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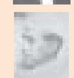
VP News

Inside

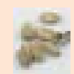
EDITORIAL

Bricks of the Universe (page 34)

Birbal Sahni (page 26)



Cardamom (page 23)



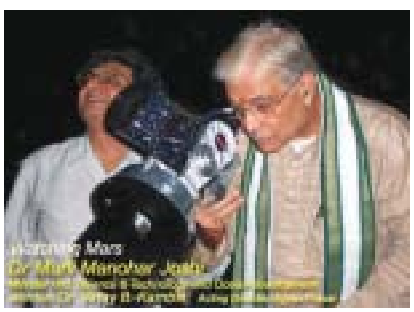
Carl Friedrich Gauss (page 22)

Recent Developments in Science and Technology (page 19)

Vigyan Prasar Mars Show

As part of Science popularization activities of Vigyan Prasar, MARS Shows coinciding with the MARS' closest approach to Earth was organised in the various parts of Delhi. Honourable Minister for HRD, Science & Technology and Ocean Development Dr Murli Manohar Joshi and Prof V.S. Ramamurthy, Secretary Deptt. of Science and Technology also had a view of Mars through the telescope.

On 28 August, 2003 a public viewing programme as well a lecture on Mars was organized at Kirkhi Village, Malaviya Nagar, in which more than 70 people participated.



On 29 August, 2003 a show was organised in Saket, South Delhi in which, more than 200 - children, students and general public participated. On 30 August, 2003, the show was held at Mayur Vihar in which over 800 people participated. The show covered live viewing of Mars through a telescope (by Sh Bhaskar Karnik, Fellow), Lecture demonstration through slides (Dr T V Venkateswaran, PSO), as well as Internet based viewing of Live pictures (Sh V. Krishnamoorthy, Consultant). A lecture on Mars was organised at DTEA Hr Secondary School, Lodi Road.

Science Communication Workshop in Kolkata

A two day Seminar-cum-Workshop on the state of science communication in West Bengal and Tripura was organized by Vigyan Prasar in collaboration with the Science Association of Bengal at Indian Association for the Cultivation of Science, Kolkata, on September 8 and 9, 2003. About 75 science communicators and writers from West Bengal and Tripura attended the Workshop. While welcoming the participants, Dr. Amit Chakraborty, Fellow, Vigyan Prasar, and former Station Director, All India Radio, Kolkata, explained the need for organizing such workshop where participants are expected to interact on the state of science communication in the regional language. Dr. Subodh Mahanti represented Vigyan Prasar and narrated aims, objectives and the activities being undertaken by Vigyan Prasar for spreading scientific literacy in the country. Dr. Saroj Ghosh, former Director General, National Council of Science Museums in his keynote address said: "Science is now being taught only in the classrooms but real science lies beyond the classrooms. Science is a process of understanding Nature. General public do not have positive attitude

(L to R) Dr. S. Roy Chowdhury (speaking), Dr. Saroj Ghosh, Prof. A. K. Barua, Dr. Subodh Mahanti and Dr. Amit Chakraborty

contd. on page...19

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

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Editor : Dr. V.B. Kamble

The Challenge of AIDS

The dreaded Human Immunodeficiency Virus (HIV) was spotted by Luc Montaigner and Robert Gallo in Pasteur Institute of Paris in 1983. Ever since, scientists across the globe have been putting in intense efforts to find a cure for this scourge. Till date no drug is available that is fully effective. Apparently, HIV infections were imported into India in the early to mid -1980s. It is the HIV that eventually causes Acquired Immune Deficiency Syndrome (AIDS).The first case of AIDS in India was detected in 1986. Since then, HIV infections have been reported in all States and Union Territories. While a vaccine for AIDS still remains elusive, the number of AIDS victims battling for life is growing at an alarming rate. According to the latest statistics of the National AIDS Control Organisation (NACO), the nodal agency that coordinates all AIDS control and prevention activity in India, currently over 39.7 lakh people in India have AIDS.

Why is it so difficult to develop a vaccine that can effectively prevent AIDS? HIV is an RNA (ribonucleic acid) virus, that is, its basic genetic material is RNA. DNA (deoxyribonucleic acid) and RNA are proteins that carry genetic information. A body cell proceeds from DNA through RNA to duplication of itself. Because it has no native DNA, the virus smartly reverses the normal sequence of duplication. RNA from the virus uses the host cell's DNA to produce its own viral DNA. It is then that the normal duplication process begins. Once inside a host body, HIV primarily infects 'T' lymphocytes and monocytes which are major components of the immune system. The virus takes over the reproductive machinery and starts reproducing itself. The cell weakens and eventually dies, releasing the newly made viruses into the blood stream. Other white blood cells are invaded and they too die. This is how the body is left vulnerable to 'opportunistic' diseases – tuberculosis, pneumonia, meningitis and encephalitis being only a few. Despite the long incubation period of a few years to turn into full blown AIDS, the body does not have enough time to produce antibodies to ward off disease. How is that? This is due to the fact that HIV mutates at such a fast rate that by the time an antibody is produced, the virus has changed its appearance and the antibody is unable to recognize its target! The virus also escapes detection by hiding inside a host cell's DNA or by directly moving from one cell to another cell, bypassing the blood stream. In the latter case, even if there is a specific antibody against the virus, the two will never come into contact, since the antibodies circulate in the blood.

How does HIV spread? With the exception of HIV transmission from mother to child and via infected blood / blood products, tissues or organs, all other HIV transmission occurs only as a result of those human behaviours that place an individual at risk of acquiring an HIV infection. The primary risk behaviours that place a person at significant risk of acquiring or transmitting an HIV infection include the sharing of drug injecting equipment and / or having unprotected sexual intercourse with multiple sex partners. Only those persons who are involved in some HIV-risk behaviours or whose sex partner is involved in some HIV-risk behaviours are at any risk of acquiring an HIV infection via sexual intercourse. In addition, the threat of tuberculosis related to HIV infection poses a major public health challenge due to the high prevalence of tuberculosis infection in India.

The distribution of HIV / AIDS in India is very heterogeneous. HIV epidemics are focused very sharply in a few southern States, with most of India having extremely low rates of infection. The major impact of HIV/AIDS is being felt in Maharashtra, Tamil Nadu, Pondichery, and Manipur. Since the first HIV-positive case was detected in India in 1986, the virus has moved beyond the confines of high-risk groups, such as sex workers, and entered the general population. The stigma associated with HIV/AIDS is only one of the problems faced by those unfortunate enough to get infected. The most worrying sign of this is the growing numbers of pregnant women who turn out to be HIV-positive. Active Retroviral Therapy (ART) - a combination of drugs - can prevent some of the infections associated with AIDS. However, this treatment being expensive has eluded the common man. ART provides the infected an opportunity to lead a normal life, delays onset of full blown AIDS, and reduces the transmission of HIV by infected mothers. In particular, in 1996, Brazil gave its citizens the right to free medication for HIV / AIDS, and backed by community programmes to monitor the drug consumption, was successful in stabilizing its HIV / AIDS population to half a million.

NACO estimates that there has been a 15 per cent increase in just one year in the number of new infections! Surely, prevention – through public awareness programmes and making the treatment available in public hospitals - is the only way to contain the spread of the virus that causes AIDS. However, we also have a responsibility to care for those already infected with HIV. Recently, South Africa, the country with world's largest HIV population, has taken an historic decision to begin treatment in public hospitals of its five million citizens infected with HIV. Incidentally, we are the world's second largest population affected with HIV. What hope do we have? Since at any point of time, only about 20 to 30 per cent of the infected need treatment, their treatment may only cost about Rs. 4,000 crore, equivalent to about 0.5 per cent of the GDP. This should certainly be affordable.

True, the number of people suffering from tuberculosis, malaria and diabetes is many times larger than HIV / AIDS and that these populations cannot be ignored. But in the absence of any cure, HIV / AIDS poses a unique challenge. Let us accept that we are confronted with a major health crisis. This why we need to follow the examples of Brazil and South Africa without any delay. Spreading awareness about HIV / AIDS is everybody's responsibility – mine and yours. Let us contain the virus before it gets fully blown up.

❒ V. B. Kamble

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Bricks of the Universe

Quarks, Gluons and Leptons

❑ U. C. Agrawala and H.L. Nigam

From the very beginning man wanted to know the ultimate particles constituting the matter: The first ever such attempt was perhaps that of a Greek philosopher who 'proposed the term 'atoms' and simultaneously by an Indian scientist named Kanada who proposed the concept of 'Anu' and 'Parmaanu' independently. These were the theoretical models and did not shed any light on the forces holding these particles together. After a blind period of about thousand and half years, Dalton in 1805 revived the concept of 'atom' .He proposed that the atoms of one element are identical while those of different elements were different. These atoms combine' to give different compounds. His concept of molecules is the same as that of 'Anu' proposed by Kanada. Thus the ninety different elements existing in nature are composed of ninety different atoms which compose all the matter present in nature. It is only the discovery of electron by J. J. Thompson and that of Rutherford's point-like nucleus-which led to a relationship between electrical properties of matter and its structure. Further developments concerning the nature and properties of the electrical charges revealed the structure of matter and the elementarity of the particles in a little more detail. Until 1932 the electrons, protons and neutrons were considered the only fundamental particles. Electrons formed the outer part of the atom while the protons and neutrons exist together inside the nucleus. The forces that hold the electrons and protons together were purely electromagnetic, while the force holding protons and neutrons together inside the nucleus is nuclear force which is 137 times stronger than that of electromagnetic force. The study for understanding the nature of these forces alongwith classifying a large number of newly created particles during the collision of high energy particles could give a model of matter consisting of quarks, gluons and leptons.

Murray Gell-Mann

The model is based primarily on the application of continuous group (Lie group) theory which involves rather complex mathematical manipulations. Our endeavor here is to present a simplified nonmathematical and elementary description of the model based on quarks and leptons and the forces holding the quarks together. We believe that this model, is not the final answer for the structure of matter and continuing further endeavor may reveal the more intricate relationship among the forces holding together these fundamental particles.

New particles

Usually there are two ways by which one could look inside a system (1) By irradiating the system with some proper radiation which can resolve the constituents inside the system (2) By colliding the system with high energy particles so that the constituents inside it may be ejected which are then analyzed. The first method has a limitation because the wavelength of the radiation used should be smaller than the size of the object. The radius of the nucleus is of the order of 10^{-13} cm. Rutherford by using the low energy α-ray radiation could only see the nucleus as a point. The second method consists in colliding the matter with high energy particles. In this way by using photons having energy greater than the ionization energy of the electrons, electrons are emitted from the atoms. By using very high energy beams of electrons, the presence of protons and neutrons was revealed.

For example, around 1930, new particles began to make their appearance in the cosmic ray events. Starting with Anderson's discovery of positrons in 1932, followed by the discovery of muon in 1937 in cosmic ray events, similar studies found evidence of more penetrating charged particles whose interacting behavior with matter could not be understood in terms of the then existing particles. This indicated a new alternative in which the observed penetratibilities of the particles in matter was explained by proposing a new series of particles with charge ± e with masses greater than the electron mass. Along with cosmic ray studies, the developments of a) particle accelerators capable of producing beams of very high energy particles (of BeV and GeV range) and b) the improved version of particle detectors (very sensitive) were the next accomplishments in this direction. With these systems many experiments have led to the discovery of new particles formed as a result of very high energy collisions between particles. The emerging particles after collisions in some cases were smaller in mass and in other cases larger than the colliding particles. In this way a very large number of particles are being produced by these accelerators. The number of particle have grown to the extent that it is impossible to enlist them here. In fact these particles are listed in "Particle Data Book" which is revised every two years by adding in it newly discovered particles.

During one such experiment in 1960, the collision of very high energy electron beam fired at protons revealed the presence of point-like particles the protons. Similar results were obtained using neutrons. This implied that protons and neutrons are no more elementary and contain point-like scattering centers within them.

Prior to knowing more about the nature of these new particles, their production raised an issue, " After all, from where these particles come? " Obviously these are produced in the nuclear reactions, but only when there is sufficient energy to create the additional mass of the new particles ($E= mc^2$). For example, if a proton of great enough kinetic energy strikes another proton (static or moving), some of the incoming proton's kinetic energy gets converted into mass, the mass of a p-meson according to the reaction $E= mc^2$.

$$p^* + p = p + p + \pi^0 \qquad (1)$$
$$p^* + p = p + n + \pi^+ \qquad (2)$$

In case the kinetic energy of proton is not so much, it simply bounces off from the target proton and no π - mesons are created.

Studying the properties of these new particles are classifed into two groups. Particles and anti-particles. This was also indicated by the discovery of positron, which has all the properties similar to that of an electron except the electric charge. In fact, no particle has been generated or formed which does not have its antiparticles. The antiparticles have properties identical to their respective counter particles except their charge. The charge of the antiparticle is opposite to that of particle. Or in some cases the magnetic moment of the antiparticles is oriented in the opposite direction relative to their spin (eg. Neutrino and antineutrino). Antiparticles are also produced in nuclear reactions, but they do not exist very long in presence of their particles and get annihilated producing energy in the form of photons.

It will be interesting to know that the first complete anti-atom having negatively charged nucleus surrounded by positron was generated in 1955. Neutral particles such as neutron, photon, etc. also have antiparticles which have the same mass and identical in some properties but opposite in others.

Table 1 list the names of a few particle then antiparticles and some of their properties.

Classification of Particles

Although there is an incomplete understanding of these particles, but progress has been made towards then classification and introducing some order in them. One of the classification has already been given above.

The second broad division consists of two groups (1) Fermions having half integral spins (eg. ½, 3/2. 5/2, etc) and obeying the Pauli exclusion principle (2) Bosons having either zero spin or integral spin (0,1,2,---) and not obeying the Pauli exclusion principle.

The third broad division consists of four groups (1) Photon (2) Leptons (3) Mesons (4) Baryons. Mesons and Baryons together are called Hadrons. We will briefly discuss them below.

(1) Photon

It is associated with electromagnetic field with no charge, no mass and moves with the velocity of light. Its angular momentum is one unit (unit = $h/2\pi$) It is boson and does not obey the Pauli principle.

(2) Leptons

Leptons have spin 1/2 unit {½ ($h/2\pi$)}. Its known members are electron (e^-), muon (μ^-) and taon (τ^-). Associated with them are their corresponding neutrinos i.e. e-neutrino (ν_e-), μ-neutrino (ν_μ^-) and τ-neutrino (ν_τ-). All these particles have their antiparticles. Thus we have positron (e^+) , antimuon (μ^+) and anti-taon (τ^+) and their corresponding antineutrinos (viz. $\bar{\nu}_e$, $\bar{\nu}_\mu$, and $\bar{\nu}_\tau$). The properties of μ^- and μ^+ are similar to e^- and e^+ respectively, except (a) their rest mass (mass of ≈ 207 times the rest mass of electron) and (b) their half life (2.2×10^{-6} secs) decaying into an electron, ν_μ and $\bar{\nu}_e$.

They all are involved in weak interactions. During interaction a quantum number [lepton charge (= ±1)] is conserved. All the leptons are given a lepton number of + 1 and the antileptons, a number -1. Thus a process in which fundamental particles are transformed into other fundamental particles can occur only when the lepton number is conserved during transformation. In this manner, it is easy to formulate that the total number of leptons in the universe remains unaltered.

(a) $\mu^- \to e^- + \bar{\nu}_e + \nu_\mu$ (3)

Lepton No. +1 +1 -1 +1 Total change = 0

and $n \to p + e^- + \nu_e$ (4)

Lepton No. 0 0 +1 -1 Total change = 0

(n,p, has a lepton number zero because they are not leptons)

(3) Mesons

Mesons have spin zero. They are classified as bosons, not obeying, Pauli principle. Any number of mesons can be in any one state. Their number does not remain unaltered in the universe. There are in general three categories of mesons (a) metastable mesons (having half life longer them 10^{-24} secs. (π - mesons or pions (π). (b) k-mesons (kaons) and η- meson (or eta). (π^+, π^0, π^-), three kaons (k^+, k^0, k^-) and one Eta particle (η^0) π+pions and K^+ kaons have their corresponding anti-pions viz, π^- and K^- respectively. η^0 is its own antiparticle. Their properties are given in Table 1. Pions interact strongly. With nucleons they are responsible for strong forces. They may act as a glue for holding protons and neutrons together in the nucleus.

If one studies nuclear reactions involving mesons one finds that there is no conservation law for mesons analogous to the law of lepton number conservation. Thus in the reaction,

$$p + p \to p + p + \pi^0 \qquad (5)$$
$$p + n + \pi^+$$

and $p + n \to p + p + \pi^+$

we start with no meson but end up with one meson ($\pi^{\pm/0}$). In (6) though the lepton number is preserved, but a meson disappears and only leptons appears in its place.

$$\pi^0 \to \gamma + \gamma \qquad (6)$$
$$\pi^+ \to \mu^+ + \nu_\mu$$
$$\pi^- \to \mu^- + \bar{\nu}_\mu$$

This principle is also true with other bosons, (eg. photons). Thus when an atom absorbs a light photon (boson), photon disappears or when it emits light photon (boson) a photon is created. In equation (6) a π^0 meson disappears to give two bosons (photons).

(4) Baryon

All the baryons have spin ½ or 3/2 and are fermions obeying Pauli principle. Baryons further can be classified (a) nucleons (n, $\bar{n}$, p, $\bar{p}$) (b) Lambda particles (Λ^0 $\bar{\Lambda}^0$) (c) sigmas (Σ^+, Σ^0, Σ^-, $\bar{\Sigma}^+$, $\bar{\Sigma}^0$, $\bar{\Sigma}^-$) and (d) χ's ($\Xi^0\Xi^-$ $\bar{\Xi}^0\bar{\Xi}^+$) (e) omegas ($\Omega^-\bar{\Omega}^+$) having the spin 3/2. The Λ, χ and Ω particles are known as hyperons because their rest masses are heavier than nucleons. Their other properties are given in Table 1.

Analogous to lepton number (conserved in weak interactions) baryons also follow a law of conservation i.e. the Baryon number. All baryons are given + 1 as their baryon number and their antibaryons, - 1 as their baryon number. Those which are not baryons are given 0 baryon number. Thus all mesons are assigned zero as their baryon number. Baryon number is the same thing as the mass number 'A' assigned to any atomic nucleus. Thus, in the decay of neutron (Eq. 7)

$$n \rightarrow p + e^- + \bar{\nu}_e \qquad (7)$$

n and p are given +1 as their baryon number while e and $\bar{\nu}_e$ have zero as their baryon number. In this decay process, both baryon number and lepton number are conserved. .

Interestingly Λ^0 and neutron by particles are similar in many respects and there is a possibility of replacing neutrons in a atomic nucleus.

Two other conservation laws

Besides lepton number and baryon number, there are two more conservation laws which are to be observed in any nuclear reaction. These are (a) Strangeness Number and (b) Isotopic spin.

Strangeness Number

Weak interactions involving leptons are generally of two types

(1) Processes involving neutrinos, e.g.

$n \rightarrow p + e^- + \bar{\nu}_e$

$\pi^+ \rightarrow \mu^+ + \nu_\mu$

(2) Process involving particles which are called as

Table 1.

Name	Symbol Char	Rest mass (MeV)	Spin	Lepton no.	Baryon no.	Strangeness	Mean life (sec)	Quark composition	Sym 1 Charge	Rest. Mass (MeV)	Spin	Lepton No	Baryon No.	Strangeness	Decay
	Particle								Antiparticle						
Photon	γ	0	1			0	Constent		y	0	1				
graviton		0	2			0	Constent		y	0	2				
Electron	β^-, e^-	0.511004	1/2	1	0	0	Constent		B+, e+	0.511004	1/2	-1	0		
Neutriono	ν_e	0	1/2	1	0	0	Constent		ve	0	1/2	-1	0		
Meson	μ^-	105.66	1/2	1	0	0	2.198×10^{-6}		u+	105.66	1/2	-1	0		
Neutriono	ν_μ^-	0	1/2	1	0	0	Constent		$\bar{\nu}_\mu$	0	1/2	-1	0		$e^-+\bar{\nu}_e+\bar{\nu}_\mu$
Taon	τ^-	1.784 GeV	1/2	1	0	0	3.0×10^{-15}		τ^+	1.784 GeV	1/2	-1	0		
Neutriono	ν_τ	0	1/2	1	0	0			$\bar{\nu}_\tau$	0	1/2	-1	0		
Pion															
(Neutral)	π^0	134.97	0			0	0.84×10^{-16}		π^0	134.97	0		0		2γ
(Positive)	π^+	139.58	0			0	2.6×18^{-8}	p $\bar{n}$	π^-	139.58	0		0		$\mu^++\bar{\nu}_\mu$
(Negative)	π^-	139.58	0			0	2.6×18^{-8}	n $\bar{p}$	π^+	139.58	0		0		$\mu^-+\bar{\nu}_\mu$
Kaon	K^0	497.8	0				0.84×10^{-10}	s $\bar{p}$	$\bar{K}^0$	497.8	0		-1	-1	$\pi^\pm+\pi^++\pi^-$
(Neutral)	K^0_S					+1	5.17×10^{-8}	n $\bar{s}$							
	K^0_L														
(Positive)	K^+	493.8	0			+1+1	1.24×10^{-8}	p $\bar{s}$	K^+	493.8	0		-1	+1	$\pi^\pm+\pi^0$
(Negative)	K^-	493.8	0			-1	1.24×10^{-8}	s $\bar{p}$	K^-	493.8	0			-1	$\mu^\pm+\nu_\mu^-$
Eta (Neutral)	η^0	548.8	0			0	2.5×10^{-19}		η^0	548.8	0			0	$\pi^++\pi+\pi^0$
Ex (Neutral)	X^0	957.5	0				71.6×10^{-22}		X^0	957.5	0			0	$\pi^++\pi^-+\eta^0$ $\pi^++\pi^-+\gamma$
Rho															
Positive	p^+	765	1						p^-	765	1				$\pi^++\pi^0$
Negative	p^-	765	1						p^+	765	1				$\pi^-+\pi^0$
Neutral	p^0	767	1						p^0	767	1				$\pi^++\pi^-$, $\pi^0+\pi^0$
Omega	ω^0	783.9	1						ω^0	783.9	1				$\pi^++\pi^-+\pi^0$
Kas															
Positive	K^{*+}	892	1						K^{*-}	892	1				$K^++\pi^0$, $K^0+\pi^+$
Negative	K^{*-}	892	1						K^{*+}	892	1				$K^-+\pi^0$, $K^0+\pi^-$

contd....

Neutral	K^{*0}	899	1						K^{*0}	899	1				$K^0+\pi^0$, $K^++\pi^-$
Phi	φ^0	1019.5	1						φ^0	1019.5	1				$\pi^++\pi^-+\pi^0$
Proton	p+	938.26	1/2	0	1	0	(Constent)	ppn	$\bar{p}^-$	938.26	1/2	0	-1	0	
Neutron	n^0	939.55	1/2	0	1	0	0.39×10^3	pnn	n^0	939.55	1/2	0	-1	0	$p+e^-+\bar{\nu}_e$
Lambda	Λ^0	1115.6	1/2	0	1	-1	2.52×10^{-19}	pns	$\bar{\Lambda}^0$	1115.6	1/2	0	-1	+1	$p+\pi^-$, $n+\pi^0$
Sigma															
Positive	Σ^+	1189.4	1/2	0	1	-1	0.08×10^{-10}	pps	$\bar{\Sigma}^-$	1189.4	1/2	0	-1	+1	$p+\pi^-$, $n+\pi^+$
Neutral	Σ^0	1192.5	1/2	0	1	-1	1.0×10^{-14}	pns	$\bar{\Sigma}^0$	1192.5	1/2	0	-1	+1	$\Lambda^0+\gamma$
Negative	Σ^-	1197.4	1/2	0	1	-1	1.49×10^{-10}	nns	$\bar{\Sigma}^+$	1197.4	1/2	0	-1	+1	$n+\pi^-$
x															
Neutral	Ξ^0	1314.7	1/2	0	1	-2	3.0×10^{-10}	pss	$\bar{\Xi}^0$	1314.7	1/2	0	-1	+2	$\Lambda^0+\pi^0$
Negative	Ξ^-	1321.3	1/2	0	1	-2	1.66×10^{-10}	nss	$\bar{\Xi}^+$	1321.3	1/2	0	-1	+2	
Delta Double	Δ^{++}	1233	3/2	0				ppp	$\bar{\Delta}^{--}$	1233	3/2	0			$p^++\pi^+$
Positive															$p+\pi^0$
Single Positive	Δ^+	1233	3/2	0				ppn	$\bar{\Delta}^-$	1233	3/2	0			$n^0+\pi^+$
Neutral	Δ^0	1234	3/2	0				pnn	$\bar{\Delta}^0$	1234	3/2	0			$n^0+\pi^-$
Negative	Δ^-	1241	3/2	0				nnn	$\bar{\Delta}^+$	1241	3/2	0			
Sigma Star															
Positive	Σ^{*+}	1383	3/2	0			-1	pps	$\bar{\Sigma}^{*+}$	1383	3/2	0		+1	$\Lambda^0+\pi^+$
Neutral	Σ^{*0}	1385	3/2	0			-1	pns	$\bar{\Sigma}^{*0}$	1385	3/2	0		+1	$\Lambda^0+\pi^0$
Negative	Σ^{*-}	1386	3/2	0			-1	nns	$\bar{\Sigma}^{*-}$	1386	3/2	0		+1	$\Lambda^0+\pi^-$
x Star															
Neutral	Ξ^{*0}	1529	3/2	0			-2	pss	$\bar{\Xi}^0$	1529	3/2	0		+2	$\Xi^0+\pi^0$, $\Xi^-+\pi^+$
Negative	Ξ^{*-}	1534	3/2	0			-2	nss	$\bar{\Xi}^-$	1534	3/2	0		+2	$\Xi^0+\pi^-$, $\Xi^-+\pi^0$
Omega															
Negative	Ω^-	1672	3/2	0			-3	sss	$\bar{\Omega}^+$	1672	3/2	0		+3	$\Xi^0+\pi^-$, $\Xi^-+\pi^0$

'Strange particles,' viz. kaons, and hyperons, (Λ, Σ, Ξ and Ω) . For example.

$\Lambda^0 \rightarrow p + \pi^-$ (weak interaction)

Since this reaction involves an emission of π particle, we should categorize it as a strong interaction having a half life of 10^{-23} sec. In fact, its half life is found to be 2.5 x 10^{-10} sec. Therefore it is a weak interaction. To explain such reactions, another quantum number, called the strangeness number has been assigned to particles like Λ^0 (baryons and mesons which ought to interact by strong interaction; but do not go by that type of interaction). Table I includes the strangeness number of the hyperons. (the strangeness number to their anti - particles are the same with sign changed. eg. Strangeness number of K^0 is + 1 and that of $\bar{K}^0$, - 1). Thus all processes with a half life of 10^{-23} sec that undergo through strong interaction are also found to conserve strangeness number. This is trivial for the processes not involving strange particles (eg. $n \rightarrow p + \pi^-$) because the strangeness zero is assigned to all the particles involved in the process. But consider such processes in which strange particles are involved (eg. $\pi^- + p \rightarrow K^0 + \Lambda^0$). Since on the reactant side π^- and p have strangeness number zero on the right side strangeness number of K^0 is + 1, the strangeness number of Λ^0 ought to be -1 in order to conserve the strangeness number. Hence the process goes through strong interaction. On the other hand in the reaction ($\Lambda^0 \rightarrow P+\pi^-$), the strangeness number of Λ^0, p and π^- are + 1, 0,0 respectively and hence the strangeness is not conserved in the reaction. With the result, the process goes through **weak** interaction (half life = 10^{-10} sec).

Another parameter assigned to all the hadron particles is Y (hypercharge) defined as Y = (B+S) where B is the Baryon number. If Y is conserved in the reaction, both B and S must also be conserved in it.

Isotopic spin

Another quantum number to be conserved in strong interaction is related to charge quantum number Q, it has the value +1 for particles with charge +e, zero for neutral and - 1 for particles with charge e^- . There are particles with charge 2e, or - 2e (Q is the same as the atomic number Z for a nucleus, and the baryon number, A).

Isotopic quantum number is needed because the fundamental particles are grouped in smaller submultiplets

(Table 1) whose members have approximately the same mass and spin, but they have different electronic charge. Thus we have submultiplets like (n, p), (π^0, π^+, π^-), $(\Sigma^0, \Sigma^+, \Sigma^-)$, (Ξ^0, Ξ^-), (K^0, K^+) etc. A small group of this kind is known as charge multiplets (isomultiplets). The isotopic spin number I is the same for all the members of a charge submultiplet (n,p) have the same value of I, so are $(\Sigma^0, \Sigma^+, \Sigma^-)$and so on. The number of members in a charge submultiplets is (2I + 1) (n_0 = 2I + 1). Thus for (n,p) charge multiplet this number 2. (2 = 2I + 1, hence I= ½). In this way the value of I for each charge nultiplets can be calculated . The values of I for $(\Sigma^0, \Sigma^+, \Sigma^-)$, (π^0, π^+, π^-) $(\Xi^0, \Xi^-)$and (K0, K+) are respectively + 1, +I, ½, ½. The reason for such a definition of I is that there is strong mathematical analogy between spin quantum number `J' associated with angular momentum and the value of I. Similar to the angular momentum J and J_3, for an above one can also calculate the isotopic spin I and I_3. Thus for I= ½, we may have I_3 to be (1/2, -1/2) and for I= 1, I_3, can have the value (+1, -1,0) i.e. (2I+1) values.

As we range through (2I+1) values for I_3, we can also range (2I+1) values for Q (charge), but I_3, and Q are not the same thing. We can define the value of Q as

$$Q = I_3 + 1/2\,(B+S) = I_3 + Y/2$$

All the members of a charge multiplet have the same value of Y and so at the same value of s one may have different I values. In this manner we have assigned B, I, I_3 , Q, Y and S quantum numbers to all the metastable hadrons. Table I gives these values.

(A) Pattern

Now we consider each set of related particles as multiplets. We draw a I_3 Y plane (Fig . 1) with I_3 as abscissa and Y as ordinate. In this plane, let us label each particle in a submultiplet that increase by one unit increase of electric charge (eg. p^+, n^0). The origin is chosen at the middle, so for each positive observed number, there is also a negative one.

Let Y be a hypercharge and I_3 its isotopic spin component for a given particle. One, can then represent one particle by one point in the plane. This way one can represent all the particles of one multiplet on this plane. Figs. 2 and 3 illustrate the plots for baryons with spin ½ and spin 3/2 particles. Similar plots can be made for mesons. In this manner all baryons and mesons can be classified in an eight fold and decafold ways on the Y I_3 plane.

We have assigned a fourth quantum number to these particles, viz. strangeness (S). If the strangeness is absolutely conserved in nuclear reactions the particles with S≠0 (eg. $\Sigma^-, \Sigma^0, \Sigma^+$,$K^0$, K^+ etc.) should not decay via strong interaction into lower energy hadrons. They ought to be stable particles. In fact, all these particles do decay. This decaying, through forbidden, through strong interaction, takes place via weak or/ and electromagnetic interactions.

Gell-mann and No'emann explained these patterns of the particles on the I_3 Y plane using symmetry principles applied to these particles. He considered the group SU(3) which is a group of unitary unimodular transformation in the complex plane in three dimensions. Here we shall not deal with this group. We will only describe some of is relevant results. Accordingly one can assign two quantum number (eg. I_3 and S) to each member of each part of the multiplet. The possible dimensions of the irreducible representation of this group could be 1, 3, 3*, 6,6*, 8,10, 10*--- etc. Thus the mesons and baryons can be assigned to eight or ten dimensional irreducible representation (cf Table II)

Table II

Baryons	Mesons	Quantum Nos. I	Y= B+S
n, p	K^0 K^+	1/2	1
$\Sigma^-, \Sigma^0, \Sigma^+$	π^-, π^0, π^+	1	0
Λ	n^0	0	0
Ξ^-, Ξ^0	$K^- K^0$	1/2	-1

If Hamiltonian were truly invariant under the operations of SU(3) all the particles belonging to a multiplet would have the same energy (mass), but in reality it is not true. The reason given for the different masses in a given multiplet is that the symmetry SU(3) is broken by the medium strong and electromagnetic interactions leading to the differentiation between particles of different hypercharge and different I_3, (Fig 5.). It is this breaking of SU(3) symmetry, which is responsible for the mass variations among the particles of the same multiplets.

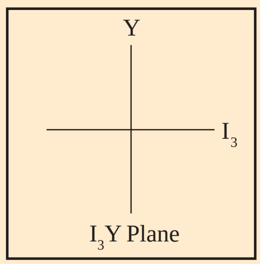

Fig. : 1

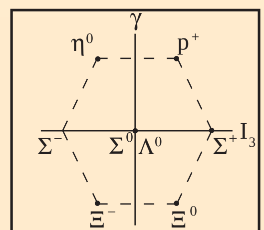

Fig. 2 : Baryon with spin

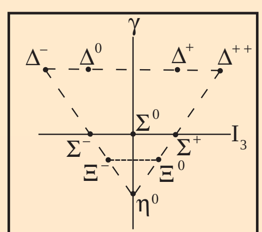

Fig. 3 : Baryon with spin

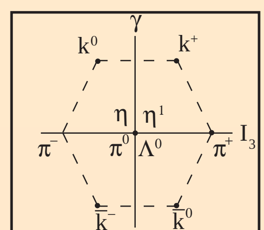

Fig. 4 : Mesons

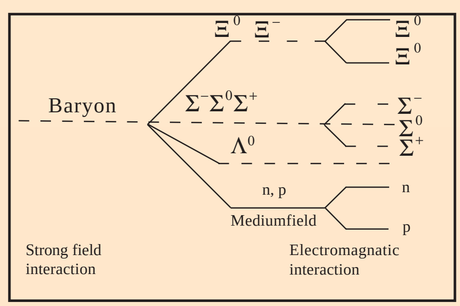

Fig. 5 : Mesons

Analogous to Mandeleef's orginal periodic table one can make predictions for the new undiscovered particles Thus a particle Ω^-, not known before, but predicted by SU (3) classification was discovered at a later date having the mass 1675 MeV and found its place in SU(3) decuplet whose nine members were known before. In this manner the theory can organize the data of all the known or undiscovered particles. As energies of the colliding particles are increasing by designing of the better accelerators more and more short lived particles have been and will be generated. These are called "Resonances". All these resonances also find place in the SU (3) scheme.

Is the above theory (e.g. eight fold way) a complete and dynamical theory? Despite the prediction of the new particle Ω^- fitting well in the decuplet fold way, it is not found to be complete Thus (a) it can not predict the new "**supermultiplets**". (b)Although it has given a relationship between the masses of the hadrons, but the problems like "why the particles have masses" could not be answered by it. It, therefore, could not reflect the whole picture of the particles. However, the patterns explained by it, paved the way for going towards some more fundamental structure of matter. This is like the periodic table of Mendeleev which helped in explaining the structure of atoms through electrons, protons, and neutrons.

Quarks

The answer of the problem raised in the preceding paragraph came from Gell Mann and Ne'eman simultaneously in 1963. They proposed that there should be particles belonging to the irreducible representation of dimension three of SU(3) group (see foregoing paragraph). The quantum number of these particles deduced by them should have the values I= ½, Y = 1/3 and I=0, Y= -2/3. Using these values of Y the values of Q for these particles should be (Q = 2/3, -1/3) and (Q= -1/3). It is these fractionally charged particles which he named as "QUARKS" thus there should be three quarks. Up (u), down (d) and strange quarks (s) because it carries strangeness. The antiquarks are designed respectively as $\bar{u}$, $\bar{d}$ and $\bar{s}$. The properties of these quarks are given in Table III. One of the surprising features of quarks is that they all carry non-integral charge and 1/3 baryon number. For their antiquarks, the charge, baryon number and the strangeness number for charm, beauty and truth quarks number are opposite in sign. The spin for both quarks and antiquarks is ½ and the isospin number I is ½ for d and u and zero for s quarks.

Table III (Quarks)

Quarks Properties	**d**	**u**	**s**	**c**	**b**	**t**
Charge	-1/3	2/3	-1/3	2/3	-1/3	2/3
Mass (MeV)	4	7	150	1300	5500	17000
Spin	1/2	1/2	1/2	1/2	1/2	1/2
Strangeness	0	0	-1	0	0	0
Charm	0	0	0	1	0	0
Beauty	0	0	0	0	-1	0
Truth	0	0	0	0	0	1
Baryon no.	1/3	1/3	1/3	1/3	/13	1/3
Isospin no.	1/2	1/2	0			

According to this model the following rules are applicable.

1. All mesons are composed of one quark and one antiquark
2. All baryons are composed of three quarks
3. All antibaryons are composed of three antiquarks
4. Leptons do not have the quark structures.

The quark configurations of all the mesons and baryons are given in Table 1. It can be verified from the values given in (Table I) that the electric charge, the baryon number and the strangeness of all the particles equals the sum of the corresponding values (quantum number) of the composing quarks. It should be further noted that the quark model is applicable to hadrons and to those particles, which interact, by strong forces. This model also explains other properties of the particles. Thus,

(1) There are only nine mesons of spin zero with masses less than 1500 MeV. (eight mesons +n'). The number nine signify that there are only nine different combinations of quark and antiquark pairs. These are (u, $\bar{u}$), (d $\bar{d}$), (s $\bar{s}$), (u, $\bar{d}$), (u, $\bar{s}$), (d, $\bar{u}$), (s, $\bar{u}$), (d, $\bar{s}$) and (s, $\bar{d}$). The charge and strangeness of these pairs (mesons) are given in Table IV. According to these values of Q and S, these nine mesons occupy seven positions. It is not possible to expect mesons with strangeness - I alongwith + 1 charge or strangeness of + 1 with Q= -1.

Table IV (Mesons)

Q→ S↓	+1	0	-1
1	u $\bar{s}$	u $\bar{d}$	-
0	d $\bar{s}$	u $\bar{u}$, d $\bar{d}$, s $\bar{s}$	s $\bar{d}$
-1	-	d $\bar{u}$	s $\bar{u}$

Table V (Baryons)

Q→ S↓	0	-1	-2	-3
+2	uuu	-	-	-
+1	uud	uus	-	-
0	udd	uds	uss	-
-1	ddd	dds	dss	sss

In the same way there are only ten combination of three quarks corresponding to ten values of S and Q (see Table V). Again it is understandable why baryons with strangeness - 3 along with charge 0 and 1, or strangeness of -2 with charge of +1, or strangeness of - 1 with charge of +2 could not be found.

This model also explains the integral spin values of mesons the half integral values of baryon. In mesons the spin values can be zero (↑↓) or integral spin (↑↑) . The baryon on the other hand is the combination of three quarks. Their spin can be added to ½ (↑↑↓) or 3/2 (↑↑↑). With the result, the values of the spin angular momentum of the baryons are half integral. Since the orbital angular momentum of the quark (L+S) can be 0,1,2,-- so the total angular momentum J(L+S) can be integral (L +O) for mesons and half integral (L + ½ or 3/2) for baryons. In the same way baryon number for the mesons will be zero and for baryons +1.

Note that only two quarks u and d (present in protons and neutrons) are sufficient to build all the matter in the world, because our matter is composed of only protons, neutrons and electrons only.

In the above description only three quarks u, d and s are defined. But in the table, the number of the quarks given is six. It is because that other three quarks are later discovered while explaining the phenomenon of those weak interactions, in explaning which the net electric charge of the participating hadrons does not change; but its strangeness changes, Similarly the unified field theory (UFT) of weak and electro magnetic interactions (electro weak theory) pointed out to added symmetry between quarks and leptons. An addition of a new symmetry implies the addition of a new quantum number. This led to for fourth quark c, i.e the charm similar to s quark which carry the quantum number strangeness. The quantum number of charm is +1, which no other quark has. This is called the flavour. This flavour (or charge) is conserved in strong electromagnetic interaction but not in weak interactions. It carries the electric charge of +2/3 baryon number 1/3, and charm +1 while the anticharm quark has the values (-2/3, 1/3 and -1) respectively.

The discovery of still heavier particles could be explained by the higher quarks (u,d,s,c) paved the way for the existence of other quarks. A fifth quark heavier than c quark was then found and named as beauty quark (b) with flavour 1. It explained the presence of another heavy meson whose structure is written as (b d). Its properties are given is Table V. Since all other quarks belong to one generation (eg. (ud) one generation, (s.c) second generation), beauty quark remained without its partner in the third generation. The led to the speculation of the sixth quark with a new kind of flavour. It was later found in 1985 and named as Truth (t) when a new meson containing the truth containing quark was detected. Its properties are given in Table VI. Thus these six quarks were able to explain the structure of matter present till date. Possibly the future may detect another generation of quarks besides these three generations. This could only be possible if we go still higher energy beams of particles, which need still bigger accelerators.

The present situation is that we have six quarks grouped in three generations (u,d) (s,c), (b,t) which can explain all the matter. All the new hadrons fit well on the assumption that three quarks form a baryon and pair of quark and antiquark form a meson. The properties of some of the mesons and baryons are given in Table VI.

Table VI : Quark configurations

Mesons	Baryons	Atoms
π^+ .... $u\bar{d}$	p = uud	He = $u_6 d_6 e_2$
π^- .... $\bar{u}d$	n = udd	c = $u_{18} d_{18} e_6$
π^0 .... $u\bar{u} + d\bar{d}$	Λ = uds	
K^+ .... $u\bar{s}$	Λ^{++} = uuu	
φ .... $s\bar{s}$	Ω = sss	
J/φ .... $c\bar{c}$		
Y .... $b\bar{b}$		

Gluons

It will be interesting to find that uptil now no particle has been isolated which has two quarks or two quarks and an antiquark. These quarks prefer to combine each as a quark and an antiquark pair or three quarks together. Secondly no account has been given what holds them quarks and antiquarks together in mesons and baryons.

Experimentally it has been found that quarks in hadrons behave as if they are almost freely floating and the bonds between them are weaker than that found between the nucleons inside the nucleus. Despite the fact that bonds between quarks inside baryons and mesons are weak, no one could isolate a free quark . It implies that possibly the forces between quarks are weaker when they are close together but become stronger and stronger as the distance between them becomes greater and greater (confinement of quarks). It has also been found that the interaction between them is strong.

Quarks are Fermi particles with spin ½. How then the three quarks (e.g. in Ω (sss), Λ^{++}(uuu) or Λ^{-}(ddd) with a total spin 3/2 with zero orbital angular momentum (L=0) are expected to obey the Pauli principle. Faced with this problem, of the most acceptable explanation given by physicsts is that quarks do obey Pauli principle, but they possess another quantum number (colour) which can have one of the three different values for each quark , Red (R), Yellow (Y), Blue (B). Thus every quark can have any one of the three colors. Thus in Ω for example, the trhee quarks (s,s,s) are indeed identical in all their numbers (strangeness, charge, spin etc.) but they differ with respect to their new quantum number viz, colour eg., R, T, or B, Thus the three quarks in Ω are a red s, a yellow s and a blue s. In this way the three quarks are not in the same state and thus follow the Pauli principle. The combination of three different colours like in Ω makes it colorless (or white). Similar is the case of antiquark system. Thus an important principle regarding colour combination of quarks in hadrons and mesons is that only coloured quarks are allowed in mesons and hadrons whose colour combination make them colourless. Thuse quark and antiquark combination makes them colourless. The three colours together make a hydron colourless as in Ω particle.

The forces between quarks originate in colours. In that way they behave like electrical charges. The theory of this coloured force (chromdynamic force) also implies that a new form of matter name "GLUONS" should also exit. Analogous to electrical force similar colour charges repeal while the opposite attract as happens in meson where we have a combination of opposite colour charges. Besides these opposite charges in quarks and antiquarks, there are unlike charges like Red-Yellow or Red-blue etc. The theory in that case assumes that the messengers of chromic forces has eight electrically neutral particles of zero mass and spin 1. (resembling photons). These parricles are named as GLUONS. These gluons, unlike photons, have colors (photon are colourless with no electric charge.) In fact gluons are bicoloured made up of a colour and anticolour (like mesons). Being themselves coloured, they exert chromodynamic force among each other which serves as a string binding in quarks. This causes force to increase as the separation between quarks increases. Thus when a gluon is absorbed or emitted, the colour of the quark changes depending on the colour and the anticolour of the gluon which it carries.

For example, if the blue U quark emits a gluon carrying the blue and antired (GB r), the quark becomes a red U quark ($U_b \rightarrow U_r + Gb\bar{r}$ and $dr + Gb\bar{r} \rightarrow d_b$).

There are six colour changing gluons ($Gr\bar{b}$, $Gr\bar{y}$, $Gb\bar{r}$, $Gy\bar{r}$, $Gy\bar{b}$) and two colour preserving gluons which carry combinations of colours called 'Go, Go'. This makes the number of gluons to be eight in number.

Similar to charge particles, an accelerated quark emits gluons (no free gluon has been separated) but these emitted gluons remained confined within the hadrons. In case, it gets liberated, it gets converted within the hadron to a known hadron prior to their existence in free state. Gluons are continually exchanged between the quarks and a part of the momentum of the quarks is being used by these gluons running to and fro within it. Thus they produce a very strong force within the quarks. The theory that describes the colour force among quarks within hadrons is known as quantum chromodynamics (Q C D) similar to quantum electrodynamics (Q E D) which describes the electrical force. Through the Q C D is highly mathematical in nature but it appears to provides a reasonable and logical description of the "REAL" strong interactions occurring between the quarks. It also explains as to why the forces between the quarks are different from the forces among hadrons (like nuclear forces between protons and neutrons). The "Real" strong force acts only between than are the residual forces like 'Vander waals' or covalent forces between atoms. These residual forces are also strong and act only over short distances among the mesons. The "REAL" strong forces are responsible for the properties of baryons (like magnetic moments) and plays a very important role in generating masses of the hadrons, giving rise to subtle fine structural effects in the spectrum of particle masses.

The excitation energy in atomic systems are only a few electron volts and an excited atom can radiate extra energy as a photon and relax to its ground state. If the photon energy has energy more than twice the rest mass energy to an electroc, it gets materialized to an electron-positron pair. The requires an energy of MeV range, quite beyond the atomic range. Quark systems have excitation energy to hundreds of MeV. Excited levels can decay by emitting photons or by creating quark and antiquark pair from its excess energy and relaxing to its ground state such as a proton.

Notice how the organizational scheme of mesons and baryons is consistent in specifying that quarks and gluons can not be isolated, by asserting that the isolated particles must be colorless. Since each quark is coloured, so the isolated quark must also be coloured and so is gluon. Colour free combinations of quarks must consist of quark-antiquark pair or a trio of quarks or antiquarks each containing one of the three colours.

During the various voyages into the structure of matter, we have identified various building blocks. But we believe that the Nature should be very simile and there should be only a few building blocks used in the building of matter. Thus the concept of economy describes the diversity represented by one hundred elements, formed by proton, neutron and electron as their building blocks. The same principal has taken to the concept of quarks and antiquarks bonded together by gluons and to that of six leptons as the building blocks of all matter. It is possible that further proliferation of the particle in future may lead us to still another theory where still fewer building blocks may construct the whole matter around us. At the time of the article going to the press , the discovery of a new particle contain five quarks ' pentaquaks" has been announced. Theoretical prediction about pentaquaks was made by Russian physicist in 1997.

Let us wait and look for future developments.

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Letters to the Editor

Dream 2047 is very informative and full of knowledge specially for researchers like us. I am a researcher in Wildlife Ecology. Your magazine is very different from others. The editorial, “Thomas Alva Edison - The Wizard of Menio Park” was very good.

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Dream 2047 is very much interesting to read about scientists, who has contributed in developing science. The “DNA Double Helix” and “25 years of IVF” articles were very interesting. I congratulate you and your faculty for developing scientific knowledge and scientific temper as well as scientific thinking among the individuals.

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Birbal Sahni

Founder of Palaeobotanical Research in India

❑ Subodh Mahanti

"Through the span of a century, men have arisen now an again who, by their ability, their dint of application and inspiration, have shifted facts of science amidst a maze of confusing evidence, and who have thus left an indelible impression upon the sands of time. Such men have not merely unveiled scientific truths, not only contributed their iota to the sum total of scientific knowledge, but have also added dignity and lustre to the science they have pursued. Birbal Sahni was one among such men.

Quoted from "Professor Birbal Sahni" (A booklet), Birbal Sahni Institute of Palaeobotany, Lucknow, 2002.

My own interest in palaeobotany raises the hope that I may help bring this fascinating subject more prominently to the notice of my countrymen; and perhaps even succeed in including a larger number of them to turn their attention to the rich field that it offers for original investigation.

Birbal Sahni while speaking as President of the Botany Section of the Indian Science Congress in 1920.

Many of the problems of the country could be easily solved if the people had the single-minded devotion to duty that marks Dr. Sahni…There is need for reconciling and adjusting one's mind to the changing times and thinking in a scientific manner. Science alone can help us to understand our problems, for science means seeking the truth. I am, therefore, happy to lay the foundation – stone of this institute which will help the people to take interest in science and create in them a consciousness about science.

Pt. Jawaharlal Nehru in his speech while laying the foundation stone of the Birbal Sahni Institute of Palaeobotany on April 3, 1949.

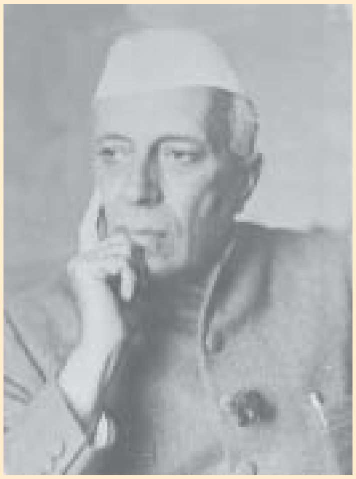
Birbal Sahni, the founder of palaeobotanical research in India, was a dreamer and a visionary. He founded the Institute of Palaeobotany at Lucknow, which was later renamed as Birbal Sahni Institute of Palaeobotany after his death. Sahni was a great teacher. He believed that to be a good teacher one has to be a good researcher. He was a superb communicator of science at all levels. Sahni was a great patriot. To quote one of his students, T. S. Sadasivan: "To his students he was an ideal to be emulated, he was loved and respected. A nationalist to the core, his personality was one that attracted attention of the entire scientific community. He never sought anything from anyone. In fact, he was sought after for his wise counsel both Administrative and Academics. A man of taste. Everything about him was spick and span; his attire was simple and elegant, a flowing 'Achkan', 'Churidars' and a Gandhi Cap, all from handspun, handwoven khadi. All this added to his charm. Even after forty years of his passing away, we, the students of this enchanting Guru have nothing but fond memories of the many years we were privileged to spend with such a one. His philosophy of life was one of attached detachment like a true Vedantin, for, that is what in his outlook. Duty was his main forte."

Birbal Sahni

Birbal Sahni was born on November 14, 1891 at Bhera, a small trading town in the Shahpur District, now a part of West Punjab in Pakistan. Sahni's ancestors came to Bhera from Dehra Ismail Khan in the North-West Frontier Province of the erstwhile State of Punjab before 1947. The family finally migrated to Lahore. He was the third child of his parents, Ruchi Ram Sahni and Shrimati Iswari Devi Anand. Ruchi Ram Sahni, who played a pioneering role in popularizing science in Punjab, was a self-made man. He was a scientist, an innovator, an euthusiastic educationist, a fierce patriot and a devoted social worker. Ruchi Ram was a man of independent thinking and progressive ideas. After saving the India Meteorological Department for about 2 years, Ruchi Ram joined the Government College, Lahore, from where he retired as Senior Professor of Chemistry in 1918. Ruchi Ram encouraged his children to think and act according to one's own judgments. Birbal Sahni imbibed a spirit of patriotism from his father.

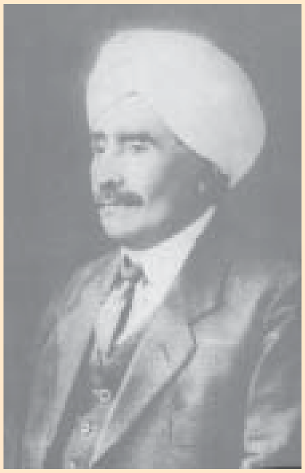
Sahni had his early education first at the Mission School and then at the Central Model School at Lahore. After completing his school education Sahni joined the Government College at Lahore, where, as mentioned earlier, his father was serving as Professor of Chemistry. His teacher of botany, Professor Shiv Ram Kashyap, a well-known bryologist, influenced him to take botany as his main career. He had developed a strong bond with the plant world. Shakti M. Gupta in her biography of Birbal Sahni has written: "Birbal showed his love for plants at a very young age. The family had got used to his habit of collecting plants to make a herbarium or preserved them in bottles for further study. While a student at Government College, Sahni was in the habit of roaming around in the open space beyond their house, outside the city walls and in the vicinity of Broadlaugh Hall. Often he would uproot a plant that was new to him and bring it home to plant it in the garden."

After his graduation in 1911 from the Punjab University Sahni proceeded to England, where he entered the Emmanuel College at Cambridge. In 1913 Sahni obtained a first class in Part-I of the Natural Sciences Tripos and he completed the Part-II of the Tripos in 1915. Around the same time he also obtained the BSc Degree of the London University. After obtaining his Tripos in Natural Sciences, Sahni started doing research under the inspiring guidance of Professor Albert Charles Seward, an internationally acclaimed palaeobotanist. In 1919, Sahni was awarded the degree of Doctor of Science (DSc) by the London University for his researches on fossil plants. While he was still a student at Cambridge, Sahni was asked to revise Lawson's textbook of botany, to suit the requirements of students of botany in India. The *Textbook of Botany* by Lawson and Sahni became a widely read book both in colleges and universities of India. After a brief period of work at Munich, Germany, under Goebel, a well-known morphologist, Sahni returned to India in 1919. He initially (for about a year) worked as Professor of Botany at Banaras Hindu University, Varanasi, and Punjab University. He then joined the newly created Botany Department of Lucknow University, as its first Professor and Head, a post he held till his death in 1949. He also served as the Head of the Department of Geology of the Lucknow University. Soon after his joining, Sahni made the Department of Botany an active centre of teaching and research. He inspired generations of young botanists throughout his long teaching career at the University. His concern for his students was proverbial.


Pt. Jawaharlal Nehru

Sahni's research contribution in palaeobotany covered such a vast range that no aspect of palaeobotany in India was left untouched by him. Amongst a large number of fossil plants described by him from Rajmahal Hills of Bihar, was his most remarkable discovery of a new group of fossil gymnosperms, to which he gave the name "Pentoxylae". Sahni studied *Ptilophyllum* and other related elements from Rajmahal Hill and found that stem *Bucklandia*, leaf *Ptilophyllum* and flower *Williamsonia* belong to the same plant which he reconstructed and named as *Williamsonia* sewardiana.

Sahni was greatly interested in archaeology and he published a number of papers in this field. His work on the "Technique of casting coins in ancient India" set a new standard in archaeological research in India. This won him the Nelson Wright Medal of the Numinsmatic Society of India in 1945. He was also interested in all kinds of geological problems. In fact Sahni had acquired a thorough knowledge in geology. He believed that palaeobotanical researches divorced from geological background would lead nowhere. Palaeobotanical studies should be done in relation to the geological and geographical conditions under which the plants lived and died. He himself made important contributions in geological studies. He threw considerable light on problems like the age of the Decan Traps, the Saline Series and the timing of the Himalayan uplift. Because of abiding interest in geology and his fundamental contributions to the study of plant life in the past, Sahni was elected as President of the Geology Section of the Indian Science Congress. Unlike today, in those days to become a sectional president of the Indian Science Congress meant a great honour and recognition.


Ruchi Ram Sahni

In September 1939, a Committee of Paeleobotanists working in India was formed. Sahni was its Convener. Its objective was 'to co-ordinate the research work done on palaeobotany in India and to issue periodic report's. The Committee brought out its first report, "Palaeobotany in India" in 1943. The members of the Committee of Palaeo-botanists established a Palaeobotanical Society in May 1946 by signing a Memorandum of Association. On June 03, 1946 a Trust was created under the Societies Registraton Act with a nucleus of funds, immovable property, library and fossil collection donated by Sahni and his wife for the promotion of research in paleobotany. The Society was created for foundation of 'A Research Institute having a broad international outlook, comprising a museum, a library, a laboratory, residential quarters and auxiliary buildings." On September 10, 1946 the Governing Body of the Palaeobotanical Society established an Institute. Initially started functioning in a room in the Department of Botany at the University of Lucknow. In September 1948 the institute received a generous gift of an estate comprising a large building on 3.5 acres of land from the Government of Uttar Pradesh. It was situated at 53 University Road, Lucknow. The foundation-stone of the new building of the Institute was laid down by Jawaharlal Nehru, India's first Prime-Minister, on April 03, 1949. Sahni in his inaugural speech, which also happened to be his last speech (as he died within a week of the inauguration of the Institute), said: "It is our hope that in this stone a link will have been forged in the chain of international goodwill and cultural cooperation. By laying this foundation-stone you (Pt. Jawaharlal Nehru) will, therefore, be helping us to achieve, for this young institute, a hopeful future of a broad and truly international outlook which is one of our main objectives. For what is it, after all that pious men worship in a stone which they place in a temple, but an idea, or an ideal, a great truth, a hope or a wish for a higher existence, whether in this world or the next? And what is it that this stone symbolizes? – the great fact of the antiquity of plant life on the globe, the intellect of men ever striving to bring the fact more and more clearly to light, revealing different stages not only in the evolution of the plant kingdom in a more and more orderly and understandable sequence but also the evolution of his own poor understanding of these truths. The very construction of it, the flaws and imperfections in its entire make up, the labour that has gone into its preparation, are all but symbols of our imperfect and helpless efforts at constructing something new, something worthwhile." Nehru, who himself was a student of science and in which he kept an abiding faith throughout his life, said on the occasion : "I used to attend Professor Seward's lectures in Botany and I also learnt some Geology at Cambridge. This is one of the reasons for my interest in today's proceedings.

But the real cause for my interest is that Professor Sahni symbolizes in him the kind of scientist that every scientist should be. He has devoted his life with all its energy at his command to his research and most assuredly he will continue to do so. This quality in a man concerning his work exercises a tremendous influence on others. A man who pursues his work in such a devoted manner follows the right path, his work is good, the man is good."

After the sudden death of Sahni, the Governing Body of the Palaeobotanical Society authorized his wife, Sabitri Sahni, to act as Director of the Institute. She was also authorized to look after the duties of the President of the Palaeobotanical Society. She worked hard to realize her husband's dream. She managed the Institute in its formative yeas (1949 to 1969). The Institute, what it is at present, owes a lot to her courage against heavy odds. Commenting on Mrs. Sahni's contribution, Shakti M. Gupta wrote: "The Palaeobotanical Institute that Dr. Sahni had toiled so hard to bring to life was a lifetime mission for him and he had conceived the idea of starting such an institute in mid-thirties. But even though he sowed the seeds of the institute, he was not destined to see it flower. The task of putting the Institute on a sound footing and making it recognized internationally was left to his wife, Mrs. Savitri Sahni. She has done a commendable job. The institute, what it is today, owes a lot to her courage against heavy odds. Professor Sahni's last words were addressed to he, 'Nourish the Institute.'"

By the end of 1952 the major part of the building was ready. It was opened by Nehru, who had also laid its foundation-stone in 1949. While opening the new building of the Institute, Nehru said : "The progress in scientific knowledge of any country opens the minds of its people and this is the advantage that counts in the ultimate analysis. A big country has many advantages and disadvantages. A disadvantage is that being self-sufficient, its people become introvert and do not like to learn from people of other countries. This closes their minds and ultimately, they become narrow minded. This is the most harmful attitude that any nation can develop. The very fact that a large number of scientists have come from foreign countries specially to attend his function shows the regard in which Dr. Sahni is held in the scientific world. It is a misfortune that he died just after starting this institute and in an early age. I was impressed by Dr. Sahni's sincerity. I was attracted by the proposal put by Dr. Sahni for building a research Institute for Paleobotany partly because of his interest in the subject that he had developed during his stay at Cambridge, but mainly due to his personality. He was a balanced man, a man of even temper like every great scientist. Such men are always few."

In November 1969 the Palaeobotanical Society divested its possession of the Institute and transferred its assets to Birbal Institute of Plaeobotany Society whereby the Birbal Sahni Institute of Palaebotany came under the management of its new Governing Body under the Department of Science and Technology, Government of India.

Besides his deep interest in science, Sahni pursued his other hobbies. Shakti M. Gupta wrote: "Not many are aware of Professor Sahni's deep interest in the arts. He was very fond of music and could play the sitar and the violin. Hisone great hobby was drawing and clay-modelling and whatever time permitted, he loved a game of chess. From an very early age he was fond of games and retained this interest in sports till late in life. At school and college, he was keen on hockey and tennis and also represented these institutions in the hockey Xis. Even at Cambridge he represented India Majlis at tennis and played against the Oxford Majlis.

Sahni received a number of awards and prizes in recognition of his significant research contributions. He was the recipient of the Barclay Medal of the Royal Asiatic Society of Bengal in 1936, the Nelson Wright Medal of the Numismatic Society of India in 1945 and Sir C. R. Reddy National Prize in 1947. Sahni was elected a Fellow of theGeological Society of Great Britain. He also served on the Editorial Board of the botanical journal *Chronica Botanica*. He was the Vice President of the Palaeobotany Sections of the Fifth and Sixth International Botanical Congresses in 1930 and 1935 held at Cambridge and Amsterdam respectively. In 1936 Sahni was elected as Fellow of the Royal Society of London. He was the first Indian botanist to be elected by the Royal Society. Professor Seward, who proposed Sahni's name, wrote Sahni affectionately: "On Thursday last at a meeting of the Council of the Royal Society your name was included in the list of New Fellows. It is with no ordinary pleasure that I send my heartiest congratulation…It did give me extraordinary pleasure when I found the Botanical Committee agreed with me about yourself. May you long enjoy the position which you so thoroughly deserve". Sahni was the General President of the Indian Science Congress in 1940. He was twice the President of the National Academy of Sciences, Allahabad. Sahni was a founder member of the Indian Botanical Society. He also served as its President. Sahni was elected an Honorary President of the International Botanical Congress held at Stckholm in 1950. However, his untimely death prevented him from being physically present there.

Sahni died on the night of 9^{th}-10^{th} April, 1949 within less than a week of the foundation-stone laying ceremony of his institute.

We would like to end this article by quoting from an obutuary written by one of Sahni's students, Professor T. S. Sadasivan: "A celebrated botanist has passed away in the wake of national exuberance and I firmly believe that posterity will class Professor Sahni with Engler, Strasburgor, Goebel, Sachs and de Bary of Germany, Guillermond of France and Scott, Seward and Bower of the United Kingdom, for his outlook like these men of science was truly rational, national and International variety. Professor Sahni has left "foot prints" not 'on sends of time' but on the geological time-scale.

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Cardamom

The Most Pleasantly Scented Spice

❑ T V Venkateswaran

Often named as the "third most expensive" spice in the world (after saffron and vanilla), Cardamom is considered to be indigenous to Southern India and Sri Lanka. The high price reflects the high reputation of this most pleasantly scented spice. Even though indigenous to South India and Sri Lanka, today, Guatemala has become the most important producer of cardamom. Cardamom belongs to Zingiberaceae (ginger) family. Indian cardamom is slightly smaller, but more aromatic, compared to the Sri Lankan variety and considered far superior to Guatemalan variety.

Hindus place Cardamom under or on the *Pinda*- sacrificial rice offered to the dead in their *Shradh* ceremony. As early as 4 B.C., Indian Ayurvedic medicine texts used the spice to remove fat and as a cure for urinary and skin complaints. Cardamom, it is said, was grown in the garden of the king of Babylon in 721 BC. The ancient Egyptians chewed cardamoms to whiten their teeth and simultaneously sweeten their breath. Cardamom was used in perfumes by ancient Greeks and Romans, and also recommended by Apicius, a famous Roman epicure, to counteract over-indulgence. It was probably imported into Europe around A.D. 1214.

Chemistry

Though the aromatic flavour is mainly due to the Cardamom seeds, normally the whole fruit (pods) are sold and used. Sensoric quality of cardamom is usually described as sweet aromatic, and very pleasant. The seeds lose their flavour quickly when ground; even left ungrounded, the seeds show a loss of about 40% of the essential oil per year. Therefore, only whole cardamom pods are sold; and before usage, the pods are usually crushed. Further, green pods are significantly superior in fragrance to the yellow or white bleached ones.

Figure 1: Green pods and seeds

Analysis of cardamom capsules indicates that moisture is 20%; protein 10.2%; ether extract 2.2%; mineral matter 5.4%; crude fiber 20.1; carbohydrate 42.1%; calcium 0.13%; phosphorus 0.16% cardamom also has; Iron 5 mg/ 100 g. Cardamom owes its aroma and therapeutic properties to the volatile essential oil present in the seeds. Oil yield is slightly higher in Sri Lankan variety as compared to South Indian. The content of essential oil in the seeds is strongly dependant on storage conditions, but may be as high as 8%. It consists chiefly of terpene bodies, whose constitution is $C_{10}H_{16}$. In the oil were found α-terpineol 45%, myrcene 27%, limonene 8%, menthone 6%, α-phellandrene 3%, 1,8-cineol 2%, sabinene 2% and heptane 2%. Other sources report 1,8-cineol (20 to 50%), α-terpenylacetate (30%), sabinene, limonene (2 to 14%) and borneol. In the seeds of round cardamom from Jawa (*A. kepulaga*), the content of essential oil is lower (2 to 4%), and the oil contains mainly 1,8 cineol (up to 70%) plus α-pinene (16%); furthermore, α-pinene, α-terpineol and humulene were found.

Volatile components of cardamom is said to exhibit antimicrobial activity and contius anti-aflatoxin substances and thus has inhibitory properties against aflatoxins synthesis. Cardamom prevents bad berth. It is used as additive in iron-enriched foods to mask the unpleasant taste of heme. Cardamom is considered to be an aromatic stimulant, carminative and flavouring agent. Powdered cardamom mixed with ginger, cloves and caraway is a good stomachic useful in atonic dyspepsia. Cardamom increases biliary flow out of the gallbladder and reportedly prevents infections and viruses from settling in.

Cardamom is the richest known source of the compound cineole, which is present in most oils used by aromatherapists for preventing fainting. Cineole is a potent antiseptic that kills bad breath bacteria and treats other infections. Cineole also has expectorant activity for clearing breathing passages. Cardamom is also rich in the compound, borneol, known to help prevent and treat gallbladder and kidney stones. Cardamom seeds are reported to be effective for emphysema, heartburn, laryngitis and other conditions. Studies show that the antispasmodic activity of cardamom oil is exerted through muscarinic receptor blockage.

Cardamom consumption:

Despite its numerous applications in the cooking styles, substantial amount of cardamom produced worldwide is used for making coffee! Cardamom-flavoured coffee, almost a symbol for Arab hospitality, is prepared by simply adding freshly ground cardamom seeds to the coffee powder. Arabic nomad tribe, Bedouins, have even developed a specially designed coffee pots that can keep several cardamom capsules in their spouts; such that the coffee gets in contact with the spice only during being poured into the glass.

Hence it is not surprising that 60% of the world production is exported to Arab (South West Asia, North Africa) countries. Yet not all cardamom is consumed for coffee in Arab countries; it is also used for cookery. The spicy mixture *baharat* and meat-and-rice dishes such as *kabsah* contain a multitude of spices similar to Indian *biriyanis.* Moroccan mixture *ras el hanout* or the famous Ethiopian spice *berebere* are also cardamom garnished.

Cardamom is often included in Indian sweet dishes and drinks. At least partially because of its high price, it is seen as a 'festive' spice. In the Moghul cuisine, cardamom is abundantly used in the delicious rice dishes -*biriyanis* and in several mild meat dishes. Typically, the pods are fried together

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Carl Friedrich Gauss

Prince of Mathematics

❑ Utpal Mukhopadhyay

It was 30 March, 1796. A young man of Brunswick, Germany, made such a discovery that dispelled all dilemma of his mind and catapulted him to the world of mathematics. That young man was none other than Carl Friedrich Gauss, an all time great mathematician. What he discovered on that eventful day? We shall come to it later. Before that, let us have a look at Gauss's life-saketch.

Carl Friedrich Gauss

On 30 April, 1777, exactly fifty years after the death of Isaac Newton, Gauss was born in Brunswick town of Germany. His father used to earn by various laborious work like building construction, canal digging, water bearing etc. Naturally he was of rough nature. So he failed to notice the talent of his son. Fortunately, Gauss's mother Dorothea was a completely different person. She survived for 97 years and her long life was centred around his genius son. She spent her last twenty years in the residence of his son and when she lost her eyesight a few years before her death, Gauss himself nursed and attended his mother. This reflects a generous side of Gauss.

Budding Talent

Gauss's talent was legendary. At the age of three only, one day when his father was calculating his weekly wages, Gauss detected an error in his father's calculation and corrected it. He took admission in a school at the age of seven. Mr. Bütner, mathematics teacher of that school was of cruel nature. He used to set up mathematical problems for his students which were full of laborious calculations. One day he asked his students to find out the sum of all integers form 1 to 100. Within a few moments, Gauses answered correctly which made Mr. Bütner spell-bound. When he enquired about the process adopted by Gauss, he was surprised to find that Gauss actually adopted the method of finding the sum of an arithmetical progression. After this incident, that teacher became very affectionate to Gauss and shortly admitted that the had nothing more new to teach Gauss. Mr. J.M. Bartels, an old companion of Mr. Bütuer was very much interested in mathematics. Since then Gauss and Bartels began to study jointy and very soon new ideas began to crop up in young Gauss's mind.

At the age of twelve only, Gauss started criticizing axioms of Euclidean geometry and laid the foundations of non-Euclidean geometry at thirteen. He got mastery over convergence of infinite series and presented the proof of General Bionomial Theorem when he was only fifteen. These works of Gauss drew the attention of Ferdinand, Duke of Brunswick and when Gauss entered to Carolyn College, Duke shouldered the entire expenditure of the college. In three years of his stay, at Carolyn College, Gauss read 'Principia of Newton (1642-1727) and became familiar with the main works of famous mathematicians like Euler (1707-1783) and Lagrange (1736-1813).

From seed to tree

After clearing his college examination in 1795, Gauss was in a dilemma. Since his mastery over various languages was comparable to that of mathematics, he was hesitant in deciding his subject of study in University. At the time on 30 March, 1796, Gauss made the discovery mentioned earlier and selected mathematics as his future subject of study. On that particular day. Gauss discovered the method of constructing regular polygon with 17 sides by Euclidean method. i.e. using ruler and compass only. Ancient Greeks discovered the method of constructing triangles and pentagons by Euclidean method and since then it was believed by mathematicians that no other egular polygon except triangle and pentagon can be constructed by Euclidean method whose number of sides is a prime number. After two thousand years, a youngman of nineteen proved that idea to be wrong. Being too much delighted by this discovery, Gauss wished that a regular polygon of 17 sides be inscribed in his grave. It should be mentioned here that the famous Greek mathematician Archimedes (Ca 287 BC-212 BC) proved that the ratio of the volumes of a right circular cone inscribed in a hemisphere which is further inscribed in a right circular cylinder is 1:2:3. According to Archimedes's' wish, in his tombstone a cone inscribed in a hemisphere which is further inscribed in a cylinder was engraved. Most probably, keeping Archinedes's wish in his mind, Gauss expressed his desire. Though Gauss's desire was not exactly fullfilled, but in his honour a monument was erected in Brunswick in which a 17-sided regular polygon was engraved. That particular date (march 30, 1796) was significant in Gauss's life for another reason because from that date he began to maintain his 'Notizenjournal', diary for keeping record of his scientific discoveries. In only 19 pages of that diary he recorded as many as 146 mathematical results which he discovered, The first entry of that diary is the discovery of 30 March, 1796 and the date of last authenticated discovery was 9 July, 1814. Forty three years after Gauss's death, mathematical community of the whole world came to know about 'Notizenjournal' while it was in the custody of his grandson. Famous mathematician Felix Klein (1849-1925) published the subject matter of this diary in the form of a book in 1901. It should be mentioned here that Indian mathematician Ramanujan (1887-1919) also kept his mathematical results in three notebooks. These three notebooks of Ramanujan are now kept in Tata Institute of Fundamental Research in Bombay.

Gauss was a student of Gottingen University from 1795 to October 1798. Those three years were very fruitful years of Gauss's life. Since Duke Ferinand shoulddered all the expenditure of Gauss at University, it was possible for Gauss to pay all his attention to his studies. Within those three years. Gauss made fundamental research in Numebr Theory which was a very favourtie field of Gauss throughout his life. Before 1798 Gauss almost completed his first and possibly best work "Disquisitiones artithemeticae'. This book was published in 1801 and Gauss devoted this book to Duke Ferdinand.

Nikolai Lobachevsky

Flower in Full Bloom

After leaving Gottingen, Gauss spent some time for earning by giving private tuitions but failed in it. Then again Duke saved him by making arrangement for some monthly grant for Gauss. Gauss married for the first time in 1805 and after Duke's demise in 1806, he was in financial hardship. But already Gauss's fame was spread out in Europe and in 1807, St. Petersbug University offered him Professorship. But, by the intervention of some influential persons of Germany, Gauss stayed in Germany and received the post of Director of Gottingen Observatory and was appointed afterwards as a Porfessor of Astronomy.

Gauss spent the rest of his life at Gottingen. Barring one occasion, when he went to Berlin to participate in a science seminar, he never left Gottingen. From 1821 to 1848 Gauss worked as a scientific advisor of Hanover and Denmark Government. The nature of work performed by Gauss during this period paved the way for his fundamental research work in differential geometry. In last twenty years of his life, Gauss did important research work in analytical dynamics and optics. In around 1830, he also paid attention to electricity and magnetism, two branches of physics which were just developing then.

Inspite of being basically a mathematician and theoretical physicist, Gauss was equally competent in experimental science. He modified and improved scientific and astronomical instruments. He invented two instruments named Heliotrope and Bifilar Magnetometer. Working with his colleague Wilbelm Weber (1804-1891), Gauss constructed electrically operated telegraph which was much better than the traditional one. For a long time he continued theoretical and practical research work of high standard on magnetism. For this reason famous British physicist James Clerk Maxwell (1831-1879) has written in his book 'Electricity and Magnetism' that from all the three points of view of instruments used, observation and calculations – Gauss's research on magnetism had reconstructed the entire science. So it is appropriate that the unit of magnetic intensity has been named as 'Gauss'. Throughout his life Gauss enjoyed a sound physique and maintained his power of thinking. He breathed his last on 23 February, 1855 at the age of 78.

Mathematical and other Scientific Works

Fundamental Theorem of Algebra

In 1799 Gauss received his 'Doctorate' degree from Helmstadt University. In his doctoral theisis he proved that every equation with real or imaginary coefficients has at least one root, real or imaginary. At present this theorem is known as 'Fundamental Theorem of Algebra'.

Theory of Functions and Infinite Series

Gauss made significant contributions in Theory of Functions of complex Variables. In 1811 he proposed a theorem which laid the foundations of theory of functions of complex variables and played an important role in the field of mathematical physics of nineteenth century. But that discovery remained unknown to most of the mathematicians of that time. Shortly after that famous mathematician Augustus Cauchy (1789-1867) rediscovered that theorem and hence this theorem is now known as Cauchy's Theorem.

One year after that Gauss discovered Hypergemetric series and the differential equation associated with it. He also discussed about the convergency of that series.

Astronomical Works

On the first day of the year 1801 Giuseppe Piazzi discovered the first asteroid Ceres. At that time it was possible to observe that asteroid for 41 days only. Then Ceres disappeared from vision for a few months. But depending on the observational data for such a short period, Gauss calculated the orbit of Ceres. The recovery of the asteroid was depending on that calculation. The accuracy of Gauss's calculation was realized when in October 1801. Ceres was rediscovered by astronomers at that very place indicated by Gauss's calculation.

Within next six years, three more asteroids were discovered and reliability of Gauss's method of calculations was verified once again. Afterwards, in 1809 Gauss published his results on astronomy in a book entitled 'Theoria motus corporum coelestium'. In this book detailed discussions on the calculations of orbits of planets and comets have been made and is regarded as the second best work of Gauss. This book is a landmark in the field of application of mathematics in astronomy.

Work in Numerical Analysis

Gauss made important contributions in the field of Numerical Analysis. In 1814 he devised a method of evaluating a definite integral by replacing that integral by a linear function. Apart from that he discovered two different ways of solving a system of linear simultaneous equations. Of these two, one is direct and another is indirect method. in 1874, Seidel modified the indirect method and is known at present as Gauss-Seidel method.

The 1812 Gauss created a chart known as Gaussian Logarithms. This chart is used by sailors for solving various problems of navigation.

Work on Differential Geometry

The third major work of Gauss was 'Disquisitiones generales circasuperficies curvas', published in 1827. In this book Gauss made concrete discussions about Differential Geometry of three dimensional planes as well as proposed a new idea about planes which afterwards got a new dimension by the work of his student Bernhard Riemann (1826-1866).

Discovery of Non-Euclidean Geometry

In the second decade of 19th century, Nikolai Labachevsky (1792-1856) and Janos Bolyai (1802-1860), quite independently of each other, discovered Non-Euclidean Geometry. But much before that Gauss also arrived at the same idea but being afraid of criticism he did not publish his results. Both Bolyai and Labschevsky were ridiculed by most of the mathematicians because they failed to realize the significance of the discovery. It has already been mentioned that in his school days Gauss started pondering over Non-Euclidean Geometry. In a letter to his friend in 1792, Gauss described him about his ideas on Non-Euclidean Geometry. Afterwards, he progressed further in the same line to discover Non-Euclidean Geometry.

Work on Number Theory

It has been mentioned earlier that Theory of Numbers was a very favourite field to Gauss. He wrote down his results on Number Theory in the book "Disquisitiones arithemticae' published in 1801. There are seven sections in the book and in the seventh section Gauss discussed his method of constructing a 17-sided regular polygon by Euclidean method. The results of this seventh section is regarded as the best work of Gauss on Number Theory.

Epilogue

Gauss was one of those rare brand of mathematicians who have shown their talent by moving effortlessly from one branch of mathematics to another. In that sense he may be put into the same class as that of Achimedes Newton, Euler etc., Gauss's range of work is so vast that it is not possible to discuss his entire work ina small article. Only it can be said that he was the last of the versatile mathematicians. Results of his work acted as a lighthouse to future generations of mathematicians. That's why to his contemporary mathematicians he was the 'Prince of Mathematics'.

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with onion, bay leaves and other sweet spices to intensify their fragrance. Cardamom is also frequently added to the Northern Indian *garam masala* especially in Kashmir, where the Moghul influence is particularly strong. Kashmiri people like sweet green tea flavoured with cardamom pods; a must drink, invariably served in the famous houseboats of Srinagar. In Sri Lanka, the pods are added to fiery beef or chicken curries, together with cinnamon. Cardamom-flavoured sweets are found all over the Indian subcontinent. In contrast, cardamom is rather used sparsely in Europe, except some cookie recipes such as German *Lebkuchen*. Nonetheless in Scandinavian countries, cardamom is popular not only for cookies and sweet breads but also for pastries and sausages.


Figure 2: Flower and unripe pods

The plant:

Cardamom is a tall, herbaceous perennial, with branching subterranean rootstock from which arise a number of upright leafy shoots, 1- 6 m height bearing alternate elliptical or lanceolate sheeting leaves 30 cm to 100 cm long. Flowers borne in panicles (60 cm to 120 cm long), arising from the base of vegetative shoots; panicles upright throughout their length or upright first and ultimately pendent or prostrate. Flowers are about 8 cm long, white or pale green in colour with a central lip streaked with violet, borne in a close seruies on the rachis; they are bisexual, but self- sterile and open in succession from, the base towards the tip.

The fruit, which is the useful part, is not obtained until the shrub has reached its utmost height, which requires 4 years. Cardamom fruit are ovoid or oblong, from 10 to 15 Mm. long, obtusely triangular, rounded at the base, beaked, longitudinally striate; of a pale-buff color, 3-celled, with a thin, leathery, nearly tasteless pericarp, and a central placenta. The seeds are about 4 mm. long, reddish-brown, angular, rugose, depressed at the hilum, surrounded by a thin, membranous arillus, and have an agreeable odor and a pungent, aromatic taste. They contain about 75 per cent of the seeds, which contain the active properties, while their covering, which has very little smell or taste, should be rejected; the aromatic, camphoraceous flavor of the seeds is soon lost when deprived of the capsules covering them.

It is native to moist evergreen forest of south India and Sri Lanka; also reported at Burma, South East Asia and Malaya archipelago. It is found wild in Western Ghats, between 2500 and 500 ft. It is usually found whereever the overhead canopy has been thinned by natural causes or by human action. From the point of view of evolution, it can be regarded as forming element in a pre-climax stage of the evergreen forest in this region. *Elettaria-cardamom- repens* inhabits the mountainous parts of the coast of Malabar, where it grows both cultivated and uncultivated, the cultivated plants generally yielding the commercial cardamoms. Cardamom is still collected as minor forest produce from the wild plants; even while it is grown in plantations similar to that of coffee and tea.

Cardamom thrives under moderate natural shade and tolerate loftier canopy but is susceptible to sunlight. Hence when cardamom is cultivated, care is taken to provide shade either by intercropping it with areca or planting tall trees. Cardamom can be propagated either by vegetatively by division of rhizomes or by seedling transplantation.

Today, cardamom is cultivated in India, Nepal, Sri Lanka, Guatemala, Mexico, Thailand and Central America. Indian cardamom is considered premium quality: the Malabar variety, more rounded in shape, has a pleasant mellow flavor; the Mysore variety, which is ribbed and three-cornered, has a slightly harsher flavor. Guatemalan cardamom compares favorably with that of Indian origin.

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Recent Developments in Science and Technology

Optic fiber delivers solar surgery

Solar energy is cheap and abundant source of energy. Now this energy will be used in surgery. The working prototype made by Israeli physicists concentrates sunlight down a fiber-optic cable to provide a tool for surgeons. Jeffrey Gordon and his colleagues at Ben-Gurion University in Israel hope it might one day replace the expensive surgical lasers used in operations such as the destruction of tumors in the liver.

The light for the surgical “suntrap” is gathered by a parabolic mirrored dish, 20 centimeters across. This concentrates the light, which is then focused on to the tip of an optical fiber. The fiber can be up to 100 meters long.

The device delivers less than a third of the light flux densities of surgical lasers, which have a typical output of 100 Watts per square-millimetre. Gordon told that in our clinical trial, we found that the optimal light density was just 3 Watt per square millimeter for destroying liver cells. We were able to reach temperatures of 60 °C in the cells, which is enough to kill them.

***Source**: New Scientist, July 2003*

Bood Test May Reveal Smokers’ Risk of Lung Cancer

Smoking is a major cause of lung cancer, which accounts for 30 percent of all cancer deaths. But new research indicates that some smokers are at greater risk of succumbing to the disease than others. According to a report published in the *Journal of the National Cancer Institute,* smokers carrying a newly discovered genetic marker are up to 10 times more likely to get lung cancer than those without it.

Exposure to numerous things in everyday life, from sunlight to cigarette smoke, can degrade DNA, but our bodies have developed mechanisms to mitigate this damage. Zvi Livneh of the Weizmann Institute in Israel and colleagues studied the role of a repair enzyme known as OGG1, which deletes DNA parts that have been damaged by oxygen radicals, in preventing lung cancer. The researchers found that among lung cancer sufferers, 40 percent had low OGG1 levels compared to only 4 percent of the general population. In addition, the scientists determined that smokers with low OGG1 activity were five to 10 times as likely to suffer from the disease than smokers who have normal OGG1 activity were. This risk increased to 120 times when comparing the group to non-smokers with normal levels of the enzyme.

Levels of OGG1 can be monitored using a simple blood test. The authors thus suggest that screening smokers for this new marker could provide people with a greater incentive to kick the habit.

***Source** :Scientific American Sept 2003*

Compiled by : Kapil Tripathi

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Science communication... *(contd. from page...36)*

towards science. To them science is academic.” He felt, there has to be more efforts in science popularization so that the people do not take refuge in anti-science or pseudo-science. Prof. A. K. Barua. Padmashri, presided over the inaugural function. In his presidential address, he expressed his optimism about India gaining the status of a developed country by the year 2020. The inaugural session ended with a vote of thanks by Dr. S. Roy Chowdhury, Secretary, Science Association of Bengal.

The workshop was divided in five sessions spread over 2 days. The topic of Session-I was ‘Science Communication in Bangla: General Viewpoints’. Shankar Chakraborty, President, Paschim Bangla Vigyan Manch chaired the session. The speakers discussed about the problems and prospects of science communication in Bengali language. The topic of the session-II was ‘Science Communication:Print Media.’ While chairing the session, Samarjit Kar, well-known science journalist, said it was time science writers went for soul-searching as to why laymen were not so receptive to science communication efforts. He argued that a deficiency in expert communication skill on the part of the communicator was at the root of the problem. He urged that the science writer should really try to catch people’s attention if they are serious about reaching the target audience.

The next session was on “science communication : Electronic media., Dr. Alok Sen, Former Science Producer of Doordarshan and the Producer of widely acclaimed programme “Quest” chaired the session. He said that commercialisation of media was making science popularization extremely difficult. The Manager of Media houses was so keen on advertisement that they hardly bothered about science communication, he pointed out.

“Science communication through television is a victim of the same malady” said Dr. Amit Chakraboty. “A recent survey done on a private TV channel revealed that of the 600 News stories telecast in May & June this year, only 10 were related to Science and technology.

The issue of session–IV was “Science communication : Role of Government & NGOs’. It was chaired by Dr. Subodh Mahanty and representatives of the science and technology council, Govt. of Tripura and West Bengal participated. They expressed their confidence in joint effort of Govt. agencies and NGOs in popularizing science.

The last session was devoted to the future prospects of Science Communication in Bangla. Prof. T.N. Das, an eminent scientist and editor of “Indian Biologist” acted as chairperson. While participating Mr. S. Goswami, Director, Birla Industrial and Technological Museum said: “Life is based on science which is found everywhere in nature. To survive on this planet we have to understand the principles of nature”. The other speakers expressed their optimism in the bright future of popularizing science through regional languages.

The participants gathered in the post lunch period of the 2nd day and interacted on the proposed science serial Radio in Bengali to be produced by Vigyan Prasar. It was proposed that the series be based on the history of science.

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VP Celebrates Hindi Divas

On the occasion of Hindi Pakhwada (1-14 September, 2003) Vigyan Prasar organised an elocution competition on "Use of Hindi in Office-Work". Dr. V.B. Kamble, Acting Director, Vigyan Prasar distributed the prizes to the winners of the competition. He urged the staff members to use Hindi to the maximum extent in office work.