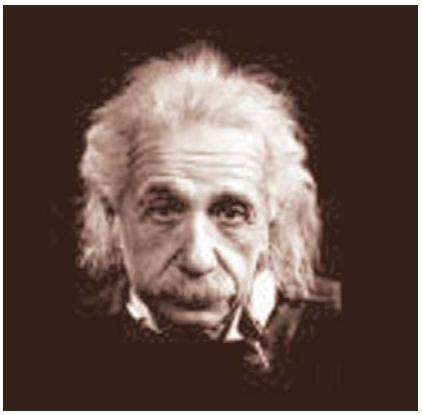
VP News

Inside

International Year of Physics – 2005 : Vigyan Prasar's initiatives

Year 2005 marks the centenary of the monumental publications of Einstein that led to a revolution in Physics. With the discovery of X-rays in 1895 followed by the discovery of radioactivity and the electron, a new era in physics began. Quantum Mechanics, describing the microworld, shook the foundations of classical physics. The decade 1895 to 1905, also witnessed invention of aeroplane and radio.



Albert Einstein

Vigyan Prasar has brought out two booklets, titled 'All motion is relative' and 'Albert Einstein' (both in English and Hindi.). Resource materials based on the articles published in *DREAM 2047* on X-rays: The Unknown Glimmer, Discovery of Radio Activity, The Discovery of the Electron, Planck and the Quantum of Energy, All Motion is Relative, Riding on Radio Waves, Bosons—The Birds that Flock and Sing Together, Raman Effect and Biographies of Physicists will be brought out for the Regional Master Resource Persons' Training Programmes, which will be conducted jointly with National Council for Science and Technology Communication (NCSTC), DST. *Story of Physics* (comic book) has been brought in colour version.

Seven video films have been commissioned. These are on: Discovery of X-Rays, Radioactivity, Radio Waves, Electron, the Theory of Relativity, Quantum Mechanics; and Invention of Radio and Aeroplane. Historical development of these path-breaking discoveries and explanation of the phenomena would be the integral part of each film. Video films on three eminent Indian physicists are also being produced. A Video film on Dr. P. C. Vaidya and Prof. A. K. Raychaudhury will be produced jointly with IUCAA, Pune. This film has already been commissioned. The other film on Dr. K. S. Krishnan will be produced jointly with Institute of Mathematical Sciences, Chennai.

A 13 part radio serial on 'Emergence of Modern Science' in English and Hindi has been commissioned. Major discoveries during the period 1895-1905 will be covered under this series. Easy to understand storylines have prepared to explain these phenomena to the general people. Multimedia presentations on topics described above are under preparation. These will be utilized for lecture demonstration and resource person training workshops. Several lectures on different topics of Physics by eminent Scientists would be organized in collaboration with National Science Centre, New Delhi.

Exhibition of posters and other software brought out by Vigyan Prasar would be organized throughout the year in collaboration with National Science Centre, New Delhi.

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

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Editor : Dr. V.B. Kamble

Science in Schools

One of the objectives of science education is to develop inventiveness and creativity along with competence. True, science education in India develops competence, but seldom encourages inventiveness and creativity. This is evident from the fact that Indian students perform very well in formal and scholastic tests, but few make it to the grade of outstanding researchers or original thinkers. It is certainly paradoxical that India has produced, and continues to produce, outstanding scientists, engineers, and doctors - yet science teaching in schools in India is in poor shape. An average science student in the country demonstrates neither inventiveness nor creativity. Yet there is a scramble for admission to science stream in schools - not because our bright girls and boys are genuinely interested in a scientific career, but because this is the path that leads to the gateway of the preferred career in medicine or engineering.

Children are naturally observant and curious, and love observing and exploring the world around them. Indeed this is what science is all about. Unfortunately these are the very traits suppressed by the way science is taught in our schools. Science and technology are progressing ever more rapidly. So is the ever increasing load of information in the school curricula! Science is presented as a mere collection of facts, laws and formulae, and figuring out how to apply them - a system that encourages rote learning rather than encouraging curiosity and exploration. With the growing importance of science and technology for the socioeconomic development of our country, it is imperative that the present system for teaching and learning science in schools be totally overhauled as a matter of utmost urgency.

Surely, teaching of science in schools is expected to foster the natural curiosity, encourage learning through observation, and teach the children to work with their hands, without burdening them with a rigorous curriculum and examinations. Incidentally, the issue of a heavy school bag and a heavy syllabus was addressed by the Yash Pal Committee in 1993 in a report entitled “Learning without Burden”. Our science education encourages students to learn the concepts by heart but never understand them! It is imperative that they are introduced to basic scientific concepts appropriate for their age through observation and simple activities. Further, there has to be continuity and coherence in the curriculum at all stages, say, from primary to upper primary, upper primary to secondary and secondary to senior secondary levels. The science courses would need to be restructured with less curriculum load and in an imaginative manner in order that they become easily comprehensible and interesting. Despite peer pressure and intense competition, children then would not experience a high level of stress pushing them into a state of depression; or as in some cases even take the extreme step of taking their own lives.

However, could restructuring of the science courses with lesser curriculum load alone be sufficient to provide scope for joy of learning, inventiveness and creativity? It is in this context that non-formal mode of education assumes significance, wherein children could undertake investigative science projects, develop innovative models / exhibits, or just tinker around with a few simple gadgets. To provide an environment for innovation, inventiveness and creativity, it would be imperative to provide a suitable forum like science clubs at schools with minimal facilities like a few simple tools, measuring instruments, and a modest library. The activities of the clubs could range from individual projects to group projects. Indeed, a variety of innovative software and teaching / learning packages and activity kits have been developed by several Government / non-Government organizations in the country that could be made available to them. However, the teachers would need to be oriented to help children do such co-curricular activities. Science clubs could be affiliated to existing national networks of science clubs and could even play a major role in communicating science and technology to the general public. Further, the children could be encouraged to participate in activities like the National Children’s Science Congress and the National Science Exhibition.

Not that there have been no conscious attempts to improve science education in schools. The National Council of Educational Research and Training (NCERT), which was set up as an autonomous organization to advise the Union and State Governments on school education policies, has played a key role in developing science curricula, syllabi and text books since the early sixties of the previous century. Till mid-seventies, a disciplinary approach for teaching of science was recommended – there were separate text books for physics, chemistry and biology. Later, science was considered as part of environmental studies at primary level, and as one composite subject at upper primary and secondary stages. In 1986, the National Policy on Education considered, for the first time, the teaching of science at secondary stage as a single subject

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Wolfgang Ernst Pauli

'The Conscience of Twentieth-Century Physics'

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"Pauli was a physicist much respected by his colleagues for his deep insight into the newly emerging quantum theory…His name is mainly linked with two substantial achievements. The first, formulated in 1924, is known as the Pauli exclusion principle…With this principle the distribution of orbital electrons at last became clear, that is, they could be explained and predicted in purely quantum terms…Pauli's second great insight was in resolving a problem in beta decay—a type of radioactivity in which electrons are emitted by the atomic nucleus."

The Oxford Dictionary of Scientists

Pauli had a caustic wit; he was not a good lecturer and he was notoriously bad as an experimentalist; but he is one of the giants of 20th-century theoretical physics.

The Cambridge Dictionary of Scientists

"Pauli was one of the great theoretical physicists of his generation. As an originator of simple yet penetrating ideas he was perhaps the greatest. He was also a man of great charm, known personally to most of his colleagues, and held in affection as well as admiration by very many—young as well as old. He attained in his later years to a position approaching that of an oracle—one quick of opinion, yet happy as well as willing to change his mind when new facts had been discovered."

Times obituary

Wolfgang Ernst Pauli was one of the most outstanding physicists of the twentieth century. In his work he was a perfectionist. He extended his rigorous criteria not only to his own work but also to the work of his friends as well. He was a great critique. This earned him the title of "Conscience of Physics". David C. Cassidy wrote: "Pauli was called "the conscience of physics" for his mastery of theoretical physics and his critical assessment of ongoing work. His review articles and books on relativity theory, statistical mechanics, and quantum physics are masterpieces of physical insight." Pauli helped to lay the foundations of the quantum theory of fields. Pauli demonstrated that a fourth quantum number called 'spin' quantum number, taking on only half-integer values, was required to describe the state of an atomic electron. However, Pauli's most significant contribution to physics was his exclusion principle, which states that no two electrons in an atom can exist in exactly same state, with the same quantum numbers. This enabled to give a clear quantum description of electron distribution within different atomic energy states. Pauli, and independently Arnold Sommerfeld, devised an atomic model that explained the electrical and thermal properties of metals. While explaining the process of radioactive beta-decay, Pauli was the first to recognize the existence of neutrino, an uncharged and almost massless particle which carries off energy in radioactive beta decay. Pauli also contributed in completing Dirac's quantum electrodynamics. His other major contributions dealt with the electric properties of metals and with the relation between spin and statistics for elementary particles.

Wolfgang Pauli

Pauli did not take much pain in publishing his ideas and results. Instead he announced them in lengthy correspondences with colleagues, with whom he had close friendships. He particularly undertook lengthy correspondences with Bohr and Heisenberg. It was not surprising that because of non-publishing, much of Pauli's work went un-credited. It was also true that the correspondences were often copied and circulated.

Wolfgang Ernst Pauli was born on April 25, 1900 to Wolfgang Joseph and Berta Camilla. In 1898, Wolfgang Joseph changed his name to Wolfgang Joseph Pauli. Wolfgang Joseph was originally a Jew but converted to a Roman Catholic. He was a qualified physician and he had earned a good name within a short span of time but later he gave up his medical practice for research in chemistry and physics and he went on to become a university professor in chemistry. Pauli's father was influenced by his friend Ernst Mach, to study science. Pauli's middle name "Ernst"

was given by his father in honour of Ernst Mach. Pauli was also greatly influenced by Mach, who also happened to be his godfather. Pauli thought that his acquaintance with Mach was 'the most important event' that happened in his intellectual life. Pauli later wrote: "Among my books there is a somewhat dusty case; it contains a silver cup made in the art nouveau style and in there is a card…written in old-fashioned, adorned letters: 'Dr. E. Mach, Professor at the University of Vienna'….[He] had kindly agreed to assume the role of my godfather …. (and) the result seems to be that I was baptized in this way to (become more) anti-metaphysical than Catholic…[That] cup…remained the symbol of *aqua permanens* (holy water), which drives away the evil metaphysical spirits."

Pieter Zeeman

Pauli completed his schooling at the Doblingen Gymnasium. He was not an ordinary student. He read Einstein's paper on relativity while still he was in the Gymnasium. He graduated from the Gymnasium in July 1918 with distinction and then joined the Ludwig-Maximilian University at Munich. He submitted his first paper on the theory of relativity within two months of leaving school. While pursuing his undergraduate studies he wrote another two papers on the theory of relativity. Among his teachers at Munich was Sommerfeld, who had great regard for extraordinary talent of Pauli. Sommerfeld asked Pauli to write a review article on relativity for the prestigious *Encyclpaedia der mathematischen Wissenschaften* (German Encyclopadia of Mathematics). Pauli completed his review article two months after receiving his PhD. The article, which ran into 233 pages, was published as a monograph. The work remains a standard reference to this day. Einstein himself appreciated the report very much. He said: "Whoever studies this mature, grandly conceived work would not believe that the author is a twenty-one year old man. One wonders what to admire most, the psychological understanding for the development of ideas, the sureness of mathematical deduction, the profound physical insight, the capacity for lucid, systematical presentation, the knowledge of the literature, the complete treatment of the subject matter, or the sureness of critical appraisal."

Arnold Sommerfeld

Heisenberg commenting on Pauli's way of life in his student days at Munich wrote: "Wolfgang was a typical night bird. He preferred the town, liked to spend evenings in some café, and would thereafter work on his physics with great intensity and great success. To Sommerfeld's dismay he would therefore rarely attend morning lectures and would not turn up until about noon."

At Munich, Pauli came in contact with Heisenberg and both became friends. They developed a life-long professional collaboration. They encouraged each other to make most significant contributions in quantum physics. They undertook an extensive correspondence and today this is an important source of history of twentieth century physics. Cassidy wrote: "Like most quantum physicists of the 1920s, Heisenberg and Pauli were products of the European upper-middle-class cultural elite. Both of their fathers were professors: Pauli's, a professor of colloid chemistry at the University of Vienna; Heisenberg's, a professor of Byzantine philology at the University of Munich. Both sons attended outstanding humanistic gymnasia (high schools), which emphasized classical languages and literature. Both were attracted to physics by the excitement attending Albert Einstein's theory of relativity, and both earned doctorates in theoretical physics with Arnold Sommerfeld in Munich. Pauli arrived at the University of Munich in 1918, two years ahead of Heisenberg. Heisenberg's early encounter with Pauli, then in his last semester, helped to turn Heisenberg toward atomic theory."

Further he continues: "Heisenberg and Pauli entered their profession at a time of great ferment. New data and analyses indicated the inadequacy of the planetary quantum model of the atom developed earlier by Bohr and Sommerfeld. At the same time, turmoil surrounding the German defeat in World War I, hyperinflation, and a boycott of German science made professional advancement difficult for young physicists." Commenting on his student days at Munich, Pauli in his Nobel Lecture, said: "I was not spared the shock which every physicist accustomed to the classical way of thinking experienced when he came to know Bohr's basic postulate of quantum theory for the first time."

Pauli was awarded PhD in 1921. In his report on the thesis Sommerfeld wrote: "…like his many already published smaller investigations and his larger Encyclopaedia article, the full command of the tools of mathematical physics."

In October 1921 Pauli was appointed as Max Born's assistant at the University of Gottingen. He spent about a year at Gottingen. It was at Gottingen, Pauli first met Niels Bohr. Recalling his first meeting with Bohr, Pauli wrote: "…a new phase of my scientific life began when I met Niels Bohr personally for the first time. This was in 1922, when he gave a series of guest lectures at Gottingen when he reported on his theoretical investigations on the periodic system of elements. During these meetings, Bohr asked me whether I could come to Copenhagen for a year." Pauli accepted Bohr's invitation and he spent one year (1922-23) at Copenhagen. "Following Bohr's invitation, I went to Cpenhagen in autumn of 1922, where I made a serious

effort to explain the so-called 'anomalous Zeeman effect', ...a type of splitting of the spectral lines in a magnetic field which is different from the normal triplet."

From Copenhagen, Pauli went to the University of Hamburg. Pauli later wrote: "Very soon after my return to the University of Hamburgh, in 1923, I gave there my inaugural lecture as privatdozent on the periodic system of elements. The contents of the lecture appeared very unsatisfactory to me, since the problem of the closing of the electronic shells had been clarified no further." In 1928, Pauli became Professor of Theoretical Physics at the Federal Institute of Technology at Zurich. Under his guidance the institute became a great centre of theoretical physics.

Ernst Mach

In 1924, Pauli proposed that a fourth quantum number is needed in quantum theory. Niels Bohr's atomic model proposed in 1913 was extended by Sommerfeld in 1915. According to the Bohr-Sommerfeld model, each electron orbiting the nucleus of an atom had three quantum numbers—principle quantum number (n), azimuthal quantum number (l), and magnetic quantum number (m). Pauli introduced a fourth quantum number, which may take numerical values +1/2 or -1/2. This was necessary to specify electron energy states. It was later found that the two values correspond to possible values of the 'spin' of the electron. The concept of spin was experimentally verified in 1926. A set of four quantum numbers could give a complete picture of the quantum states of atoms.

In 1925, Pauli introduced an additional principle, called exclusion principle, for understanding the structure of all atoms with more than one electron. According to Pauli's principle: "There cannot exist two or more equivalent electrons in the atom for which...[the values of all four] quantum numbers coincide. If the atom contains an electron for which these quantum numbers have certain values then this state is "occupied"". Thus according to this principle no two quantum states of an atom can have the same fingerprint. This principle explained why not all the electrons in an atom occupy the orbit nearest to the nucleus, where the least amount of energy is required to complete an orbit. Pauli discovered the exclusion principle as he was trying to understand the anomalous Zeeman effect, named after the Dutch Physicist, Pieter Zeeman. Pauli in his Nobel lecture, while describing how he discovered the exclusion principle, said: "The history of the discovery of the 'exclusion principle'...goes back to my student days...(It) was at the University of Munich that I was introduced by Sommerfeld to the structure of the atom—somewhat strange from the point of view of classical physics...A new phase of my scientific life began when I met Niels Bohr personally for the first time. This was in 1922, when he gave a series of guest lectures at Gottingen, in which he reported on his theoretical investigations on the Periodic System of the Elements ... Following Bohr's invitation, I went to Copenhagen in the autumn of 1922, where I made a serious effort to explain the so-called 'anomalous Zeeman effect'..."

Max Born

In 1926, Pauli used Heisenberg's matrix theory of modern quantum mechanics to derive the observed spectrum of the hydrogen atom. The result provided credence to Heisenberg's theory.

In 1927, he introduced Pauli matrices as a basis of spin operators. This solved the non-relativistic theory of spin, which in turn influenced Dirac in his discovery of the Dirac equation for the relativistic electron.

In the late 1920s it was found that when a beta particle is emitted from an atomic nucleus, invariably there was some missing energy and momentum. This was viewed as grave violation of laws of conservation. To save the situation Pauli proposed that the missing energy and momentum is carried away from the nucleus by some particle. In December 1930 Pauli proposed, in an "open letter" to Meitner and Geiger, that the beta puzzle...might be solved by introducing into the nucleus a new, neutral particle: "[There is] the possibility that there could exist in the nuclei electrically neutral particles that I wish to call neutrons, which have spin ½ and obey the exclusion principle, and additionally differ from light quanta in that they do not travel with the velocity of light: The mass of the neutron must be of the same order of magnitude as the electron mass and, in any case, not larger than 0.01 proton mass. The continuous beta-spectrum would then become understandable by the assumption that in beta-decay a neutron is emitted together with the electron, in such a way that the sum of the energies of neutron and electron is constant." Pauli did not publish his idea immediately. He first publicly defended his hypothesis at a conference in Pasadena on June 16, 1931. His announcement was reported by the *New York Times* on June 17, 1931. It wrote: "A new habitant of the heart of the atom was introduced to the world of physics today when Dr W Pauli of the Institute of Technology in Zurich, Switzerland, postulated the existence of particles which he christened "neutrons." Pauli's prediction was published in print 1933. By that time "heavy neutron" had already been discovered by Chadwick. Pauli had no clear idea about the properties of the particle. In 1934, Enrico Fermi

proposed that Pauli's particle be called a "neutrino", which is Italian for "little neutral one." Fermi also correctly stated that the particle was not a constituent of the nucleus as Pauli originally believed. Neutrinos are so small that they were almost impossible to detect with the technologies available at the time of their prediction. And years passed but scientists failed to prove their existence. The existence of the particle predicted by Pauli was finally experimentally verified in 1956.

In 194, Pauli proved the spin-statistics theorem. This theorem, an important result of quantum mechanics, states that particles with half-integer spin are fermions, while particles with integer spin are bosons.

In 1931, Pauli was awarded the Lorentz Medal in Amsterdam. Pauli was awarded the Nobel Prize in 1945 for his "…decisive contribution through his discovery in 1925 of a new law of Nature, the exclusion principle or Pauli principle." Pauli was first nominated for Nobel Prize in 1933 and continued to receive nomination for eight years but not the Prize. Finally he got the Prize in 1945 after Einstein nominated him. Einstein in a telegram sent to the Nobel Committee wrote: "Nominate Wolfgang Pauli for physics prize… [His] contribution to modern quantum theory consisting in the so-called Pauli or exclusion principle became fundamental part of modern quantum physics…."

Paul Adrien Maurice Dirac

Pauli could not be present at the Prize giving ceremony at Stockholm. However, a special ceremony was organized at Princeton on December 10, 1945. In this function I. Waller delivered a presentation speech in Pauli's absence. He said: "Pauli based his investigation on a profound analysis of the experimental and theoretical knowledge in atomic physics at the time. He found that four quantum numbers are in general needed in order to define the energy state of an electron. He then pronounced his principle, which can be expressed by saying that there cannot be more than one electron in each energy state when this state is completely defined. Three quantum numbers only can be related to the revolution of the electron round the nucleus. The necessity of a fourth quantum number proved the existence of interesting properties of the electron.

Other physicists found that these properties may be interpreted by stating that the electron has 'spin', i.e., that it behaves to some extent as if it were rapidly rotating round an axis through its centre of gravity.

Pauli showed himself that the electronic configuration is made fully intelligible by the exclusion principle, which is therefore essential for the elucidation of the characteristic physical and chemical properties of different elements. Among those important phenomena for the explanation of which the Pauli principle is indispensable, we mention the electric conductivity of metals and the magnetic properties of matter.

In 1925 and 1926 essential progress of another kind was made in the quantum theory, which is the foundation of atomic physics. New and revolutionary methods were developed for the description of the motion of particles."

At personal level Pauli suffered much. Pauli's mother committed suicide in 1927. He was much attached to his mother. This made him lonely. The situation worsened when his father remarried in the following year. He referred to his father's new wife as "the evil step-mother." His first marriage with Kathe Margarethe Deppner lasted less than year. After the divorce Pauli had a severe breakdown and resorted to drinking. Pauli consulted the psychiatrist and psycho therapist Carl Jung.

Pauli took keen interest in history and philosophy of science. Laurikainen wrote: "During the last 1-15 years of his life, Pauli spent much time studying the history and philosophy of science. His starting point was the philosophy of quantum mechanics, but this led him to psychology, the history of ideas and many other fields, not least the relation of religion of natural science."

In 1944, Pauli was appointed to the chair of theoretical physics at the Institute for Advanced Study, Princeton, New Jersey and then in 1946 he became a naturalized citizen of the United States. After the Second World War was over, Pauli returned to Zurich. Pieter Zeeman. In 1953, Pauli was elected a Fellow of the Royal Society of London. He was elected Fellow of the Swiss Physical Society, the American Physical Society, and the American Association for the Advancement of Science. In 1958, Pauli was awarded the Planck Medal.

Pauli died on December 15, 1958 in Zurich.

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Cumin

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You can't do without cumin for south Indian Sambar Podi (sambar powder) or for that matter Mexican sauces or chilli con carne, nor 'tarka' of Vegetables is conceivable in the North India without Cumin. As far away as two ends of the globe cumin is an essential spices in Latin America, South East Asia or rather world-over; though indigenous to Egypt. Tasting strong, heavy and warm with a spicy-sweet aroma and a flavour described as pungent, powerful, sharp and slightly bitter, Cumin (Cuminum cyminum) is one of the oldest spices. However frying or dry roasting modifies aroma of cumin. Cumin is widely cultivated in Europe, Asia, the Middle East, and North Africa with India and Iran as

the largest cumin exporters. The valued portion of the plant is the dried fruit called cumin seed, which is esteemed as a condiment. In ancient times cumin was a symbol of greed and meanness. Curiously, by the Middle Ages it was regarded as a symbol of faithfulness!

Origin

Cumin is native to the Levant and Upper Egypt; that is Nile valley is especially associated with Morocco, where it is extensively used. Yet propagated by Arabian traders, it now grows in most hot countries, especially India, North Africa, China and the Americas. Cumin was known to the Egyptians as early as 5000 years ago; the seeds have been found in the Pyramids; making it one of the earliest of spices to be harnessed. The Romans and the Greeks used it medicinally and cosmetically to induce a pallid complexion.

At times cumin signified greed and cupidity among the Greeks; thus the avaricious Roman Emperor, Marcus Aurelius, was nicknamed 'Cuminus' because of his avarice, and misers were jocularly said to have eaten Cumin. Cumin is mentioned in Isaiah xxvii. 25 and 27, and Matthew xxiii. 23, and in the works of Hippocrates and Dioscorides. From Pliny we learn that the ancients took the ground seed medicinally with bread, water or wine, and that it was accounted the best of condiments. The seeds of the Cumin when smoked, were found to occasion pallor of the face, whence the expression of Horace, exsangue cuminum. Kanyakumari inscriptions (c 1000 ACE) of Prakrama Pandiyan, a Tamil King, indicates that Cumin was used in preparation of a sweet dish – Paniyaram- along with fruits, sugarcane and dry ginger.

Etymology

English cumin comes from Latin cuminum, which was loaned from Greek kyminon which incidentally is akin to Old Hebrew kammon, Egyptian kamnini, Akkadian kamunu. In Tamil it is Jiragam possibly derived from the Sanskrit 'Jeera'- whose root signify "decayed, aged" (jarana, jirana , jirna). Another name for cumin in Sanskrit sugandha (well-smelling) is also used for a many of other aromatics, indicates that cumin was highly popular in ancient India. Another, more frequent Sanskrit name of cumin is ajaji.

Botany

Cumin plant is a small, slender, glabrous herbaceous annual belonging to parsley family. The plant can usually reach 25 cm while some varieties can double this height. Often the plant stalk tends to droop under its own weight. The blue-green linear leaves are finely divided and generally turned back at the ends. The upper leaves are nearly stalkless, but the lower ones have longer leaf stalks. The flowers are small, pale rose or white, in stalked umbels with only four to six rays, each of which are about 3 cm long. Cumin is grown from seed. A hot climate and sandy soil are preferred, but it can be grown under green house too. It flourishes best in sunny places with some rainfall. The seeds are normally ready for harvest four months after planting. The harvest of the plant is made as and when the seeds

turn to brown, and the stalk are threshed, cumin seeds separated thereafter dried like the other Umbelliferae. The 'seeds' (actually the fruit) come as paired or separate carpels, and are 3-6mm long. The small, boat-shaped seed have a striped pattern of nine ridges and oil canals, and are hairy, brownish in colour, tapering at each extremity, with tiny stalks attached. They resemble caraway seeds, but are lighter in colour and unlike caraway, have minute bristles hardly visible to the naked eye.

Main Constituents

The strong aromatic smell and the warm, bitterish taste of Cumin fruits are due to the presence of a volatile oil which is separated by distillation of the fruit with water, and exists in the proportion of 2 to 4 per cent. It is limpid and pale yellow in colour, and is mainly a mixture of cymol or cymene and cuminic aldehyde, or cyminol [C_3H_7-C_6H_4-CHO]. Cumin aldehyd (p-isopropyl-benzaldehyd) present in the essential oil to an extent of 25- 35 % thus gives cumin its characteristic taste, aroma and flavour. In addition perilla aldehyd, cumin alcohol, ±- and ²-pinene (21%), dipentene, p-cymene and ²-phellandrene are also found in the essential oil.

In toasted cumin fruits, a large number of flavour compounds such as pyrazines are found. Besides pyrazine and various alkyl derivatives (particularly, 2,5- and 2,6-dimethyl pyrazine), 2-alkoxy-3-alkylpyrazines (2-ethoxy-3-isopropyl pyrazine, 2-methoxy-3-sec-butyl pyrazine, 2-methoxy-3-methyl pyrazine) sulfur compound (2-methylthio-3-isopropyl pyrazine) are detected to be the key compounds.

Culinary Uses

Cumin is a most popular spice all over the world, especially in Latin America, North Africa and all over Asia, but least so in Europe, although it had been a common spice in the times of the Roman Empire. Today, cumin usage in Europe is restricted to flavouring cheese in the Netherlands and in France. This seed spice is, like coriander, an ancient Mediterranean flavor. It is popular in Morocco in kabobs and couscous, in England in mulligatawny soup, in German sausages, pickles, cakes and breads, and Dutch cheese. Cumin is grown extensively in Iran, and is used in many Persian recipes. However, the Iranian spice, black cumin, and the similar spice, nigella, are as popular in Iran, India and a few other countries, and are often confused. Black cumin is the fruit of a related plant that grows wild in Iran and the Northern Indian region of Kashmir. It is sometimes preferred to ordinary (white) cumin for Northern Indian meat kormas.

Cumin is one of the most typical spices for India, especially the Southern part. The fruits are used as a whole, and are fried or dry-roasted before usage. Legumes, especially lentils, are normally flavoured by cumin fried in butter fat. Furthermore, the seeds form an important part of sambar podi (sambaar powder), curry powder, garam masala and of the Bengali spice mixture panch phoron. Cumin is essential for the preparation of Northern Indian tandoori dishes. The usage of toasted legumes is typical for South Indian cuisine; the fragrance of roasted cumin, typically in combination with coriander, is the most characteristic impression from South Indian or Sri Lankan cuisine! In Indian recipes, cumin is frequently confused with caraway, which it resembles in appearance though not in taste, cumin being far more powerful. This is due to a misunderstanding of the Indian word jeera. The term usually means cumin, but can occasionally mean caraway (Shajira).

Other Uses

Oil of cumin is used in fragrances. Cumin resembles other similar old spices, having been advocated for many medical indications; for example cumin is considered an effective remedy for indigestion in many traditional medical practices. As a medicinal plant, cumin has been utilized as an antispasmodic, carminative, sedative, and stimulant in home remedies. Used in a poultice, it relieves swelling of the breast or the testicles. Smoked in a pipe with ghee, it is taken to relieve the hiccups, and Cumin is said to stimulates the appetite. Cumin is also used in veterinary practice, in which it is employed as a carminative. It is supposed to increase lactation and reduce nausea in pregnancy. It has been used for a very long time as traditional home remedy in the treatment of diarrhoea, dyspepsia and gastric disorders, and as an antiseptic agent; but scientific evaluation is yet to be made. Nonetheless, studies carried out suggest that cumin oil has antibacterial activity. Distinct phototoxic effects have been reported from undiluted cumin oil. Minimum inhibitory concentration studies (MIC) with isolated cuminaldehyde indicate that it is effective upon different microorganisms, including bacterial strains, yeasts and fungi suggesting that the greater part of this antimicrobial activity may be attributed to the cuminaldehyde that is present in the dried fruit of this plant.

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Indian Statistical Institute

❑ Manas Pratim Das
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It was in the early nineteen twenties that research in the theory and applications of Statistics as a new scientific discipline began in India through the pioneering initiative of Professor P.C. Mahalanobis. Soon after his return from England, Mahalanobis began to carry out statistical studies with the help of some part-time assistants. A chance meeting with Dr. Nelson Annandale (the then Director of the Zoological and Anthropological Survey of India) and subsequent interactions with him led to the first scientific paper by Mahalanobis on the statistical analysis of stature of Anglo-Indian males of Calcutta. This was followed by further research in anthropometry, in meteorology and in problems of flood control in North Bengal and Orissa. Gradually, a small group of young scientists was picked up by him to start the Statistical Laboratory, in the Department of Physics, Presidency College, Calcutta, where he was a Professor.

Indian Statistical Institute, Kolkata

Fresh developments, in this regard, took place in the early nineteen thirties. Realising the necessity of a concerted effort for the advancement of theoretical and applied statistics in India, Professor Mahalanobis together with Professor P.N.Banerjee and N.R. Sen, both of Calcutta University, convened a Meeting on 17 December 1931, to consider various steps to be undertaken for the establishment of an association for the advancement of Statistics in the country. It was unanimously resolved that the Indian Statistical Institute be established with Sir R.N. Mukherjee as President and Professor P.C. Mahalanobis as (Honorary) Secretary. The Indian Statistical Institute (ISI) was registered as a non- government and non-profit distributing learned society on 28 April 1932, under the Societies' Registration Act No. XXI of 1860.The total expenditure in the first year was a meager Rs.238.00 and the number of workers was only two or three. From such a modest beginning, the Institute grew, under the remarkable leadership of Professor Mahalanobis, into an all-India Institution. Now the Institute has its headquarters in Kolkata and two Centres at Delhi and Bangalore, and a branch at Giridih. In addition, it has a network of units of Statistical Quality Control and Operations Research (SQC-OR) Division at Baroda, Mumbai, Pune, Coimbatore, Chennai and Hyderabad.

From the very beginning, Professor Mahalanobis and his associates including Professor S.S. Bose, R.C. Bose, S.N. Roy, K.R. Nair, K. Kishan and H.C. Sinha worked with untiring enthusiasm for the development of statistical theory and applications in different areas of natural and social sciences. Sankhya, the Indian Journal of Statistics, was started in 1933 with P.C. Mahalanobis as its Editor, and received instant international recognition, which continues till today. Pioneering research activities were carried out in many areas of statistical theory, especially in the core areas of multivariate analysis, sample surveys and design of experiments. Such activities were strengthened and new directions were opened up by Professor C.R.Rao and many others who joined the Institute in the forties and the tradition continues. The Institute pioneered the development of statistical methods in agricultural research and in the conduct of large scale sample surveys. This led to a large number of high quality research publications and to the introduction of training activities offering short term courses in Statistics for officers in government departments and scientific institutions. The scientists of ISI, led by Professor Mahalanobis, helped in introducing the first postgraduate degree course in Statistics in India at the Calcutta University in 1941.

In 1937, Professor Mahalanobis started sample surveys to estimate the area under jute crop in Bengal as an exploratory work, which later grew to a full- scale survey of the entire province in 1941. At the request of the Government of Bengal in 1944, a survey of economic and social conditions in Bengal was undertaken by the Institute to assess the cause and impact of the severe famine, which had occurred in 1943.This survey yielded information of much social significance. Gradually, sample surveys of agricultural crops and other socioeconomic surveys became some of the important activities of the Institute and earned the Institute and Professor Mahalanobis international reputation. After independence, Professor Mahalanobis was appointed Honorary Statistical Adviser to the Cabinet, Government of India, and in 1950, through his initiative, the National Sample Survey (NSS) was started for conducting socio-economic surveys on a continuing basis. This was the

first ever attempt in India to have a database for various developmental programmes and the five year plans. The ISI group on sample surveys served as the Technical Wing of the NSS from 1950 until 1972 when the latter was transferred to the Government of India.

The ISI also played a pioneering role in starting the Statistical Quality Control (SQC) movement in India by organizing a visit of Professor W.A. Shewhart, the father of SQC, to India in December 1947 and later by inviting other experts like Dr. W.E. Deming, Dr. Ellis R.Ott, Dr. H.C. Tippett and Dr. Genichi Taguchi. The SQC promotional work was gradually spread all over the industrial centres in India under a comprehensive programme covering education and training, applied research and consultancy services.

Research in Economics was greatly stimulated in the Institute when in 1954 Prime Minister Jawaharlal Nehru entrusted the preparation of the draft Second Five-Year Plan of the country to Professor Mahalanobis and the Institute. The " Draft" submitted by Professor Mahalanobis and the planning models formulated by him in that connection have since been regarded as major contributions to economic planning in India. Since then many economists of the Institute have worked in different centres of the Institute on various aspects of national planning and until 1970, were directly helping the Planning Commission in the preparation of the long term perspective plans for the country. Professor Mahalanobis's participation in 1946 in the annual scientific conferences of the Milbank Foundation led to the initiation of systematic studies in India on the growth of population. It is worth mentioning here that the application of statistical techniques in many areas in Social and Natural Sciences began in the Institute in the fifties .For example, the Institute developed new statistical methodologies for the analysis of directional geological data.

The Institute, since its inception, recognized the need for development and use of accurate and fast computing equipment for the processing and analyses of data. Professor Mahalanobis strongly believed that to be a good statistician one must also learn to compute and must there fore have the best computing aids. The Institute has lived up to this tradition from the very beginning. In 1953, a small analog computer was designed and built in the Institute. In 1956, the Institute acquired a HEC-2M machine form the U.K. which was the first digital computer in India, while in 1958 a digital computer URAL was received as a gift from U.S.S.R. Since1956 till mid sixties, the Institute was de

Interview with the Director, Prof. K. B. Sinha

Prof. K.B. Sinha

Q. Starting from the day it was founded, the Indian Statistical Institute has always held a leading position among scientific institutions in India . What is the underlying reason?

Ans: Early reason is that its founder Prof. Mahalanobis was engaged in formulating some of the major plans for the development of India. He is, in fact, known as the architect of second five-year plan. In order to achieve its goal Prof. Mahalanobis created a systematic methodology of undertaking sample survey in various area of country's economic activity which ultimately culminated in the formation of National Sample Survey Organisation (NSSO). This is the aspect of the Indian Statistical Institute that went into the development activity of the country. Other aspect, less known in India, is its leading position in certain areas of academic pursuit for which it is internationally very well known.

Q. With changing times, how has ISI reoriented its curriculum and approach to research?

Ans: As a leading institute, ISI undertakes from time to time, revision of its curriculum as well as reviewing of introduction of new courses. For example, Master of Science in Quantitative Economics or M.S.Q.E., M. Tech. in Computer Science, M.Tech (QR & OR), courses in the past and B. Math and M. Math courses recently. Also, one may mention introduction of special papers like Actuarial Statisticsto enable the graduates look for jobs in the newly liberalized insurance market. In research, the philosophy in ISI has been to be very liberal i.e. the researcher decides on what he or she wants to do. This is possible because ISI do not cater to large scale experimental activity.

Q. What are the problems facing the institute?

Ans: While funding has not been a major problem facing ISI in recent times, making certain reforms like accountability in administration, teaching and research have been one. With its liberal atmosphere and reasonable funding this institute certainly can and should aspire to scale greater heights in research.

Q. What are your future plans?

Ans: Though there have been some movement towards infrastructure development in Kolkata, a lot more needs to be done. In the other campuses there have been successful implementation of infrastructure development plans. While on the one hand, industry friendly courses are being offered to cater to the needs of the industry, there have been attempts to introduce newer areas of research in existing broad disciplines. However, ISI has to make special efforts to increase its income from external sources while at the same time not lowering the standard so as to keep its premier position among research institutions in the country.

Q. Your message to budding scientists.

Ans: My message would be that if you want to do science, it is useful to have an element of romanticism with the particular area(s) of science that one is interested in and it is absolutely essential not to be afraid to pursue the goal relentlessly.

Interviewer: Manas Pratim Das

facto a national computer centre. In early sixties, the Institute, in collaboration with the Jadavpur University, undertook the design, development and fabrication of a fully transistorized digital computer, called ISIJU-1 which was commissioned in 1966 by Shri M.C. Chagla, the then Minister of Education, Government of India. The Institute has regularly upgraded its computing facilities and currently has a network of high-performance computers and a large bandwidth connection to the Internet.

As the Institute expanded, its research, teaching, training and project activities earned national and international recognition. The outstanding contributions of the Institute to theoretical and applied statistical work culminated in Prime Minister Jawaharlal Nehru piloting the bill in the Parliament leading to the Indian Statistical Institute Act of 1959, which recognized the Institute as an Institute of National Importance . By this act, the Institute was empowered to award degrees and diplomas, and the already existing teaching and training programmes were consolidated and expanded. Further more, the courses leading to the degrees of Bachelor of Statistics(B.Stat-Honours) and Master of Statistics (M.Stat) as well as Ph.D. programmes were started from June 1960. Later on, courses leading to Master of Technology degrees in Computer Science and in Quality, Reliability and Operations Research were introduced. These programmes have been eminently successful in turning out well-trained students, many of whom have gone on to attain international reputation.

The Indian Statistical Act of 1959 was amended by the Parliament in September 1995 to empower the Institute to award Degree/Diplomas not only in Statistics but also in Mathematics, Quantitative Economics, Computer Science and other such subjects related to Statistics as may be determined by the from time to time. Following the amendment, a Master of Science course in Quantitative Economics and an undergraduate course, B. Math (Honours) in Mathematics have been added to the teaching and training programmes.

The role and importance of ISI in conducting teaching and training in Statistics has been approved by international bodies as well. In 1950, the International Statistical Institute in Netherlands, jointly with the Indian Statistical Institute, initiated the International Statistical Education Centre(ISEC) at Calcutta to impart training in Theoretical and Applied Statistics to participants selected from developing countries. The centre is run by ISI jointly under the auspices of UNESCO, International Statistical Institute and the Government of India.

The Institute has always been at the forefront of research in Statistics, Probability and Mathematics, both nationally and internationally. In Computer Science, new research areas were introduced in keeping with global developments. Selected areas in natural sciences began with small groups and saw some spectacular developments like the excavation of important dinosaur fossils from the Godavari valley. This also justifies the adoption of "Unity in Diversity" as the motto of the Institute.

For a long time the Institute has been organizing international conferences and symposia, sometimes on focused topics, sometimes on a broader field. These attract participants from all over the world making those meet truly global in nature.

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Science in Schools *(contd. from page 31)*

rather than three separate disciplines. In the National Science Curriculum Framework – 2000, science and technology, rather than science alone, were introduced at upper primary and secondary stages.

NCERT is currently engaged in its periodic National Curriculum Framework Review. A review of the science education in schools has also been undertaken as part of this process to look at the ways to reform the teaching of science in schools. True, countrywide school curricular reform is a complex and difficult process since education is a subject that falls under the purview of the State Governments. The task is made even more difficult due to the fact that resistance to change is generally quite high.

There is no gainsaying the fact that better science education in schools would encourage not only competence but also inventiveness and creativity, and at the same time expose our bright children to the thrill and challenges of science. Then they will not turn away from a career in science. This would help our country transform into a nation of scientifically thinking people, equipped to make informed choices and decisions. More so in a world where stem cells, nanotechnology, genetically modified crops and Information and Communication Technology have a direct bearing on everyday life.

❒ **V. B. Kamble**

Would you like to write or translate articles for **DREAM 2047?**

Vigyan Prasar invites individuals to contribute articles (including interviews with eminent scientists and profiles of Indian scientific institutions) for publication in DREAM-2047. The articles may be accompanied by sufficient number of illustrations. The articles should be written in a language that can be understood by lay-readers. The article (both in hardcopy and electronic version) should accompany a brief write-up about the author with mailing address, phone number and e-mail ID. The articles also could be e-mailed in the MS word format. Vigyan Prasar will not be responsible for the statements and opinions expressed by the authors in their articles/write-ups published in Dream-2047. **The author will ensure that there is no copyright violation**. Unsolicited articles will not automatically ensure publication in Dream-2047. The articles will be accepted for publication based only on their merits. Vigyan Prasar's decision will be final in this regrrd.

Vigyan Prasar also invites translators for translating English articles into Hindi and vice versa. Kindly send your resume along with samples of your recent translation works.

Editor

Neck Pain

Ease the Strain

❑ Dr. Yatish Agarwal
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The human neck is an extraordinary engineering marvel. Besides supporting the all-useful head, its easy flexibility permits a vast range of movements. This moment you may be gazing at the stars, the next peering at the velvet green that covers your lawn. You can also take a lateral movement that allows you a 180-degree motion, letting you look over either shoulder.

However, this versatility has its price. Injuries, postural wrongs, mental ills, stresses and strains, aging and a host of infections and inflammations can cause severe pain in the neck during its movements, making life a terrible mess.

That is the time you think of changing your ways and joining the healthy neck club!

Do not be an ostrich : Unless you wish to call the breakdown van, be easy on your neck. Do not place the neck in a gawky, ostrich-like stretched out position or keep it tilted at an unnatural angle to one side for long periods of time. This hurts the neck and causes lasting damage. Yet most of us do so all the time. We often use the neck as a holding arm. The neck becomes a cradle for holding the telephone receiver while the hands are employed in a totally different mission. That certainly is not clever—it puts the neck under considerable strain. Similarly, while you are working at the desk unless you use a proper upwardly slanting writing table, your neck gets stretched forward, with your ears in front of your shoulders. A bowed down neck invites a definite neck strain. You would do much better by following the *munims* of yester-years, who were cleverer than you think, writing *bahi khatas* (accounts) with their necks upright.

Take a break : Certain occupations can also strain the neck. My surgeon friends have little choice—they work in a bent-over position all day long. Beauticians, hairstylists and typists work through similar, difficult routine. The solution for them lies in resting the neck from time to time and not overstraining. Care of the neck starts with this.

Rest is a wonderful balm : If you sense discomfort in the neck, know that trouble is round the corner, shoo it away by resting your neck. Housing the neck in a soft cervical collar immobilises it and gives the neck total rest. It is the best remedy for an acute condition. You should consult an orthopedic doctor or a rehabilitation expert for further help.

Take the easy option : When you suffer an acute neck pain, either you can be stubborn and refuse all medical help, or take your doctor's help and swallow the time-tested analgesic anti-inflammatory pills. It is sensible to accept the second option and not let the problem worsen as it can be handled at an earlier stage.

All analgesics with anti-inflammatory properties are good enough. You can take a choice. The ibuprofen-paracetamol combination works pretty well for me; but nimesulide (Nimulid) and diclofenac sodium (Voveran) are equally good options. Asthmatic and ulcer patients should be very careful about using these medications, because these pills can suddenly worsen their illness.

Wrap a hot towel around your neck : Moist heat is a wonderful soother. It can penetrate deep into the tissues and relax overworked neck muscles and ligaments. So dip

a towel in hot water and wrap it around your neck. The heat will penetrate deep into your tired neck muscles and ligaments and offer them relief.

Step into a hot shower : A hot shower is an equally good alternative. Just give it a try.

Invest in a cervical pillow : There is no need to throw your pillow away. Just buy a new one. A cervical pillow is customised to offer relief to your neck.

Relaxation is a ten-lettered magic word : Staying tense all day long, seven days a week, puts a lot of strain on the neck. The muscles in the neck become stiff and tire out. It bodes ill for you. Adrenaline is nobody's buddy, except in an emergency. So relax. Your neck will feel a lot easier.

Cover the neck : During winter months, keep the neck warm. Cover it adequately. Wear a muffler or turn up the collar to keep the cold wind out. Cold wind worsens stiffness and pain in the neck.

Seek a therapist's help : To maintain the neck in the pink of health, turn to a physiotherapist. She or he can tell you about the do's and don'ts of proper working posture, teach you the active exercises that can strengthen your neck muscles and ligaments and correct the periarthritis in the shoulders to put you on your way to total recovery.

During the sub-acute stage, the doctor will assist the treatment by doing therapeutic ultrasound, carrying out pressure massage on neck muscles, conducting electrotherapy, and in more stubborn cases, traction.

Stick to your exercise schedule : Devote a few minutes daily for doing neck exercises. This will help strengthen the neck muscles and preserve the function of neck joints.

Take the first lessons with a physiotherapist, and then continue at home. For your ready reference, here is what you need to do:

Take a normal upright position : Either stand or sit upright. Position one hand on top of the other and place them over your forehead. Now push your head forward against the heel of your hand and simultaneously block this movement by applying an equal, backward force through the heel of the hand. Hold to a count of ten. Relax. Repeat five to ten times.

Next, place your hands behind your head and clasp them across. Now, push your head backwards, but resist equally with your hands, not allowing any change in position. If you do it right, you can feel the muscles tighten. Hold it this way to a count of ten. Relax. And then repeat five to ten times.

Repeat the same sequence of movements sideward. First, after placing the heel of your left hand on the left side of your head and then, by placing the right hand on the right side of your head.

Recent Developments in Science & Technology

Trial of AIDS Vaccine

Trial of AIDS Vaccine on human has begun in India to prevent the HIV infection and AIDS. This first preventive AIDS vaccine trial is being conducted at the Pune based National AIDS Research Institute and if successful a vaccine against the disease would be available within eight years. The trial is being carried out by the Indian Council of Medical Research and National AIDS Control Organisation.

Trial involve testing a vaccine named "tgAACO9(rAAV - recombinant adeno –associated viral vector). Targeted Genetics Corp, a Seattle based company and Columbus Children Research Institute in Ohio have designed the vaccine in partnership with IAVI.

The phase-I vaccine trial is the first stage of human testing and the primary purpose is to evaluate safety. The trial will take roughly 15 months to complete and will enroll 30 volunteers men and women who are in good health and not infected with HIV.

The vaccine showed encouraging results in animal, protecting some of them from developing AIDS after they became infected with an HIV-like virus.

Source : PTI News

Another Research Station in Antarctica

India has announced that another station would be setup in the Antarctica to address the geopolitical, economics and scientific needs to country more effectively. The new station is expected to be ready by 2007.

The station is expected to be helpful in the economic growth of the country as it will be in a place that is known to have rich potential in terms of hydrocarbon and other important metals such as platinum, nickel, cobalt. The establishment of new station would help in better understanding of the Indian weather especially the monsoon. Scientists have already been working on the issue from the existing station Maitri. The new station would help in their studies and research.

Source: PTI, News

'Bionic eye' may help reverse blindness

A "bionic eye" may one day help blind people see again, according to US researchers who have successfully tested the system in rats.

The eye implant - a 3-millimetre-wide chip that would fit behind the retina - could be a dramatic step above currently available technology, says the team at Stanford University, California, US.

About 1.5 million people worldwide have a disease called retinitis pigmentosa, and 700,000 people in the western world are diagnosed with age-related macular degeneration each year. In both degenerative diseases, retinal cells at the back of the eye that process light gradually die.

Groups at the University of Southern California and the University of Illinois at Chicago Medical Center, both in the US, have developed retinal implants for humans to improve these conditions..

A visual acuity of 20/20 is considered normal, while 20/400 is considered blind. Palanker and his team say their device could provide acuity of 20/80. With 20/80 vision human can certainly read large forms and live independently.

Source: Newscientist.com

Researchers Use X-Rays to 'See' Fingerprints

Television shows such as *CID* dramatize the work of forensic investigators and glamorize their high-tech toys that help catch criminals. Now real-life criminologists might soon be adding a new weapon to their crime-fighting arsenal: a visualization technique for spotting fingerprints that uses x-ray vision. Results of early tests of the novel approach will be unveiled at the annual meeting of the American Chemical Society meeting in San Diego.

In the standard approach to lifting fingerprints from a crime scene, known as contrast enhancement, a sample is treated with a substance—either vapor, liquid or powder—that adds color to a fingerprint and allows it to stand out from its background. Prints left on such surfaces as leather, plastic or fibrous textiles, can sometimes be difficult to detect, however. The technique developed by Chris Worley of the Los Alamos National Laboratory and his colleagues is a noninvasive one that relies on a process known as micro-x-ray fluorescence (MXRF). When a surface is exposed to a thin beam of x-rays, the MXRF instrument detects elements such as sodium, potassium and chlorine, which are present as salts in human sweat. Because the salts are deposited along the ridges present in a fingerprint, the fluorescence can be used to assemble a digital image of a print. "This process represents a valuable new tool for forensic investigators that could allow them to nondestructively detect prints on surfaces that might otherwise be undetectable by conventional methods.

Source: Scientificamerican.com

Compiled by : Kapil Tripathi

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Besides being an activity package, the kit is also useful for training programmes on Earthquake awareness. A comprehensive book entitled “Earthquake” also accompanies the kit. The Kit is available both in English and Hindi. The cost of this kit is Rs. 100/- plus Rs. 50/- postal charges. For more details write to the: **Director, Vigyan Prasar, C-24, Qutab Insitutional Area, New Delhi 110 016**

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