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VP News

Vigyan Prasar and National Science Day 2003

Befitting the National Science Day, Vigyan Prasar released an activity kit on 'Understanding Earthquakes', an album in words and pictures on Yellapragada SubbaRow and commenced regular broadcast over WorldSpace Satellite Digital Radio. Both the books and Activity Kit were released by Shri Bachi Singh Rawat, the Hon'ble Minster of State (S&T) in the presence of Professor Murli Manohar Joshi, the Hon'ble Union Minster S&T, HRD and Ocean Development. Present on the occasion were Prof V S Ramamurthy, Secretary Department of Science and Technology, Dr. Manju Sharma, Secretary, Department of Biotechnology, and Dr. Seyed E. Hasnain, Director, Centre for DNA Finger Printing and Diagnostic, Hyderabad.

Realizing that Earthquakes cannot be avoided, but preparedness can protect us, Vigyan Prasar has brought out an activity kit '**Understanding Earthquakes - An Activity Kit'**. This kit is useful to students and the people to learn about the basic concepts of Earthquake and related aspects. Well illustrated and deftly scripted by Raji Narasimhan and designed by Narendra Srivasatava, **Yellapragada SubbaRow, A Life in Quest of Panacea-An album in words and pictures-** is a moving saga of an Indian scientist, who against all odds, went on to discover folic acid vitamins, antibiotics like tetracycline, anti-filarial and anti-cancer drugs.

Inside

Editorial

Shri Bachi Singh Rawat, the Hon'ble Minister of State (S&T) releasing the book, Yellapragada SubbaRow: A Life in Quest of Panacea

Radio Broadcast on Science Communication for the benefit of students and teachers commenced from February 28, 2003, National Science Day, on **WorldSpace Digital Satellite Radio**. VP will broadcast the 110 Episodes of the science serial "Manav Ka Vikas" (Human Evolution) on WorldSpace channel "EQUALACCESS" both in English and Hindi, which will also include five minutes of science news/snippets on topics of current interest. The timings will be 1200 hrs to 1230 hrs and 1500 hrs to 1530 hrs, Monday to Saturday. If an episode is broadcast in English, say at 1200 hrs, the same episode will be broadcast in Hindi at 1500 hrs. A repeat broadcast of the episode would take place the following day with timings reversed (i.e. Hindi 1200-1230 hrs and English 1500-1530 hrs) for the benefit of those who missed it on the first count. Fifty VIPNET clubs to which Vigyan Prasar has provided the Digital Radio receiver on an experimental basis are listening to the broadcast and feedback is collected from them for improvement and enhancement of the digital radio broadcast.

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

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CMYK

The Road to Space

It is said that road to success is littered with ups and downs, and the road to space is littered with debris. Indeed, every nation venturing out in space has had its share of calamities. There have been some 59 failed space missions since 1990 involving launch vehicles and satellites, including two of India. However, the loss is much too poignant when the precious human lives are lost. In the 41 year history of the manned space flight, 21 lives have been lost. Three astronauts of Apollo 1 crew were killed during launch pad fire in 1967. A Soyuz 1 cosmonaut was killed on landing after 26-hour flight only a few months later. The Soyuz 11 crew of three cosmonauts was found dead in 1971 at the end of the mission. The entire crew of seven astronauts of the space shuttle Challenger was killed when it broke up barely a minute after the launch in 1986. And on 1 February, 2003 the crew of seven astronauts of the space shuttle Columbia was lost when it exploded on re-entry when they were only sixteen minutes from home - so near and yet so far! One of them was Kalpana Chawla, who dreamed stars, but did not return home. Like Seneca, she thought "the whole Universe is my native land."

Indeed, the space shuttle is the most complex space vehicle built till date. It blasts off like a rocket, flies like an aircraft, and lands like a glider. It is different from the space vehicles like Saturn rockets used for Apollo missions, Ariane, PSLV or GSLV, whose spent stages fall into the sea after blast-off and cannot be used again. On the other hand, the shuttle can fly hundreds of times. This is why it is called the Space Transport System (STS).

The STS-107, Columbia, blew up as it returned to Earth after a successful mission. Incidentally, it was the oldest of space shuttles flying its maiden mission in 1981 and affectionately nicknamed The Old Gray Lady. Its crew included, among others, an Afro-Asian, an Israeli, and the Haryana-born Kalpana Chawla. (Her early dreams of flight were inspired by JRD Tata). The theme of STS-107 was Space Research and You. It carried some 80 experiments designed to help us learn how to tackle practical, everyday problems on Earth for common benefit. Some of the experiments included the study of change in metabolism, hormone levels, and the reaction of the human body in microgravity, how heart and lungs function in space, flow of blood and body fluids in weightlessness, and macromolecular protein crystal growth. An interesting experiment Kalpana did was to examine the use of fine water mists to extinguish fire. The losses include the extremely valuable data from these scientific experiments. Indeed, Columbia crew had successfully completed its task, and that is why its tragic end has been even more poignant.

Although it is still not clear what caused Columbia's fiery descent, but it is likely that the heat shield was breached on the left wing. It is even possible that impact by space debris could have damaged the heat shield tiles. Was it an inherent structural defect? Or was it due to the heat resistant tiles having suffered damage during take-off? Until the exact cause of the accident is determined, the further STS missions have been suspended, and a hard look at the other three shuttles, namely, Endeavour, Atlantis and Discovery has become necessary. The suspension of the shuttle flights has adversely affected the half-constructed International Space Station (ISS) that has been orbiting the Earth since 1998, a project in which as many as 16 countries are involved. This would imply delays in completing the structure. Of course, the three astronauts aboard ISS do have adequate supplies for a few months. They also have an escape vehicle to get away in case of emergency. Further, despite Columbia disaster, Russia has gone ahead with its scheduled launch of an unmanned re-supply vessel to ISS.

Incidentally, Columbia was Kalpana's home on her earlier space odyssey as well in 1997 (STS-87). The mission then focused on experiments designed to study how the weightless environment of space affects various physical processes, and on observations of the Sun's outer atmospheric layers. Her specific job then was to release the Spartan satellite to study the Sun. She was the first woman to earn an aeronautical degree Punjab Engineering College 1982, Master of science in aerospace engineering from University of Texas, 1984, and Doctorate of philosophy in aerospace engineering from University of Colorado, 1988. Indeed, it was against all odds that she was chosen as an astronaut in 1994.

Let us realize that all explorations are perilous – whether in space or on Earth. Kalpana and her colleagues worked in peace and harmony several hundred kilometers away from the Earth. Their goal was universal peace and progress of humankind. We need to embark on their path on the ground beneath us as well, if we are to survive. This requires a dream, vision and courage. Kalpana said in an e-mail from Columbia to children of her former school in Karnal: "The path from dreams to success does exist. May you have the vision to find it, the courage to get on to it, and the perseverance to follow it. Wishing you great journey."

❒ **V. B. Kamble**

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Sisir Kumar Mitra

A Pioneer in Radio Physics

❒ **Subodh Mahanti**

> Sisir Kumar Mitra's decision to change over to radio research was undoubtedly a bold one. Radio was then a new born science still in its teething stage. It had not found place in the curriculum of any of the Indian universities, not to speak of research facilities in the subject. Mitra recognized this difficulty but was not deterred.
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> *J.N. Bhar in Biographical Memoirs of Fellows of the National Institute of Sciences of India, Vol.1, 1966*

Sisir Kumar Mitra is the doyen of radio science in India. He is known for his seminal work on ionosphere. The ionosphere, that extends from about 60 km to several hundreds of kilometres high in the atmosphere, plays a major role in long distance radio communications. The air in the ionosphere is ionized. The name 'ionosphere' was proposed by Robert Alexander Watson Watt, (1892-1973), a British engineer. The first experimental evidence for the existence of ionosphere was provided by Edward Victor Appleton (1892-1965) and Samuel Jackson Barnett (1873-1956) in 1925. The ionosphere has been characterized by different layers like F, E, D, and C in order of decreasing altitude. The existence of E-layer was first predicted by Oliver Heaviside (1850-1925) and Arthur Edwin Kennelly (1861-1939) and the F-layer was discovered by Appleton. The first experimental evidence of E-region of the ionosphere was obtained by Mitra and his coworkers in 1930. Mitra and his co-worker P Syam announced the reception of regular echoes from heights around 55 km and they called it D-layer, the existence of which was originally reported by Appleton in 1928. Mitra's group detected echoes from as low as 20 km. The very low level reflections were believed to come from a hitherto unsuspected layer. Mitra called this layer C-layer. One of the most important works of Mitra was his explanation for the Appleton ionization anomaly.


Sisir Kumar Mitra

Mitra introduced 'wireless' to the post-graduate course in physics at the Calcutta University. This marked the beginning of radio science teaching in India. He established a strong ionospheric research school at Calcutta. It was under Mitra's leadership a full-fledged Department of Radio Physics and Electronics was created in the Calcutta University. This was the first teaching and research department in India in Radio Physics, which later became the Institute of Radio Physics and Electronics. India's first entry into organized international scientific research was made possible by Mitra, when his laboratory participated in the second international polar year (IPY2-1932), for specific investigations on different aspects of the ionosphere. He established the first ionospheric field station at Haringhata, about 45 km north of Kolkata (then Calcutta) for ionospheric investigations in 1950. Mitra played a pioneering role in radio broadcasting in India.

To his students, Mira was a great source of inspiration. He used to emphasise that only with sustained efforts one can be successful as a researcher. He was against the concept of rigidly specified task and he never exercised rigid control over his research students. He believed that one could be a successful teacher in higher education only if one had oneself made some contribution to the subject.

Sisir Kumar Mitra was born in Kolkata on 24 October 1890. His parental home was at Konnagar in Hoogly district. His father Joykrishna Mitra was a school teacher. Joykrishna married Saratkumari, who came from a Brahmo family, in 1878 against the wishes of his parents. As a result he was disinherited from his parental property and he had to leave his parental house. The newly married couple moved to Midnapur, the hometown of Saratkumari, where they lived about a decade. In 1889, they moved to Kolkata, where Joykrishna started teaching in a school. At the time of Sisir Kumar's birth, his mother was a student in the Campbell Medical School. After passing the final examination in 1892, Saratkumari got an appointment in Lady Dufferin Medical Hospital in Bhagalpore in Bihar and the whole family moved there. Joykrishna also managed to get an appointment as clerk in the local municipal office.

Mitra started his school education in the Bhagalpore Zilla (District) School. After passing the entrance examination from the Zilla School Mitra joined the T.N.J. College, Bhagalpore, from where he passed his FA Examination. He returned to Kolkata in 1908 to join the Presidency College as a B.Sc. student where he came into contact with J.C. Bose and P.C. Ray, the two pioneers of modern scientific research in India. He used to be fascinated by instruments designed and constructed by J.C. Bose for studying the properties of microwave and to detect various responses of plants. In 1912, he passed out of Presidency College taking his M.Sc. degree in physics and topping the list of successful candidates.

The environment of the Presidency College had a strong influence on Mitra. He had made up his mind to dedicate himself to scientific research. And he also got an opportunity to work under Jagadis Chandra Bose in the Presidency College immediately after his MSc results were out. In those days it was not easy to get a research fellowship. His widowed mother, who was supporting his education at Kolkata, badly needed some financial help to run the family. Her own income was not sufficient. So when Mitra got an appointment as Lecturer in the T. N. J. College at Bhagalpore, from where he passed his FA Examination, he left Kolkata to join the same. From Bhagalpore he shifted to Bankura in West Bengal on being appointed a lecturer in the Christian College. He spent four years teaching in colleges but at the same time harbored a burning desire in his mind to pursue a research career. Of course, there was no scope for carrying out researches in these *mufassil* colleges. But then a person like Mitra could not sit idle. So he started devising ingenuous demonstration experiments with whatever he could collect from the impoverished college laboratory, for illustrating his class lectures. He also started writing popular science articles in Bengali.


Robert Alexander Watson Watt

Mitra finally got an opportunity to realize his dream of carrying out research. While Mitra was teaching in College, Sir Asutosh Mookerjee, the then Vice-Chancellor of the Calcutta University was trying to initiate postgraduate teaching and research in science. With the untiring efforts of Sir Asutosh, the University College of Science was established in 1916. Mitra was one among those who were invited by Mookerjee to join the newly created Department of Physics in the newly created University college of Science. Mitra, who was then twent-six years old, joined the Department as Lecturer. This marked the beginning of Mitra's outstanding scientific career. C. V. Raman joined the Department as Palit Professor. Mitra started working under Raman's guidance on interference and diffraction of light. Mitra worked in the laboratory of C.V. Raman in the Indian Association for the Cultivation of Science. It took him only three years to complete his doctorate thesis which enabled him to get a D.Sc. from Calcutta University in 1919.

In 1920 Mitra went to the University of Sorbonne in Paris where he joined the research group of Charles Fabry (1867-1945), who had discovered ozone in the upper atmosphere in 1913. At Fabry's Laboratory Mitra worked on the determination of wavelength standards in the region 2000-2300 angstrom of the copper spectrum. Based on this work he got his second doctorate in 1923. From Sorbonne he went to work under Marie Curie at the Institute of Radium. However, he did not stay there long. He went to work with Prof. Gutton, who was working on radio valve circuits in the Institute of Physics at the Universtiy of Nancy, Paris. Though he spent only a few months at Gutton's Laboratory but it was here that he finally made up his mind to make his career in radio research.


Edward Victor Appleton

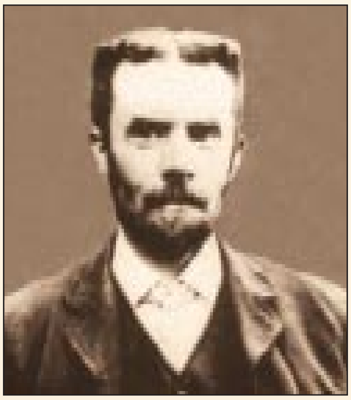
Why did he choose to shift to radio research though he was successful in spectroscopic research? "May be", as J. N. Bhar wrote, "he had been so deeply influenced by Bose's experiment on wireless waves that a desire for doing research in this line lay hidden in his subconscious mind". It may be noted that Mitra witnessed Bose's experiments when he was a student in Presidency College. Whatever might be the reason it was certainly a bold decision. When Mitra took his decision to pursue a career in radio science, it was still in its infancy. Radio science was not a part of the curriculum of any university in India and so there was no question of availability of any research facility in the subject. Without being deterred by these obstacles he wrote to Sir Asutosh Mookerjee about his decision. Sir Asutosh in his reply dated 10th May 1923 wrote: "I am glad to receive your letter dated 18th April and to hear that you have been so successful in your work. The course of investigation you suggest as to signals by wireless telegraphy is very attractive. Do please draw up a scheme and make it as inexpensive as possible. I shall see what we can do. But you must rest assured that there will be plenty of opposition. That need not frighten us; we shall have to fight our way through."

Mitra returned from France at the end of 1923 and he was appointed Khaira Professor of Physics. He became a part of the team consisting of C. V. Raman, D. M. Bose and others who organised the post-graduate teaching in physics in the Calcutta University. Mitra's task was to establish the 'wireless section' for teaching and carrying out research in the new subject. With the active support of Sir Asutosh Mookerjee, Mitra was able to start for the first time postgraduate teaching and research on wireless in India.

To have an understanding of the significance of Mitra's work one should have an idea of ionosphere and what was the status of its understanding when Mitra started his work. The presence of ionosphere is vital for long distance radio communication. Ionosphere is a region of the upper atmosphere that reflects short radio waves enabling transmission to be made round the curved surface of the earth by sky waves. All regions of our atmosphere are defined in terms of ionization, temperature and composition. The region which extends form 60 km to several thousand kilometers above the earth is called ionosphere. The existence of an ionized layer in the atmosphere or the ionosphere was first suspected in 1882 by the Scottish physicist Balfour Stewart. He proposed the existence of a layer of air capable of conducting electricity in the upper atmosphere, and whose presence, Stewart thought, was the reason for the continuous minor variation in Earth's magnetic field. However, Stewart's prediction remained mostly unnoticed till 1901 when Guglielmo Marconi (1874-1937) succeeded transmitting wireless signals across the Atlantic Ocean, a distance of about 2800 kilometres. For physicists this was an unexpected achievement. Because like light, radio waves also travel in straight lines and so their detection on the earth's surface should not be possible beyond the line of sight.

To explain the propagation of radio waves the existence of an electrically conducting air layer, as proposed by Stewart, was again invoked. This was in 1902. And this time this was proposed independently by Oliver Heavside and Arthur Kennelly. They proposed that such a layer situating about at a height of 80 km in the atmosphere would act as a repeater station by reflecting radio waves at a considerable distance beyond the horizon. The proposed layer came to be known as Kennelly-Heaveside layer, the existence of which was experimentally proved in 1924 by Edward V. Appleton and Samuel Jackson Barnett. They devised two alternative methods –the angle of incidence method and the frequency change method — to determine experimentally the location of the ionized layer which vary in behavior with the position of the sun and with sunspot cycle.

G. Breit and M. A. Tuve in the United States devised a technique for determining the height of the reflecting region. Radio waves travel with the speed of light. Thus the height of the reflecting region can be caculated if one can measure the time taken by the transmitted radio waves back to the earth. Breit and Tuve transmitted a short pulse of radio waves upward and then they determined the time taken for the pulse to be reflected back to the receiver, a few kilometers away, by means of an oscilloscope. In this way they found the altitude of the Kennely-Heaviside layer in the range of 80-100km.


Oliver Heaviside

Appleton, in the course of his investigation with radio waves of shorter wavelengths, another reflecting layer at the height of roughly 200 to 400 km. This layer was called Appleton layer. The names of these two layer were changed by Appleton as E (Kennelly-Heaveside layer) and F (Appleton layer) layers. This is the nomenclature now universally followed. Subsequently another layer, a layer below the E layer, was discovered. This layer was called D-layer. The D-layer which is located between 50 and 90 km altitude disappears during the day. The F-layer splits into two different regions, namely F1 and F2. The F1 region which exists only in daytime, has a peak density around 200km. In the F2 region, the altitude of the peak density occurs at about 300km in daytime and it shifts to higher altitude in the night. The E-region is between 90 and 160 km and the F-region (sometimes called the Appleton layer) is from 160 km up to about 400 km. These early experiments carried out by Appleton and his co-workers attracted the attention of Mitra and he decided to conduct similar investigations in his newly established laboratory. He could motivate a small team of young and enthusiastic scientists to take up this challenging work.


Arthur Adwin Kennely

Mitra's group could measure the heights of the different layers of the ionosphere by an instrument designed and built indigenously. The investigations carried out by Mitra's laboratory not only provided the first general picture of the ionospheric condition in a sub-tropical region of low altitude like Calcutta but experimental results obtained by Mitra and his coworkers also threw considerable light on the effect of thunderstorm, magnetic storm and meteoric shower on upper atmospheric ionization. Mitra also gave a theory of the D-layer which was first reported by Appleton in 1928. D-layer is an absorbing layer formed during the daytime just below the E-layer, the echo from this layer is only occasionally observed. Mitra and his co-workers conclusively established the existence of this layer. The experimental evidence for the E-layer of the ionosphere was obtained for the first time by Mitra's group. H. Rakshit working under Mitra developed the first indigenous equipment for ionospheric studies by the angle of incidence method. The Calcutta Station of the Indian State Brodcasting Service made available its medium wave transmitter to Mitra's group. They often broadcast transmissions outside regular programme period. Utilising these facilities Mitra's group experimentally proved the existence of the E-layer.

Mitra's group detected reflections from as low as as 20 km. Mitra proposed that such low-level reflections were coming from a hitherto unsuspected layer. Mitra called this layer C-layer. At the beginning the discovery was received with certain amount of skepticism by the western scientists, but later it was corroborated by many observers in England and America. The echoes originating from such a low layer may be due to reflection from the temperature discontinuities and from moisture layer in the lower atmosphere.

While developing teaching and research facilities at the Calcutta University Mitra got involved in the development of broadcasting in India. A private company called the Indian States and Eastern Agency had installed the country's first broadcast transmitter in Kolkata in 1923. The Radio Club of Bengal, a registered society, under the Chairmanship of J.R. Stapleton, published a journal called "Radio" for creating interest in this newly found subject by providing relevant information. In 1926, before the establishment of the Indian Broadcasting Company in 1927, Radio Club's transmitters at Dalhousie Square broadcast regular programme every evening. Mitra and his coworkers constructed another transmitter and installed in the newly established Wireless Laboratory in the University College of Science in Calcutta. Its call sign was 2 CZ. It is worthwhile to note that there was a time when Mitra's transmitter in his Wireless Laboratory and the Radio club's transmitter at Dalhousie Square were the only ones broadcasting regular programme in the Eastern region of India.

The wireless laboratory established by Mitra started working on the measurement of the atmospherics and for this purpose a huge aerial connected to a valve amplifier and an automatic recording devise was set up.

With the financial assistance from the Council of Scientific and Industrial Research, Mitra established a field station for ionospheric work at Haringhata- a village about 50 km from Calcutta following a suitable capital and recurring grant sanctioned by the council of Scientific and Industrial Research in 1949. An ionosounde, donated by the Commonwealth Scientific and Industrial Research Organization of Australia was installed in the station. This was the first ionosphere field station of its kind in India. In 1955, the station started round the clock observations of the ionosphered.

Mitra's well-know treatise, *The Upper Atmosphere,* was his major scientific contribution. The idea of writing such a book arose in Mitra's mind in 1935. In that year the National Institute of Sciences of India (later renamed as Indian National Science Academy) organised a symposium on ionosphere. Mitra was invited to open the symposium, which was held in August 1935. His opening address was titled 'Report on the Present State of our Knowledge of the Ionosphere'. The Report, which was a comprehensive account of the existing information on the ionosphere, was welcomed by scientists working on ionosphere all over the world. This prompted Mitra to think of writing a treatise on the upper atmosphere, of which the ionosphere was only a part. It took ten years to finalise the manuscript. This was the 'First heroic attempt', as Sir Edward Appleton remarked, to put together in one volume the results of investigations in many different fields all concerned directly or indirectly with the upper atmosphere. It is worthwhile to quote here A. P. Mitra, one of Sisir Kumar Mitra's illustrious students on the significance of *The Upper Atmosphere*. A. P. Mitra wrote: "The *Upper Atmosphere* was a milestone in atmospheric science. It considered for the first time the atmospheric environment as a whole, neutral and ionized, its thermal structure and distribution of constituents, its motions, the interaction of solar radiation and particle stream with these gaseous constituents, and the mechanism of airglow. The ionosphere was treated as only a part of this vast panorama that interlinked the Sun, the Earth and the atmosphere. This was then an entirely new concept. Secondly, deviating from the then existing practice of studying the ionosphere from the point of view of propagation of radio waves, Mitra viewed the exploring radio waves as a remote sensing tool, sensing levels which could not be reached with balloons and were only beginning to be explored by rockets...Even in this vastly changed (and greatly expanded) canvas, much of the information given in *The Upper Atmosphere* and the results of his scientific investigation stand as benchmarks. " There were other books of high repute on ionosphere like S. Champan and D J Bartel's *Geomagnetism* and J.A. Fleming's *Terrestrial Magnetism and Electricity*, but they dealt with specialized topics. So Mitra's book became indispensable as a reference book for all those who were interested in upper atmospheric research. However, the publication of the treatise was not a smooth affair. Mitra and his colleagues who worked very hard to finalise the manuscript wanted to get it published by a reputed foreign publisher. Accordingly Mitra wrote to a few reputed publishers giving the list of contents. But none came forward to undertake its publication. It is interesting to quote the letter that he got from one of the publishers rejecting his manuscript. The publishers wrote: "We have given very careful consideration to your letter of May 16th. Your name, of course, is well-known to us, and we naturally are assured that your treatise on the Upper Atmosphere is an admirable work. We are sorry to say, however, that for various reasons we do not think it would be a practicable proposition for us to undertake its publication.

In the first place, from what you say, it is a very large book and would be extremely expensive to produce even in India. Of course, it would be better to have it printed in this country, but that would be even more expensive. From previous experience of books of this nature we feel very doubtful whether it would have a large enough sale to cover the expense of publication; in fact we anticipate that it would involve us in a considerable financial loss.

Books of this kind really ought to be published by the University Presses who exist largely in order to publish learned works whose appeal is very limited. A further consideration is that even in the small field covered by your book it would have to compete with Chapman & Bartel's *Geomagnetism* and works by Sir Napier Shaw.

On the whole, therefore, we are very sorry to say that we can only thank you and regret that we feel unable to publish the work. We are returning the list of contents which you kindly sent us."

There is no wonder that such a reception from the publishers disappointed Mitra and his groups. At this juncture Meghnad Saha came in their rescue. At that time Saha was the President of the Asiatic Society of Bengal. Saha decided that the Asiatic Society would undertake the publication of the Mitra's manuscript, however costly the publication might be. Thus the Asiatic Society undertook its publication as one of its Memoirs and the first edition of *The Upper Atmosphere* came out in 1947. The book was widely appreciated and the first edition of 2000 copies was sold within three years. This was certainly a great achievement. In 1952 the Asiatic Society brought out a revised edition of the book. The entire book was translated in Russian and was published by the foreign Language Publishing House, Moscow in 1955.

Another scientific problem in which Mitra got involved was that of active nitrogen which he thought would solve the problem of the night sky luminescence. He believed that the faint glow in the night sky was due to mutual neutralisaiton of ions and electrons in the upper atmosphere. According to the theory propounded by Mitra in 1943, the after glow is emitted in the act of neutralisaton of N_2^+ ions by recombination with electrons which is a three-body collision process. The persistence of the glow was due to the fact that the third body is rarely found in the upper atmosphere and so the recombination process was delayed. In 1945 Mitra published a book titled "Active Nitrogen: A New Theory". Mitra's theory was criticized by pointing out that the presence of N_2^+ ions in the glowing gas could not be experimentally detected. He modified his theory by proposing that active nitrogen is a mixture of nitrogen atoms in the ground state and metastable state, a product of dissociative recombination of N_2^+ and electrons. So N_2^+ ions are not the active substance but they together with electrons are the parent bodies of the active substances.

In the late 30s Mitra felt the necessity of having an independent postgraduate department of electronics and radiophysics and in 1945, he submitted a proposal to the Calcutta University for creating such a department. Though the University accepted the proposal, it could not be implemented due to financial constraints. The Department came into being

The Different Layers of Atmosphere

There is no definite upper limit to the Earth's atmosphere. The atmosphere is divided into several layers. The main layers, from the bottom upwards are called the troposphere, the stratosphere, the mesosphere, the thermosphere and the exosphere.

The troposphere is the narrowest layer—it reaches about 11 km above the ground. However, the length of this layer varies around the globe and from season to season. It contains most of the air. Most weather occurs in the troposphere.

Above the troposphere lies the stratosphere. It extends from 11 to 50 km up. As this region remains calm, the airliners fly here to avoid the winds and weather lower down.

The mesosphere extends from 50 to 80 km above the Earth. If meteors fall into this layer, they burn up causing shooting stars.

Thermosphere, a layer of very thin air, extends from about 80 to 700 km above the ground. It contains the ionosphere—layers of electrically charged particles.

Exosphere is the uppermost layer of the atmosphere. It's limits are not properly defined. It begins at about 700 km and end in vacuum of space. It contains hardly any air at all.

in 1947 with the availability of funds from Ministry of Education, Government of India. The Department was transformed into the Institute of Radio Physics and Electronics, which was later selected by the University Grants Commission, as one of the first five centers of advanced study under a scheme sponsored jointly with UNESCO.

It was Mitra who felt the need of an all India Radio Research Organisation. As a first step towards realization of this goal Mitra decided to win the support of the prominent British scientists for his proposal. In his lecture before the Maxwell Society in 1936 Mitra not only highlighted the need of greater cooperation between the ionospheric scientists working in different countries but he also raised the question of establishing a co-ordinating body in India on the lines of Radio Research Board of England. For discussing the desirability of creating such a Board in India he invited leading British scientists to a dinner on May 05, 1936. The guests included Sir E. V. Appleton, Sydney Chapman (1888-1970), Sir Robert Alexander Watson-Watt (1892-1973), Edward Neville da Costa Andrade (1887-1971), R. A. Gregory, the distinguished editor of Nature and many others. All the assembled guests strongly favoured the idea mooted by Mitra. Gregory thought it fit to write an editorial on it in *Nature*. He wrote: "The time would now appear to be very opportune for considering the establishment of a similar Radio Research Board in India, where fundamental research in radio communication has so far been limited to the activities of quite small bands of workers in different universities, notably those under Prof. S. K. Mitra at Calcutta and under Prof. M. N. Saha at Allahabad…It is surely time that India was able to take its place in a such a world-wide scheme (of radio research), and it is to be hoped that those in a position to do so will foster the inauguration of a suitable Radio Research Board and provide the necessary funds to initiate its work. The research already carried out in India indicates that the Universities are ready to provide a programme of problems of a fundamental nature, and even the nucleus of a staff of trained personnel, keen and enthusiastic to continue their investigations which are at present being limited through lack of resources." After coming back to India Mitra launched a strong campaign for establishing a Radio Research Board. But while his proposal was strongly supported by the British scientists but that did not have much impact on the authorities in India. Meghnad Saha, who was then at Allahabad, lent strong support to Mitra's cause. And when Saha came back to Kolkata in 1938 they together renewed their campaign with greater vigour. Finally the Radio Research Committee was formed in 1942 under the Department of Scientific and Industrial Research, then functioning under the Department of Commerce, Government of India. Mitra was appointed as the Chairman of the Committee. This was undoubtedly a major step in promoting radio research in the country. After the appointment of the Radio Research Committee a number of radio research centers grew up in the country.

C.V. Raman

Mitra's concern for industrial development in the country is well known. While referring to the creation of the Council of Scientific and Industrial Research, in his Presidential Address at the Silver Jubilee of the National Institute of Science Mitra said: "Much of this increased scientific activity has been due to the support which scientific research began to receive from the Government with the establishment in 1940, of the Board of Scientific and Industrial Research, which later became one of the component units of the wider organization, the Council of Scientific and Industrial Research (CSIR). Indeed, the adoption of the policy of sponsoring and encouraging scientific research at the government level—was the greatest single event in the history of the progress of science in the country in the last quarter of a century." He initiated two industrial schemes in his laboratory. The first was the production of microphones and loudspeakers which resulted in the development of a carbon microphone and loudspeaker with raw materials available indigenously. The second scheme was on the production of electron tubes, which led to the fabrication of radio valves for the first time in India. The technical knowledge involved were developed in his laboratory. Though this scheme was abandoned in 1954, the experience gained and the equipment assembled led to the establishment of Electron Tube Laboratory of the Institute of Radio Physics and Electronics.

Mitra retired from the Calcutta University in 1955. He was appointed as Emeritus Professor by the University. Mitra was persuaded by the then Chief Minister of West Bengal to head the West Bengal Board of Secondary Education. At the time Mitra's taking over its Administratorship , the Board was in a very bad shape. Within a short span of time Mitra made the Board an efficient organization. It was under his Adminstratorship that the Board introduced the Higher Secondary Syllabus in the Schools in 1957. It may be noted here that the transition from the School Final to the Higher Secondary curriculum was not only beset with difficulties but the time given to Mitra to effect the change over was extremely short. But Mitra succeeded in holding the examination in time.

Charles Fabry

Mitra was intimately associated with the Indian Science Congress Association since 1935 when he became the local secretary. The success of the Silver Jubilee session of the Science Congress held at Calcutta in 1938 under the Presidentship of Sir James Jeans was to a large extent was due to the hard work and organizational ability of Mitra. He served as General Secretary of the ISCA from 1939 to 1944. He was elected sectional president in 1934 when physics and mathematics section were combined into one section. In 1955, he became the General President. Mitra was closely connected with Indian Association for the Cultivation of Science since the early twenties when he worked under C.V. Raman. He served the Association in several capacities, as its Secretary, as a member of the council, as Vice President, and as one of its trustees. He played an important role alongwith M.N. Saha in expansion of the activities of the Indian Science News. Association since its inception and acted as its Secretary, Editor, Vice President, and as one of its trustees. He helped to improve the standard and circulation of the Association's journal *Science and Culture*. He was a founder member of National Institute of Science (later renamed as Indian National Science Academy) and became its President in 1956. He served as President of Asiatic Society of Bengal during 1951-52.


Guglielmo Marconi

Mitra was a strict disciplinarian. After the untimely death of his wife, Mitra had to look after his children. This he did without allowing his scientific activities by this additional responsibility. Besides his interest in scientific activities Mitra's only pastime was chess, which he used to play on Sundays with his friends for hours together. Commenting on Mitra's personal traits J.N. Bhar wrote : "Reserved in appearance, Prof. Mitra exercised unusual restraint on his speeches and movements. He impressed those around him with his high regard for discipline, exemplary devotion to duty, keen sense of responsibility and his concern for precision and perfection in any work done by himself and under his supervision. Punctuality was inherent in his nature so much so that his associates often wittingly remarked that one could check time by noting his movement. Either at home or in office, his scrupulous observation of rules and discipline surprised even his subordinates. In all spheres, his love of order, cleanliness and beauty was easily noticeable. In short, his attention to neatness in deeds and words, in manners and appearances and in his dealing with others was remarkable. Neatness was indeed his way of life."


Sydney Chapman

Honours had come thick on Mitra. He was the recipient of King Geoge V. Silver Jubilee Medal in 1935. Joy Kissen Mukherjee Gold Medal of the Indian Association for the Cultivation of Science in 1943, and the Science Congress (Calcutta) Medal of the Asiatic Society in 1956. In 1958 he was elected Fellow of the Royal Society, London for his contribution to the study of upper atmospheric phenomena. He received the Presidential Award *Padmabhushan* in 1962.

In April 1963 Mitra was appointed as National Research Professor and Mitra thought to utilize this opportunity for preparing a revised third edition of *The Upper Atmosphere*. But this did not happen. This pioneer of radio research died on 13 August 1963 leaving unfinished two tasks he had set for himself – a third revised edition of *The Upper Atmosphere* and a textbook of quantum mechanics based on lectures he delivered in the post graduate classes.

For Further Reading

1. Sisir Kumar Mitra by J. N. Bhar in *Biographical Memoirs of Fellows of the National Insitute of Sciences of India*, Vol.1, New Delhi, 1966.
2. Sisir Kumar Mitra by A. P. Mitra, *Resonance*, July 2000.
3. Professor Sisir Kumar Mitra—As I Remember Him, Mrinal Kumar Das Gupta, *Resonance*, July 200.
4. Ionosphere and its Influence on Radio Communication by R. S. Dabas, *Resonance,* July 200.

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Pope – The Mathematician

❐ R. Parthasarathy

Gerbert has carved out a name for himself in the history of mathematics, for he was perhaps the first one in Europe to have taught the use of the Hindu-Arabic numerals. Born (ca. 954-1003) at Aurillac in Central France, he was educated in Spain and Italy.

At the age of 18, Gerbert of peasant origin, was recruited by the famous Benedictine order to the service of the Church. Besides the religious training, he learned mathematics (geometry, astronomy, arithmetic) and music, at Santa Maria de Ripoll, then subsequently in the cathedral schools at Reims and Revenna.


Gebert

Amongst his mathematical contributions, the following are cited: the adoption of Zero in Europe, his abacus using the positional system up to 27 decimal places, a standard text presenting the Arabic numerals and the invention of the mechanical clock. Gerbert was drawn deep into politics, which left him little time to pursue mathematics.

Gerbert wrote on both arithmetic and geometry and approached the German Emperor Otto III, then 16, with Boethius's De Arithmetica. The Emperor responed by inviting him to teach mathematics and engaging him in 997 as adviser, teacher and Chaplain into his Court. The next year he was elevated Archbishop of Ravenna. When Pope Gregory V died in 999 Otto decided to wrest control of the papacy by getting Gerbert elected Pope on Easter day (April 9, 999). He was the first French Pope, taking the name Sylvester II.

Muslims – held most of Spain: Gerbert proved to be a shrewd diplomat. He granted, to embellish diplomatic moves, in the year 1000, the title of King to Stephen, ruler of Hungary. Hungarians celebrated the millennium of King Stephen and his crown in 2000.

The calendar suddenly shifted from the complicated Roman numeral DCCCCZCIX the simple positional system.

"It would be amusing to conclude that a mathematician – pope solved the YIK problem, by introducing the Zero", observes *The Mathematical Intelligencer.* The adoption of Zero was a much slower process in Europe : not until the thirteenth century. Was the Arabic system definitely introduced.

The mathematician – pope's right hand is not depicted pictorially in the customary blessing pose but in the *posture of lecturing.*

Gilbert summed up his career, in the precise style of a mathematician that he passed "from R to R to R", signifying Reims to Ravenna to Rome.

(Source : The Mathematical Intelligencer, Vol.22, 2000)

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Seven Seas in a Tiny Grain of Mustard

❒ T.V. Venkateswaran

Once a small baby fit as a fiddle, died all on a sudden, for no apparent reason. The inconsolable mother took the baby to Gautham Buddha, who was camping near by, and pleaded him to restore the child to life. Unable to console the grieving mother, Buddha advised her to bring him fist full of mustard seeds from a house where no one - no child, no parent, no grant parent, no husband, no wife, no servant- had ever died, and he would use the seed to revive the baby.

The young mother ran frantically from house to house throughout the village, growing more desperate as each visit failed to produce what she sought. At last it dawned to her: Death cannot be avoided; every household will be touched by it at some point. With a sad heart but calm soul she thanked the master teacher for his lesson.

> MUSTARD *...if you have faith as small as a mustard seed, you can say to this mountain, 'Move from here to there' and it will move. (Matthew 17:20)*

Mustard has been one of the most widely grown and used spices in the world for many centuries. Cultivated in Ancient Egypt and exported to Europe by the Romans, mustard was used for both food and medicine - as a cure for anything from hysteria to snakebite to bubonic plague. In the mid-1600's, the town of Tewkesbury in Gloucestershire became famous for its thick horseradish mustard that was the rage of English cookery, that William Shakespeare (a mustard lover himself) wrote of this famous mustard: "His wit's as thick as Tewkesbury mustard!" (Henry IV, Part II). Avvaiyar, a classical woman poet while singing praise of Tamil moral work '*Thirukural*' noted the brevity of the verse, yet the expanse of the message and compared this fete as that of trying to encompass Seven seas in a tiny grain of mustard.

Origin

Mustard vies with pepper as the world's most important spice. No one knows the origin of mustard, a plant spread by birds and wind across the Northern Hemisphere. It was cultivated early on, found in Stone Age settlements, and was the primary spice known to Europeans before the Asian spice trade heated up. Ancient people from India to Egypt to Rome munched mustard seeds with meat for instant seasoning. How it was introduced into the new world is an interesting story. The story goes that Spanish *padres* scattered mustard seed to mark the trails as they travelled from mission to mission. They knew the plant reproduces so quickly that it would help them find their way.

Mustard seeds are a well-travelled spice. Ancient Rome enjoyed it as a condiment and a medicine. The New Testament of the Bible, Matthew 13:31, compares a grain of mustard to the kingdom of heaven. Crops were raised in 800 A.D. Paris to generate revenue. Vasco da Gama carried mustard on his first voyage around the Cape of Good Hope in 1497. Today it is often called the Spice of Nations because it is so universally used. Mustard deserves more credit. It is one of the least expensive spices, has a fascinating history and it's available in a variety of colors and forms.

Varieties of mustard

The three varieties of mustard are all members of the cress family. *Brassica hirta*, white or yellow seeds, and *Brassica nigra*, black mustard are both indigenous to southern Europe and the Mediterranean while *Brassica juncea* or brown mustard is indigenous to the northern Himalayas. Botanically different, though of equal use in the kitchen, are the *Sarepta mustard* or *Romanian Brown Mustard* (Br. juncea) from Eastern Europe and the *Indian Brown Mustard* (Br. integrifolia or Br. juncea, a fertile hybride from Br. nigra and Br. campestris) from India and the Middle East.

The gray-green plants grow as tall as 10 feet, their bright yellow flowers dazzling in large fields given over to mustard.

> Although the pungency of black mustard is slightly stronger than that of brown mustard, black mustard is hardly planted in Europe anymore, and brown mustard is the dominating quality on the European market. The reason is that brown mustard, unlike black mustard, can be harvested by machines which make production much cheaper in countries where working force is expensive.

Mustard has a short growing season of 90 - 110 days. In the northern hemisphere seeding typically occurs in May with harvest in August / September. The plant stands about 3-4 feet high when mature and has yellow flowers. After flowering, the seeds develop in pods until they are ready for harvest. The mustard plant bears its tiny seeds (up to 2 mm) in a pod, much like beans or peas. Mustard grows easily in temperate climates and is cultivated all over the world today. Two varieties of mustard seeds are widely grown. The reddish brown or black seed, and the pale yellow or white. The latter has a delicious, nutty flavor, whereas the black seed has a much more pungent taste.

Etymology

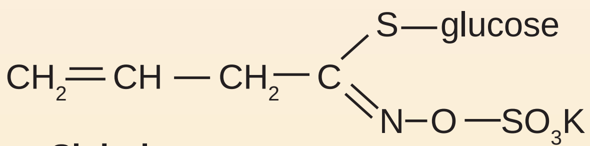
Black Mustard, scientific nomenclature is *Brassica nigra* [L.] Koch, is called Rai in Gujrati, Rai or lal sarsu in Hindi, Kadugu in Tamil and Moustárda in Greek, belong to *Brassicaceae* plant family to which cabbage also belongs.

The German Senf is a loan from Latin sinapi, as well as the Old English *senep* (preparation of mustard paste was introduced to central and Northern Europe by the Romans). The ultimate origin of this word is probably Egypt. *Mustard* (and similar words in Roman languages, and the German Mostrich for mustard paste) is derived from Latin (vinum) mustum, "must". In these early times a popular drink was unfermented grape juice - and this was often seasoned with mustard seeds. The unfermented grape juice was called MUST, with ground seeds to form “mustum ardens”. This is believed to be the origin of the word mustard. Lastly, the genus name Brassica is Latin for “cabbage”, which belongs to the same genus.

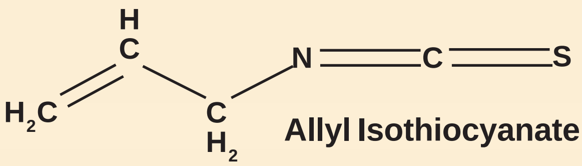
Main constituents

The dried seed do not have any fragrance, but exhibit a pungent taste after some time of chewing. Roasted seeds (more grey in colour) have a rich, nutty odour. The hot bite of mustard is the result of the volatile oils that the seed contains. The taste and smell of mustard derives from a number of compounds, mainly isothiocyanates. The active principle or volatile oil of brown mustard is allyl isothiocyanate while that of white or yellow is acrinyl isothiocyanate. The essential principles are not present as such in the seeds of brown or white mustard seeds. Precursors of these compounds are present in the mustard seeds in the form of glucosinolates, e.g. sinigrin. Isothiocyanates are produced as a result of hydrolysis of their respective glycosides, ‘sinigrin’ and sinalbin in the presence of moisture under favourable conditions.

These precursors are devoid of any smell or taste, but in the presence of water, are hydrolysed enzymatically to glucose, potassium hydrogen sulfate and isothiocyanates, e.g. allyl



Sinigrin



Allyl Isothiocyanate

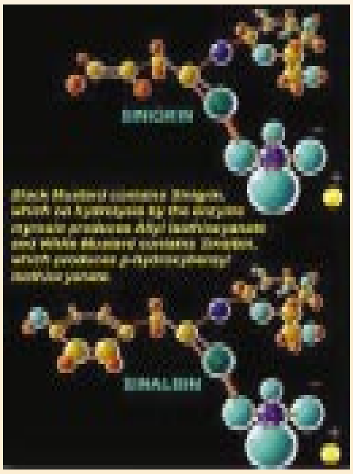
isothiocyanate, CH_2=CH-CH_2-NCS. The last compound is a moderately volatile liquid with a very pungent, irritating odour and acrid taste.

Black mustard contains about 1% sinigrin (allylgluco-sinolate), a thioglycoside-like compound (a *glucosinolate*) of ally isothiocyanate with glucose. By action of the enzyme myrosinase, allyl isothiocyanate, a pungent, lachrymatory and volatile compound, is liberated (0.7% of the dried seed). Besides allyl isothiocyanate, in Romanian Brown Mustard another related compound is found, namely crotylisothiocyanate (2-butenylisothiocyanate). Isothiocyanates are also the main ingredients of white mustard, horseradish, wasabi, rocket and cress, all of which belong to the same plant family. The more distantly related capers similarly owe their pungency to an isothiocyanate. In brown mustard the isothiocyanate found is allyl isothiocyanate. It produces a highly pungent sharp taste with a slight bitter note. Once the heat and flavour is released by the enzyme reaction and it has been stabilized by addition of preservative, it is not affected by heating.

It is also important to understand that yellow mustard has a different isothiocyanate to that of oriental/brown. The isothiocyanate present in yellow mustard seed is parahydroxybenzyl isothiocyanate. This is non-volatile and produces a sharp “mouth heat” with no pungency. This heat is unstable and dissipates slowly over a period of approximately one week after hydration, leaving a mild “eggy” taste. This heat decomposition can be accelerated by high temperatures - but only after the enzyme reaction has been completed and stabilized. Thus, pungency of black mustard paste is not as stable as the pungency of white mustard, but diminishes after some time. The reason is that its pungent principle (allyl isothiocyanate) is volatile and hydrolyses slowly.

Isothiocyanates which are present in all mustard seed and contribute to the characteristic flavour and heat of mustard is joined by a chemical bond to sugar and a sulfate salt, and is therefore protected from deterioration. The addition of water to mustard activates an enzyme -myrosinase - which breaks down the chemical bonds. On hydration the isothiocyanate is released and the heat and flavour associated with mustard is developed. Under optimum conditions - room temperature and liquid of neutral pH (i.e. water) being used to make paste - full flavour development can take up to ten minutes.

Note that isothiocyanates are highly toxic and can be used as chemical weapons, which is their biological function in the mustard plants anyway. To protect the plant organism from the isothiocyanates, they are glycosidically bound as glucosinolates (formerly called thioglycosides) and get liberated only if cells are damaged (which is supposed to have been caused by an eating animal). It is not especially toxic to humans (oral LD_{50} around 300 mg per kilogram bodyweight), but it is a very quick-acting irritant to skin and mucous membranes. It was tried, unsuccessfully, during World War I as an incapacitating chemical weapon. However allyl isothiocyanate not to be confused with mustard gas which is something quite different (It got its name because impurities in some types of mustard gas preparations smell like mustard). To obtain allyl isothiocyanate it is not necessary to isolate it from mustard seeds. It can easily be synthesised from allyl iodide and potassium thiocyanate.



Mustard Oil

Like all seeds, mustard seeds contain also significant amounts of fat oil (30%), which is used extensively for cooking. Mustard oil is colourless or pale yellow liquid with a sharp, penetrating, acrid odour. Black mustard is more important as a spice and oil plant, especially in India. Mustard oil, is popular all over Northern India and especially indispensable for the true taste of Bengali cuisine, but since it contains toxic isothiocyanates, it must be strongly heated (until some smoke evolves) immediately before frying any food in it; otherwise, severe health damage is risked. Besides glycerides of linoleic and linolenic acid, mustard oil contains glycerides of erucic

Contd. on page 22

Compression

The Heart of Digital Revolution

❒ R.K. Singh

This article analyses the digital revolution to find out whether this revolution is feasible without compression. Generally the compression is dealt with complex mathematics. An attempt has been made to explain the basic philosophy of compression using simple orange juice analogy. Various aspects of compression have been discussed with the help of concept map. Compression process is not free from many hurdles. The article while discussing these drawbacks also suggests the precautions to be taken to make the compression successful.

Introduction

Everybody is familiar with the word "Compression" in different ways. Compression process has different meaning in chemical, mechanical, civil and metallurgical engineering etc. But the moment we think about compression in electronic engineering one word which strikes our mind is "Digital". These days it is practically a cliche to claim that all electronic communication is engaged in a digital revolution. Before we discuss the impact of compression on digital revolution, let us analyse digital revolution.

Digital Revolution

All sensory signals including audio and video signals are analog at the point of origination or at the point of perception. Although analog system has been in use for decades but following defects in it are unavoidable.

- Difficulty of maintaining throughout the broadcast chain a true analog of the original signal.
- Distortions in phase and amplitude occur at all points in the system causing deterioration of the technical quality of the picture.
- Excessive attention is required in designing circuits so that these distortions are limited to manageable proportions thus increasing the cost of the system.

In case of digital the signal is first converted into a sequence of 0s and 1s (called bits) which may be transmitted or stored. The receiver then reconverts or decodes the bits into a replica of the original signal.

The main advantage of digital representation of information is the robustness of the bit stream. It can be stored and recovered, transmitted and received, processed and manipulated, all virtually without error. The only requirement is that a 'zero' bit be distinguishable from a 'one' bit, a task that has become quite easy since the invention of integrated circuit and high speed computational technology.

Digital revolution has brought a range of benefits but there are two main reasons for it's unstoppable adoption.

- The possibility to replicate in a more economic and compact way the different system components that technologies specific of a field had made possible.
- The net saving in bandwidth usage compared to the corresponding analog solution.

Some examples of digital revolutions offered by music record, speech telephony and satellite broadcasting are as follows :

- The vinyl disc, phonograph cylinder etc. has existed for over 100 years but now CD has entered in a big way.
- Analog speech has existed for over 100 years but now PCM is used in the network by billions of people unbeknownst to them.
- Analog satellite television has been in operation for 2 decades but now digital television is being watched by millions of people.

From the above it may be concluded that inexpensive integrated circuits, high speed communication networks, rapid access dense storage media and computing architectures that can easily handle video-rate data are now rapidly making the analog standard obsolete.

Digital audio and video signals integrated with computers, telecommunication networks, and consumer products have fueled the digital revolution. At the heart of this revolution is the digital compression of audio and video signal. But this digital revolution is probably not possible without the support of compression. The compression for digital revolution is like the heart for human body. As proper functioning of heart is essential for human body to survive, similarly proper compression is necessary to make digital revolution a complete success.

Digital Revolution without compression - Is it feasible ?

The first step in digital revolution is "digitization " which means sampling plus quantization. Let us examine the status of video signal after simple digitization. Video signal is converted into the digital format in accordance with the international standard CCIR Rec. 601. The three source signals, namely the luminance signal Y and the two color difference signals (chrominance) Cr and Cb are all converted to digital format using 8 bit linear PCM coding and three separate analog to digital converters (ADC). The Y signal is sampled at the rate of 13.5 million samples per second where Cr and Cb are sampled at 6.75 million samples/ second. The output from the three ADCs are multiplexed together to form a single bit stream having a bit rate of 216 million bits per second.

How this bit stream with 216 million bits/second can be transmitted/ stored?

These bits can be transmitted by a modulation scheme called QPSK (Quadrature Phase Shift Keying). From the incoming bit stream two bits are taken at a time to constitute, what is known as a symbol. In QPSK, the digital modulation is carried out by varying the phase of the RF carrier in accordance with the value of an incoming symbol. As QPSK symbol is composed of two bits it can have four possible values (00, 01, 10, 11). Accordingly the transmitted RF carrier takes one of four phase values (45o, 135o, 225o, 315o). The RF double sided bandwidth required for a digitally modulated signal is equal to the input symbol rate. Continuing with our above

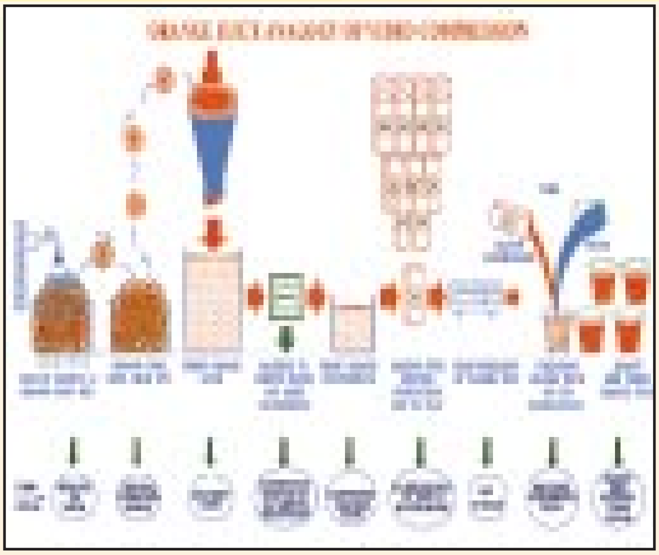


Fig - 1

example, the 216 mbps stream gives a symbol rate of 108 million symbols per second which will require a 108 MHz RF channel for transmission. But for analog TV transmission present bandwidth allocations are only 7 MHz (VHF) and 8 MHz (UHF). Therefore simple digitization of video signal will result in enormous bandwidth expansion. The difficulty of storing video information at such high data rate is easy to see. For instance, a floppy disk hold about 1.44 M bytes of data or 11.5 M bits. A typical 100 minutes movie would require over 100,000 floppy disks.

Similarly stereo audio signal in CD quality is sampled at a rate of 44.1 kHz and is quantized at 16 bits per sample. For two channels the bit stream will be 1.411 M bits/second.

From the above examples it is clear that video stream requires very high secondary storage. It also requires networks providing megabit data rate. Although this may be technically feasible with modern hardware it is not economically reasonable. Therefore it may be said that digital revolution with simple digitization is just not feasible. In other words it may be said that digital revolution with simple digitization is just not feasible.

So how digital revolution can be achieved ?

Audio and video signals have large amount of redundancy. It means that after simple digitization audio and video signal will have very large quantity of bits which may be removed without sacrificing the quality. This is achieved by a process known as "Compression".

The orange juice analogy - A simple way of understanding video compression concept

The elements of video information may be divided into three parts namely the Redundant Element, the Irrelevant Element and the Core Element. In a similar way orange may be divided into three parts like the Water Content (redundant element), the Peel, Skin and Seed (Irrelevant Element) and the Orange Content (Core Element).

The concept of complete video compression process can easily be understood with the help of an orange juice analogy described below :

Assume that you are owner of a very big orange orchard. The price of orange in your area has crashed due to excellent crop of oranges. You may incur a huge loss if you sell oranges at your place. To make profit you decide to convert oranges into orange pulp and export to other countries. The

ORANGES

1. Washing of oranges to remove dust etc. otherwise it may spoil the orange juice.
2. Removing peel, skin, seed (irrelevant element) from oranges
3. By crushing process converting orange into orange juice
4. Water content in the orange juice is redundant. An expensive plant is used to remove the redundant water content from the orange juice without destroying its quality
5. The output of the plant is pulp of orange juice whose physical quantity is much less than the orange juice quantity which is fed to the plant.
6. The orange pulp is packed in small tins. Necessary information such as name of company, details of ingredients, weight, directions for handling and converting pulp into almost like fresh orange juice are printed on each tin.
7. These small sealed tins are packed into big cartons for storage/ transportation. These tins in the carton are transported by some carriers.
8. Consumer follows the instructions written on each tin to prepare almost like fresh orange juice from the pulp. For this he is required to add correct quantity of water and ice etc.
9. The process of making orange juice from the pulp is very simple as compared to the process of converting orange juice into pulp.
10. Manufacturers do not specify how exactly pulp is prepared. It is their trade secret. They only specify its ingredients and instruction about how to prepare orange juice from the pulp.
11. The orange pulp must be prepared as per the standard specifications like ISI etc.

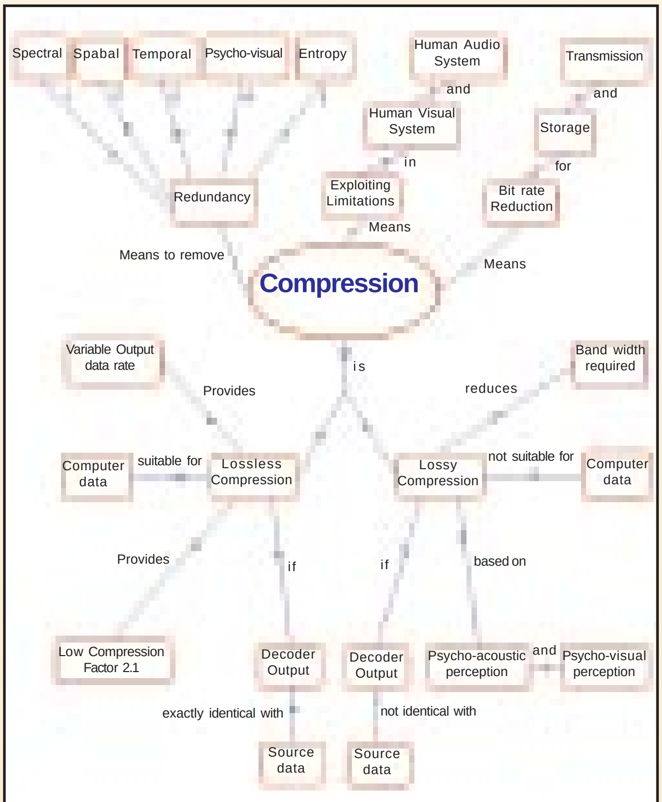
VIDEO SIGNAL

1. Filtering of video signal to remove noise etc. otherwise it may corrupt the video signal.
2. Removing unwanted information (irrelevant element) from the video signal.
3. By digitization process converting analog video into digital video.
4. A significant amount of information content in the video signal is redundant. An expensive encoder is used to remove the various types of redundant information from the digitized video signal without destroying its quality.
5. The output of the encoder is compressed digital video whose number of bits are much less than the bits of digitized video fed to the encoder.
6. The bits of compressed digital video are converted into small packets. Header of each packet contains necessary information such as name, number of bits, and direction for decoding to convert it into almost like original video signal.
7. Packets of bits are multiplexed to form group of pictures (GOP). These are now ready for storage in hard disc or transmission by modulating on carrier.
8. The decoder on receiving the packets converts the compressed bits into almost like original video signal as per the information given in the header.
9. The decoding process of converting compressed bits into video signal is much simpler than encoding process. Therefore decoders are cheaper and less complicated than encoders.
10. Encoder is like a black box. The manufacturers do not specify, how coding is done. It is their trade secret. only bit stream and decoding format is described.
11. The compression process must follow the international standards like JPEG, MPEG, H261 etc.

figure 1 describes the complete process up to the consumption of orange juice by consumer. This process is very much similar to the video signal compression process where oranges are analog to video signal. The comparison is described below :
Overview of the complete video compression process has been explained above with the help of the orange juice analogy. Now let us try to analyse the compression in more technical manner.

Understanding Meaning of Compression

Please refer concept map for compression at Fig. 2. The



CONCEPT MAP FOR COMPRESSION

Fig - 2

ultimate goal of compression is the bit-rate reduction for storage and transmission. Bit rate is the product of the sampling rate and the number of bits in each sample and this is generally constant. The information rate of a signal varies, however. The difference between the bit rate and the information rate is known as the redundancy

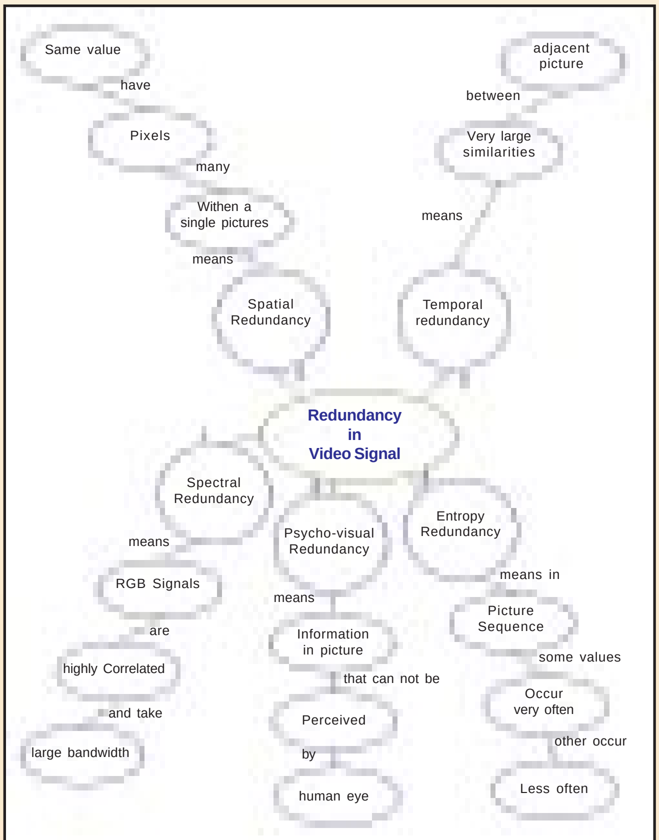
Compression means to remove redundancy from the signal. As shown in the concept map (Fig.3) the redundancy in a video signal may be classified as follows.

i) Spectral redundancy : The RGB signals coming from video cameras are highly correlated and take on large bandwidth. To decrease the amount of video sample data based on human perception, the RGB color space is converted to Y, Cr, Cb color space. The Y(luminance) has the full bandwidth and is very sensitive to human perception. The Cr and Cb (chrominance) components have a narrower bandwidth and are less discernible by human eyes. Therefore, the chrominance components are usually decimated by two, both horizontally and vertically, which results in a reduced number of samples.

ii) Spatial redundancy : Within a single picture in a sizeable areas the same or similar pixel values exist. These are redundant and need not be transmitted. The input image is partitioned into 8 x 8 pixel units, called blocks. Each block goes through the DCT process. After each block is transformed into the frequency domain through the 2-D DCT, the 64 real-valued DCT coefficients of the block are quantized to be represented by an integer.

iii) Temporal redundancy : Adjacent pictures in an image sequence are highly correlated. The input picture is partitioned into 16 x 16 pixels, called macroblocks, and then each macroblock goes through motion estimation compensation to remove the temporal redundancy. Each macroblock is coded based on the basis of prediction errors. For instance, a picture right after a scene change is intraframe coded since there is no correlation between the current picture and the previous one.

iv) Entropy redundancy : It means that things that happen often should be described briefly because we already know what to expect, and the things that happen infrequently should be described at length because they are unusual. This way, we can get the maximum amount of information with the minimum amount of description. Therefore frequently appearing signal values are assigned a smaller length of bits.



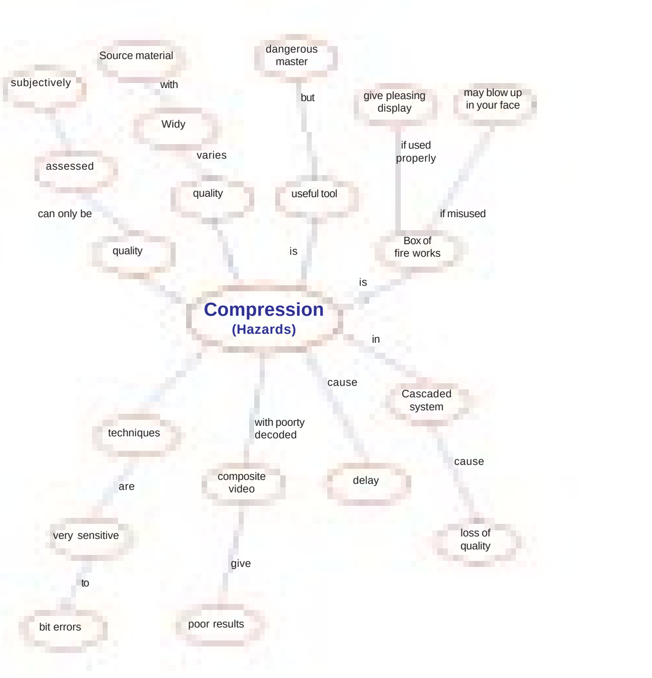
Concept Map for Redundancy in Video Signal

Fig - 3

v) Psycho-visual redundancy : In this type of redundancy the information that appears during very small duration that our eye cannot perceive is not transmitted. In other words limitations in human visual system and human audio system are exploited.

Compression is said to be lossless compression if decoder output is exactly identical with source data. It provides variable output data rate. Lossless compression is suitable for computer data and provides low compression factor of 2:1.

Compression is said to be lossy compression if decoder output is not identical with source data. It is based on psycho-acoustic and psycho-visual perception. Lossy compression reduces the bandwidth required and it is not suitable for computer data.



Concept Map for Hazards of Compression

Fig - 4

Everything is not rosy about compression (Drawbacks of Compression)

"Compression" technology has played a leading role in making "Digital Revolution" a big success. This technology is very exciting and everything appears very rosy about it. But it is far from truth. Compression is a very useful tool but a dangerous master. It is like a box of fireworks. If used wisely it gives pleasing display otherwise it can blow up in your face. There are many drawbacks of compression as described below. (Also refer concept map for hazards of compression at Fig. 4).

- By definition, compression removes redundancy from signals. Redundancy is, however, essential to making data resistant to errors. As a result the compressed data are more sensitive to errors than uncompressed data.
- Techniques for recovery original uncompressed data depend on the probabilistic characterization of the signal. Although many excellent probabilistic models of audio and video signals have been proposed, serious limitations continue to exist because of the non-stationarity of the signal statistics. In additions, statistics may vary widely from application to application.
- Unlike statistical redundancy, the removal of information based on the limitations of the human perception is irreversible. The original data cannot be recovered following such a removal. Unfortunately, human perception is very complex, varies from person to person and depends on the context and the application.
- Compression techniques using tables such as Lampel - Ziv-Wekh codecs are very sensitive to bit errors as an error in the transmission of a table value results in bit errors every time that table location is accessed. This is known as error propagation.
- Variable length coding techniques such as Huffman Code are sensitive to bit errors.
- As perceptive coders introduce noise, it will be clear that in a cascaded system codec could be confused by the noise due to the first. If the coders are identical then each may make the same decisions when they are in tandem, but if the coders are not identical the results could be disappointing.
- Signal manipulation between coders can also result in artifacts which were previously undetectable being revealed because the signal which was making them is no longer present.
- One practical drawback of compression system is that they are largely generic in structure and the same hardware can be operated at a variety of compression factors. Clearly the higher the compression factor, the cheaper the system will be to operate so there will be economic pressure to use high compression factors. Naturally the risk of artifacts is increased and so there is counter - pressure from those with engineering skills to moderate the compression.
- Cascaded compression systems cause loss of quality, and the lower the bit rates the worse this gets. Quality loss increases if any post production steps are performed between compressions.
- Compression systems cause delay.
- Compression systems work best with clean source material. Noisy signals or poorly decoded composite video give poor results.
- In motion-compensated compression system, the use of periodic intra-fields means that the coding noise varies from picture to picture and this may be visible as noise pumping. Noise pumping may also be visible where the amount of motion changes.
- Input video noise destroys inter-coding as there is less redundancy between pictures and the difference data become larger, requiring course quantizing and adding to the existing noise.
- Excess compression may also result in color bleed where fringing has taken place in the chroma or where high frequency chroma co-efficient have been discarded.

Precautions to be taken to make the heart (compression) function properly

This paper has described compression as the heart of digital revolution. Heart has to function properly to keep a human body in perfect condition, therefore constant monitoring on the working of the heart and due care is necessary. Similarly a constant watch has to be kept on compression techniques. The following precautions must be taken during compression process to achieve perfect digital revolution.

- The transmission systems using compressed data must incorporate more powerful error correction strategies and avoid compression techniques which are notoriously sensitive.
- If compression is to be used, the degree of compression should be as small as possible. In other words highest practical bit rate should be used.
- If not necessary compression should not be used.
- Audio coders need to be level calibrated so that when sound pressure level dependent decisions are made in the coder those levels actually exists at the microphone.
- Low bit rate coders should only be used for the final delivery of post produced signal to the end user.
- Compression quality should only be assessed subjectively.
- Compression quality varies widely with source material. One should be careful about demonstration which may use selected material to achieve low bit rates.
- While assessing the performance of a codec one should not hesitate in criticizing artifacts. Eyes and ears are good to assess the quality of the output of the codec.
- In case of video, use still frames to distinguish spatial artifacts from temporal artifacts.

Conclusion

It may be concluded without any doubt that compression technology has played a major role in making digital revolution a reality. The dramatic advances in signal processing and VLSI technologies have brought about significant progress in the development of compression technology. Compression has now reached the stage where it can economically be applied to video and audio systems on a wide scale. Although compression is traditionally described mathematically but in this paper complete overview of the compression process has been explained in the simplest possible manner. Compression is a wonderful tool but it has many hazards associated with it. Precautions as described are essential to avoid disappointment.

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Contd. from page 27

acid, which is considered harmful to human health; furthermore, traces of free isothiocyanates are always found in mustard oil. Therefore, in spite of its high fraction of unsaturated fatty acids (iodine index is 105), mustard oil cannot be recommended without qualification for cooking purposes. However, mustard oils are rich in W3 fatty acids which help to reduce the clotting tendency of blood.

Black (or brown) mustard seeds are also much used as a spice directly. Their pungency is completely destroyed by cooking, and therefore the ground seeds should be added as late as possible. Indians fry or roast the seeds before usage until they become gray, which totally changes their character: They get an interesting nutty taste, which cannot be compared to any other spice and which is especially loved by South Indians. Black mustard seeds are also a component in the Bengali spice mixture panch phoron and the South Indian composition sambaar podi. In Southern India, perfumed butter is commonly flavoured with black mustard seeds. It is said that adding mustard to your bath water relieves muscular pains.

Medicinal Uses

Mustard has been used as medicine for centuries. Ancient manuscripts tell of mustard's use in treating pulmonary diseases, snake bites, and skin rashes. In more recent times, mustard's healing powers have been used to relieve the suffering of rheumatism, arthritis, sore throats, and even tooth aches. According to Linnaeus, mustard is a potent aphrodisiac, which may account for its extensive use during Swedish Christmas Eve celebrations. After all, these celebrations were originally fertility rites!

Mustard is said to be Aperitif, antimicrobial, antiseptic Irritant, stimulant, diuretic, and emetic. Mustard is used in the form of poultices for external application near the seat of inward inflammation, chiefly in pneumonia, bronchitis and other diseases of the respiratory organs. It relieves congestion of various organs by drawing the blood to the surface, as in head affections, and is of service in the alleviation of neuralgia and other pains and spasms. Mustard flour is considered a capital antiseptic and sterilizing agent, as well as an excellent deodorizer. In the days before aspirin and antibiotics, Mustard plasters were commonly used throughout the world to treat a myriad of ailments. The plasters (also called poultices) were a mix of dry mustard and water applied onto a cloth. Through the well-established principle of couter-irritation, the plasters provided soothing heat and relief. Mustard plasters are still in use today in some parts of the world.

Natural preservative and emulsifier

Often, pickles made in certain part of India use mustard powder which not only provide flavour but also act as a natural organic preservative. Isothiocyanate present in mustard inhibits growth of certain yeast, mold and bacteria. Prepared mustards do not require heat treatment to have a long and stable shelf life. Even bread, made with deactivated mustard, will have an extended shelf life and taste fresher longer. Mustard flour is used to aid emulsification in products such as mayonnaise and salad dressings. It is also a good stabilizer for the fine particles of mustard accumulate at the oil / water interface in mayonnaise - acting as a physical protection against emulsion breakdown. Mustard contains almost 30% protein, and serves as a cost effective protein source in many meat products. The gums found in mustard bran act as an excellent water binder, while the flour aids in emulsion stability. The gum constitutes approximately 25% of bran, and is naturally occurring. It is cold water soluble, stable through heating or freezing. It is also an antioxidant. Tocopherols, naturally present in mustard, can effectively retard lipid oxidation in meat systems. Because mustard contains more than enough tocopherols to prevent it's own oxidation, it can lend it's antioxidant properties to the system in which it is used. • • •

A Brief History of Zero

❒ Rintu Nath

'Googol, can you say what is common in duck, egg and love?'

The question came from my uncle. I was doing my math homework and he was absorbed with some intricate problems in mathematics when suddenly he popped the question to me.

I fumbled for a second. I did not have a clue about the answer.

'Do you want more clues?' uncle asked me again seeing my blank look.

'Well, yes…' I was not sure how much that would help.

'Well, here is a cryptic clue for you: *number delivered in a circular letter*,' said he.

'I suppose all letters delivered by postman are rectangular. I did not see a circular letter ever,' I tried to reason with him.

'Fool, the word *letter* is a pun'.

This time uncle was seemingly upset over my hurried reply without giving much thought in it.

Well, before you also try thinking with me, let me introduce myself first. I am Googol. Of course, this is my nickname, but I like the name very much. And everybody calls me in this name. When I was born, my mathematician uncle has given this name to me.

The name *googol* carries an interesting story what my uncle later told me. In 1938, Dr. Edward Kasner (1878-1955), a mathematician, asked his nephew Milton Sirotta, then nine years old, to think a name for a really big number, namely, 1 with a hundred zeros after it (10^{100}). Milton came up with the name *googol*. Then at the same time, to name a still larger number, Dr. Kasner coined the term *googolplex*. It was first suggested that a *googolplex* should be 1, followed by writing zeros until you got tired. This was a description of what would happen if one actually tried to write a *googolplex*, but as you can presume that different people got tired at different times. The *googolplex* then, is determined as a specific finite number, with so many zeros after the 1 that the number of zeros is a *googol* (10^{googol}). A *googolplex* is much bigger than a *googol*, much bigger even than a *googol* times a *googol*. These inventions caught the public's fancy and are often mentioned in discussions of very large numbers. In this context, let me give you another information that Dr. Edward Kasner wrote a book with James Newman titled *Mathematics and the Imagination*.

Now about my uncle's riddle. I tried to get the information from the cryptic clue. The clue that that word *letter* is a pun led me to think about our alphabetic letter. And here we have the circular letter 'O' and the number delivered with that letter is... 'Oh, I got that!' I exclaimed, 'the answer is *Zero*'.

But still I was not sure about how to relate *zero* with *duck*, *egg* and *love*. So I commented, 'But uncle, how other three words are related with zero?'

'Well, you know when a cricketer gets a *duck*…'

'Yes, when he scores no run that means *zero*'

'And in tennis or badminton, you might have heard the score as 10-*love*'

'And in that case also the score *love* means *zero*'

'The French word for *egg* is *l'oeuf.* Now since *zero* looks more or less similar in shape as that of an egg, so *l'oeuf* after some changes became *love*, which the present reason of calling a *zero* as *love*'

'There are of course a lot of names given to *zero* or something conceptually as *zero* like *cipher*, *aught*, *nought*, *naught*, *not*, *nil*, *null*, *nothing, none*.'

'And I have heard people say the letter 'O' to say zero like O-1-3-1 to represent 0131.'

'Yes, you are right. Sometime it is quicker and easier to pronounce monosyllable words. That may be the reason for speaking 'O' as *zero*. Of course, there are some incidences where something like 'O' was used by early mathematicians to represent *zero*.'

'He might be a genius who discovered *zero*?'

'Indeed he was. But there is a long history of *zero*…'

'Tell me something about it,' I was very eager to know.

'Initially, the *zero* as a number was not available. There was the idea of empty space, which may be thought conceptually similar to zero. Babylonians around 700 BC uses three hooks to denote an empty place in the positional notation. They used a symbol sort of like a "Y" for one, and a symbol sort of like "<" for ten.'

'What about Greek mathematicians?' I asked.

'Yes, almost during the same time, Greek mathematicians made some unique contributions to mathematics. The interesting feature is that Greek math is mostly based on geometry. Euclid wrote a book on number theory named *Elements*, but that was completely based on geometry. The newer system of Greek math, which is more than 2000 years old, uses Greek letters for 1 to 9, 10 to 90, and 100 to 900. 1 is written as 'A' (alpha), 10 as 'I' (iota), and 100 as 'P' (rho). They did use a limited place system, so '111' was written as 'PIA'. For 1000 and above they used a mark such as ',' or '/' before the number of thousands. So, '1000' is ',A' or '/A' , and ten thousand is ',I' or '/I'.

'So there was no concept of zero even for Greek mathematicians,' I wondered.

'Not exactly like that. Greek astronomers might feel the need of empty space and they began to use the symbol 'O'. It is not clear why they favoured the particular notation. It may be related with the first letter of the Greek word for nothing namely *ouden* or it may come from *obol*, a coin of almost no value.'

'I think then Romans also did not have any idea of *zero*, since I know Roman number system has letter like 'X' for 10,' I said.

'You are right. Roman numerals for 1, 10, 100, and 1000 are I, X, C, and M. It is interesting that Greeks or Romans relied more on the Abacus that they used to perform arithmetic operations such as addition, subtraction, division, or multiplication and they must not have thought any operation related with *zero*.'

'So zero was not in the mind of those early Greek or Roman mathematicians,' I said.

'Yes, in early history of most of these civilizations, there was no concrete evidence of zero or its use. This may be due to conceptual difficulty to figure out something, which would represent nothingness.'

'What about Indian civilization?' I got interested.

'Around 650AD, the use of zero as a number came into Indian mathematics. The Indian used a place-value system and zero was used to denote an empty place. In fact there is evidence of an empty placeholder in positional numbers from as early as 200AD in India. In around 500AD Aryabhata devised a number system, which has no zero, as a positional system, but used to denote empty space. There is evidence that a dot had been used in earlier Indian manuscripts to denote an empty place in positional notation. For example, to represent '100' it would be two dots after 1.'

'So use of zero as number started,' I said.

'In 628 AD, Brahmagupta wrote *Brahmasphutasiddhanta* (The Opening of the Universe), and attempted to give the rules for arithmetic involving zero and negative numbers. He explained that given a number then if you subtract it from itself you obtain zero. He gave the following rules for addition, which involve zero: *The sum of zero and a negative number is negative, the sum of a positive number and zero is positive; the sum of zero and zero is zero.* Similarly, he gave the correct rules for subtraction also.

'Brahmagupta then said that any number when multiplied by zero is zero but when it comes to zero, he gave some rules that were not correct. But remember, when the concept was just developing, it is quite usual that he would make the mistake. So it is an excellent attempt to visualise number system in the light of negative numbers, zero and positive numbers.'

'Brahmagupta seems a genius!' I exclaimed.

'In 830, Mahavira wrote *Ganita Sara Samgraha* (Collections of Mathematics Briefings), which was designed as an update of Brahmagupta's book. He correctly stated the multiplication rules for zero but again gave incorrect rule for division by zero.'

'So could anybody make the correction?' I said.

'After 500 years of Brahmagupta, Bhaskara tried to solve the problem of division by stating that any number divided by zero as infinity. Well, conceptually though it is still incorrect, however Bhaskara did correctly state other properties of zero, such as square of zero is zero and square root of zero is also zero.'

'So Indian mathematicians developed the concept of zero and stated different mathematical operations involved with zero. But how did the concept spread to all over the world?' I asked.

'The Islamic and Arabic mathematicians took the ideas of the Indian mathematicians to further west. Al-Khwarizmi described the Indian place-value system of numerals based on zero and other numerals. Ibn Ezra, in the 12th century, wrote *The Book of the Number*, which spread the concepts of the Indian numeral symbols and decimal fractions to Europe.

'In 1247 the Chinese mathematician Ch'in Chiu-Shao wrote *Mathematical treatise in nine sections* which uses the symbol 'O' for zero. In 1303, Chu Shih-Chieh wrote *Jade Mirror of the Four Elements*, which again used the symbol 'O' for zero.

'In around 1200, Leonardo Fibonacci wrote *Liber Abaci* where he described the nine Indian symbols together with the sign '0'. However, the concept of *zero* took some time for acceptance. It is only around 1600 that *zero* began to come into widespread use after encountering a lot of supports and criticisms from mathematicians of the world.'

'So *shunyam* given by our forefathers was recognised in the world and made its place permanently as *zero*,' I commented.

'Interestingly, the word *zero* probably came from Sanskrit word for *shunyam* or the Hindi equivalent of *shunya*. The word *shunyam* was translated to Arabic as *al-sifer*. Fibonacci mentioned it as *cifra* from which we have obtained our present *cipher*, meaning empty space. From this original Italian word or from alteration of Medieval Latin *zephirum*, the present word *zero* might have originated.'

'That's really interesting. Uncle, I have a question. I have still a dilemma regarding division with zero. Could you please clarify more?' I expressed my problem.

'Well dear, it will take some more time for clarification. I will take it in some other day,' uncle remarked and again become engrossed with his problem after this long discussion.

I had also to finish my homework, so I stopped for the time being. But zero was moving in my brain, and many questions started coming in my mind regarding this amazing concept of *nothing*.

- **What's in a name?**
  Portuguese: zero
  Italian: nullità
  French: zéro
  German: null
  Spanish: cero
  Danish, Indonesian: nol
  Dutch: nul
  Finnish: nolla
  Hungarian: zero
  Norwegian: null
  Swedish: noll
- Words similar or closer to meaning of *zero* are *cipher*, *aught*, *nought*, *naught*, *not*, *nil*, *null*, *nothing, none.*
- Probably the synonymous word *(z)ero* and *(n)il* produced the word *zilch*, which is a slang meaning nothing. Sometime a person is also called *zilch* to indicate as being insignificant or nonentity.
- The word *goose egg* is another slang for *zero*, especially when written as a numeral to indicate that no points have been scored.
- In mathematics, the terminology *infinitesimal* indicates a function or variable continuously approaching zero as a limit.
- *Nilpotent* is an algebraic quantity that when raised to a certain power equals zero.

Source: A good account of history of zero may be found at http://www-groups.dcs.st-and.ac.uk/~history/HistTopics/Zero.html

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Recent Developments in Science & Technology

Snow Algae Absorb Greenhouse Gas :

The unicellular Algae "nivalis" leaves can absorb Green house gases. This red algae typically lives at altitudes higher than 2,500 meter and temperatures below freezing. Despite such conditions and correspondingly high radiations levels, nivalis can remove carbon dioxide from its surroundings through photosynthesis. Since snow-algae-covered areas might represent a small but significant global carbon sink.

William E. Williams, a professor of biology at St. Mary's College of Maryland and his colleagues studied patches of snow containing nivalis in the snowy rang of Rocky mountains. The scientists assembled a shallow Plexiglas chamber containing sensors for tracking photosynthesis and took measurements. They found that the bacteria absorbed carbon dioxide from both the soil and air when exposed to the ambient light of their surroundings. By filtering the natural light, the team also determined that nivalis absorbs the greenhouse gas more efficiently in red light than white, blue or green light because of its own coloring. They suggested that photosynthesis in a square meter of snow could soak up five grams of carbon each year which is certainly useful.

US recognizes Jamun's healing power :

An Indian research team has obtained a US patent on a compound extracted from the jamun, which reduces blood sugar levels. The US patens office awarded the patent for a "herbal therapeutic to control diabetes mellitus".

The research on the process was conducted by a team from the Biochemistry Department of a University of Delhi and ICMR.

Dr. Suman Bala Sharma, Professor, GTB Hospital said that "we are right now conducting toxicological tests and clinical trials. It has been tested on animals and shown good results. The component extract from Jamun pulp was tested on rabbits and found that it can reduce blood sugar." It is seen that unlike insulin injections the effects of this compound remained even after the dose stopped for two to three days.

It increases the activity of enzymes that lower blood glucose and also increase plasma insulin levels. It also reduces cholesterol levels.

ICMR has applied for the US patent in Feb 2001. Now it has been accepted but this is yet to be tested on humans and will take a time to make a proper drug.

Male Biological Clock Starts Ticking in Twenties

A lot of attention has been paid to the biological clocks of women recently, particularly when female fertility starts to decline and by how much. Now research published in the journal *Human Reproduction* suggests that a man's fertility starts to slide as early as his twenties.

Brenda Eskenazi of the University of California at Berkeley and Andrew J. Wyrobek of the Lawrence Livermore National Laboratory led a team that tested 97 healthy, nonsmoking males between the ages of 22 and 80 and found significant age-related decreases in semen quality, which is a well-known proxy for male fertility. Semen volume waned each year and sperm motility also declined significantly with age. However, Eskenazi notes, "unlike women, there appears to be no evidence of an age threshold, but rather a gradual change over time."

Complied by : Kapil Tripathi

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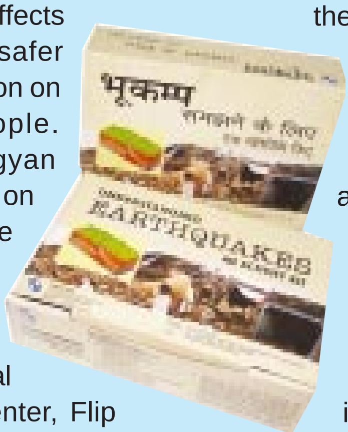
Understanding Earthquakes- An Activity Kit.

We cannot prevent Earthquakes, however, we can significantly mitigate their effects by identifying their hazards, build safer structures and communicate information on Earthquake safety among people. Identifying this as a necessity, Vigyan Prasar has brought out an activity kit on Earthquake, with the central message of "Earthquakes; we cannot avoid them. Let preparedness protect us". Quite a few activities like Cutout of Interior of the Earth and Seismological observatory; How to locate an epicenter, Flip books on various types of fault, simple demonstration of seismic waves with a slinky, three dimensional model of Earthquake faults, global mosaic of tectonic plates and on activity to understand the principle of seisomograph, colour activity sheet for seismic zones of India; Do's and Don'ts during and after an Earthquake; mini book on Earthquake related terms and activities to understand resistant structures, are the highlights at the kit.



Besides being an activity package, the kit is also useful for training programmes on Earthquake awareness. A comprehensive book entitled "Earthquakes" by Dr. S. Mahanti also accompanies the kit. The Kit is available both in English and Hindi. For more details and orders, write to the; Director, Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi 110 016.