UNIT-V

I)Srinivasa Ramanujan

It is one of the most romantic stories in the history of mathematics: in 1913, the English mathematician G. H. Hardy received a strange letter from an unknown clerk in Madras, India. The ten-page letter contained about 120 statements of theorems on infinite series, improper integrals, continued fractions, and number theory

Thus was Srinivasa Ramanujan (1887-1920) introduced to the mathematical world. Born in South India, Ramanujan was a promising student, winning academic prizes in high school. But at age 16 his life took a decisive turn after he obtained a book titled *A Synopsis of Elementary Results in Pure and Applied Mathematics*.

As a college dropout from a poor family, Ramanujan's position was precarious. He lived off the charity of friends, filling notebooks with mathematical discoveries and seeking patrons to support his work. Finally he met with modest success when the Indian mathematician Ramachandra Rao provided him with first a modest subsidy, and later a clerkship at the Madras Port Trust. During this period Ramanujan had his first paper published, a 17-page work on Bernoulli numbers that appeared in 1911 in the *Journal of the Indian Mathematical Society*. Still no one was quite sure if Ramanujan was a real genius or a crank. With the encouragement of friends, he wrote to mathematicians in Cambridge seeking validation of his work. Twice he wrote with no response; on the third try, he found Hardy.

Hardy wrote enthusiastically back to Ramanujan, and Hardy's stamp of approval improved Ramanujan's status almost immediately. Ramanujan was named a research scholar at the University of Madras, receiving double his clerk's salary and required only to submit quarterly reports on his work. But Hardy was determined that Ramanujan be brought to England. Ramanujan's mother resisted at first--high-caste Indians shunned travel to foreign lands--but finally gave in, ostensibly after a vision. In March 1914, Ramanujan boarded a steamer for England.

Ramanujan's arrival at Cambridge was the beginning of a very successful five-year collaboration with Hardy. In some ways the two made an odd pair: Hardy was a great exponent of rigor in analysis, while Ramanujan's results were (as Hardy put it) "arrived at by a process of mingled argument, intuition, and induction, of which he was entirely unable to give any coherent account". Hardy did his best to fill in the gaps in Ramanujan's education without discouraging him. He was amazed by Ramanujan's uncanny formal intuition in manipulating infinite series, continued fractions, and the like: "I have never met his equal, and can compare him only with **Euler** or **Jacobi**."

Ramanujan's years in England were mathematically productive, and he gained the recognition he hoped for. Cambridge granted him a Bachelor of Science degree "by research" in 1916, and he was elected a Fellow of the Royal Society (the first Indian to be so honored) in 1918. But the alien climate and culture took a toll on his health. Ramanujan had always lived in a tropical climate and had his mother (later his wife) to cook for him: now he faced the English winter, and he had to do all his own cooking to adhere to his caste's strict dietary rules. Wartime shortages only made things worse. In 1917 he was hospitalized, his doctors fearing for his life. By late 1918 his health had improved; he returned to India in 1919. But his health failed again, and he died the next year.

Besides his published work, Ramanujan left behind several notebooks, which have been the object of much study. The English mathematician G. N. Watson wrote a long series of papers about them. More recently the American mathematician Bruce C. Berndt has written a multi-volume study of the notebooks. In 1997 *The Ramanujan Journal* was launched to publish work "in areas of mathematics influenced by Ramanujan".

Contributions:
Indian **mathematician** Srinivasa Ramanujan made contributions to the **theory of numbers** including pioneering discoveries of the properties of the partition function. His papers were published in English and European journals, and in 1918 he was elected to the Royal Society of London.

II) Chandrasekhara Venkata Raman:

He was born at Tiruchirappalli in Southern India on November 7th, 1888. His father was a lecturer in mathematics and physics so that from the first he was immersed in an academic atmosphere. He entered Presidency College, Madras, in 1902, and in 1904 passed his B.A. examination, winning the first place and the gold medal in physics; in 1907 he gained his M.A. degree, obtaining the highest distinctions.

His earliest researches in optics and acoustics – the two fields of investigation to which he has dedicated his entire career – were carried out while he was a student.

Since at that time a scientific career did not appear to present the best possibilities, Raman joined the Indian Finance Department in 1907; though the duties of his office took most of his time, Raman found opportunities for carrying on experimental research in the laboratory of the Indian Association for the Cultivation of Science at Calcutta (of which he became Honorary Secretary in 1919).

In 1917 he was offered the newly endowed Palit Chair of Physics at Calcutta University, and decided to accept it. After 15 years at Calcutta he became Professor at the Indian Institute of Science at Bangalore (1933-1948), and since 1948 he is Director of the Raman Institute of Research at Bangalore, established and endowed by himself. He also founded the *Indian Journal of Physics* in 1926, of which he is the Editor. Raman sponsored the establishment of the Indian Academy of Sciences and has served as President since its inception. He also initiated the *Proceedings* of that academy, in which much of his work has been published, and is President of the Current Science Association, Bangalore, which publishes *Current Science (India)*.

Some of Raman's early memoirs appeared as Bulletins of the *Indian Associationfor the Cultivation of Science* (Bull. 6 and 11, dealing with the "Maintenance of Vibrations"; Bull. 15, 1918, dealing with the theory of the musical instruments of the violin family). He contributed an article on the theory of musical instruments to the 8th Volume of the *Handbuch der Physik*, 1928. In 1922 he published his work on the "Molecular Diffraction of Light", the first of a series of investigations with his collaborators which ultimately led to his discovery, on the 28th of February, 1928, of the radiation effect which bears his name ("A new radiation", *Indian J. Phys.*, 2 (1928) 387), and which gained him the 1930 Nobel Prize in Physics.

Other investigations carried out by Raman were: his experimental and theoretical studies on the diffraction of light by acoustic waves of ultrasonic and hypersonic frequencies (published 1934-1942), and those on the effects produced by X-rays on infrared vibrations in crystals exposed to ordinary light. In 1948 Raman, through studying the spectroscopic behaviour of crystals, approached in a new manner fundamental problems of crystal dynamics. His laboratory has been dealing with the structure and properties of diamond, the structure and optical behaviour of numerous iridescent substances (labradorite, pearly felspar, agate, opal, and pearls).

Among his other interests have been the optics of colloids, electrical and magnetic anisotropy, and the physiology of human vision. Raman has been honoured with a large number of honorary doctorates and memberships of scientific societies. He was elected a Fellow of the Royal Society early in his career (1924), and was knighted in 1929.

III) P.C.Roy:

Prafulla Chandra Ray, an Indian chemist, was born Aug. 2, 1861. Ray is often referred to as the father of chemistry in India. Showing great promise in his studies as a young man in Bengal, he was awarded a fellowship to the University of Edinburgh in 1882, where he received his BS and then his PhD in 1887. In a day when organic chemistry was all the rage, he chose to pursue inorganic chemistry, becoming an expert in mineral salts, such as sulfates and nitrites. He returned to India in 1888 and the next year received a position at the Presidency College in Calcutta. He was unable to obtain a position in the imperial service because he was Indian, an affront to which he took public offense. Ray was an ardent Bengali nationalist for his entire life, and unfortunately did not live quite long enough to see that dream become reality.

In 1896, he announced a major discovery of a new compound, miraculous nitrite. It is hard to believe that in a millennia of alchemical and chemical investigations, no one had discovered this particular compound, which was quite stable once one figured out how to make it. He published the discovery in several papers,

including one in the *Journal of the Chemical Society of London* in 1897 which we have in our collections (*second image*). The discovery spawned a novel field of research, allowing Ray to establish a new school of chemistry in India and attract a considerable number of students. In 1916, he joined the faculty of Calcutta University College of Science, where he established another chemical school. He retired in 1936 and died in 1944.

Ray was noteworthy for his passion for Indian independence and for his philanthropy. He lived extremely frugally, needed little money, and beginning in 1921, he donated his entire salary back to the Calcutta Department of Chemistry for research and student support. His humility and life style were as much a model for his students and contemporaries as was his expertise in inorganic chemistry. He also had an intense interest in the history of chemistry, and in 1902-08, he published *A History of Chemistry in Ancient and Medieval India*; we have a later edition in the Library, retitled *A History of Hindu Chemistry* (1956). We hope to acquire the first edition at some point.

According to the **Times of India in 2011** the Royal Society of Chemistry awarded a Chemical Landmark Plaque to Ray in 2011, the first plaque ever given to a chemist outside of Europe. This story has been picked up by all the Wikipedia-style biographies, but there is something odd about it, since Landmark Plaques are given to places, not people, and there is no mention of this on the **RSC website** We hope something about the story is true, since Ray certainly deserves more attention from the West. In India, he is a scientific hero, as he should be, and he was honored with a special exhibition at the Science Centre in Kolkata in 2011. We show here some photographs of that event (*fourth image*).

In India, Ray is always referred to as Acharya Prafulla Chandra Ray, Acharya being an honorary title meaning "one who leads by example." It would be nice if we had a title for exemplary lifestyle in the West.

IV) The **Shanti Swarup Bhatnagar Prize for Science and Technology** (**SSB**) is a science award in India given annually by the **Council of Scientific and Industrial Research** (CSIR) for notable and outstanding research**, applied or fundamental, in biology, chemistry, environmental science**, **engineering, mathematics, medicine and Physics.** The prize recognizes outstanding Indian work in science and technology. It is the most coveted award in multidisciplinary science in India. The award is named after the founder Director of the Council of Scientific & Industrial Research**, Shanti Swarup Bhatnagar**.[3] It was first awarded in 1958.

Any citizen of India engaged in research in any field of science and technology up to the age of 45 years is eligible for the prize. The prize is awarded on the basis of contributions made through work done in India only during the five years preceding the year of the prize. The prize comprises a citation, a plaque, and a cash award of ₹5 lakh (US$7,000). In addition, recipients also receive Rs. 15,000 per month up to the age of 65 years.

V) Jagadish Chandra Bose:

He was born in a **Bengali Kayastha** family in **Munsiganj (Bikrampur**), **Bengal Presidency** (present-day **Bangladesh)** on 30 November 1858, to Bama Sundari Bose and Bhagawan Chandra Bose. His father was a leading member of the **Brahmo Samaj** and worked as a deputy magistrate and assistant commissioner in **Faridpur,** Bardhaman and other places.[15]

Bose's education started in a **vernacular** school, because his father believed that one must know one's own mother tongue before beginning English, and that one should know also one's own people. Speaking at the **Bikrampur** Conference in 1915, Bose said:

At that time, sending children to English schools was an aristocratic status symbol. In the vernacular school, to which I was sent, the son of the Muslim attendant of my father sat on my right side, and the son of a fisherman sat on my left. They were my playmates. I listened spellbound to their stories of birds, animals, and aquatic creatures. Perhaps these stories created in my mind a keen interest in investigating the workings of Nature. When I returned home from school accompanied by my school fellows, my mother welcomed and fed all of us without discrimination. Although she was an orthodox old-fashioned lady. It was because of my childhood

friendship with them. I never realised that there existed a 'problem' common to the two communities, Hindus and Muslims.[15]

Bose joined the **Hare School** in 1869 and then **St. Xavier's School** at Kolkata. In 1875, he passed the Entrance Examination (equivalent to school graduation) of the **University of Calcutta** and was admitted to **St. Xavier's College, Calcutta.** At St. Xavier's, Bose came in contact with Jesuit Father **Eugene Lafont,** who played a significant role in developing his interest in natural sciences. He received a BA from the University of Calcutta in 1879.

Bose wanted to go to England to compete for the **Indian Civil Service.** However, his father, a civil servant himself, cancelled the plan. He wished his son to be a scholar, who would "rule nobody but himself." Bose went to England to study Medicine at the **University of London.** However, he had to quit because of ill health. The odour in the dissection rooms is also said to have exacerbated his illness.

Through the recommendation of **Anandamohan Bose** his brother-in-law (sister's husband) and the first Indian **Wrangler** he secured admission in **Christ's College,**Cambridge to study natural sciences. He received a BA **(Natural Sciences Tripos**) from the **University of Cambridge** and a BSc from the **University College London** affiliated under **University of London** in 1884, and a DSc from the University College London, University of London in 1896 Among Bose's teachers at Cambridge were **Lord Rayleigh, Michael Foster, James Dewar, Francis Darwin, Francis Balfour**, and Sidney Vines. At the time when Bose was a student at Cambridge, **Prafulla Chandra Roy** was a student at Edinburgh. They met in London and became intimate friends.Later he was married to **Abala Bose**the renowned feminist and social worker.

One of the important influences on Bose was **Sister Nivedita** who supported him by organizing financial support and editing his manuscripts; she made sure that Bose was able to continue with and share his work.

VI) Mankombu Sambasivan Swaminathan:

He (born 7 August 1925) is an Indian geneticist and administrator, known for his role in India's Green Revolution, a program under which high-yield varieties of wheat and rice were planted. Swaminathan has been called the "Father of Green Revolution in India" for his role in introducing and further developing high-yielding varieties of wheat in India. He is the founder of the **MS Swaminathan Research Foundation.** His stated vision is to rid the world of hunger and poverty.Swaminathan is an advocate of moving **India to sustainable development**, especially using environmentally **sustainable agriculture, sustainable food security** and the preservation of **biodiversity,** which he calls an "evergreen revolution.

M. S. Swaminathan was born **in Kumbakonam**, Tamilnadu on 7 August 1925. He was the second son of surgeon Dr. M.K. Sambasivan and Parvati Thangammal Sambasivan. Swaminathan learned from his father, "that the word 'impossible' exists mainly in our minds and that given the requisite will and effort, great tasks can be accomplished." M.K. Sambasivam, a follower of **Mahatma Gandhi,** took the lead in Kumbakonam in "burning his foreign clothes," a symbolic act in support of the **Swadeshi movement:** which emphasized the use of Indian rather than foreign-made clothes, and hand-loomed rather than mill-spun cloth. The political purpose of the swadeshi movement was to free India from dependence on imports and to protect the village industry. His father led in opening the temples to Dalits, part of the temple entry movement of the **Indian independence movement in Tamil Nadu,** and in eradicating filariasis in Kumbakonam, an area long infected with the dreaded disease. The sense of service to one's fellow man was thus ingrained in him early.

After his father's death when he was 11, young Swaminathan was looked after by his uncle, M. K. Narayanaswami, a radiologist. He attended the local high school and later the Catholic Little Flower High School in Kumbakonam, from which he matriculated at age 15.Coming from a family of doctors, he naturally took admission in a medical school. But, when he witnessed the **Great Bengal famine of 1943,** he decided to devote his life to getting rid of hunger from India. He was influenced by **Mahatma Gandhi** while he took this decision. He simply switched from the medical field to the agricultural field. He then went on to finish his undergraduate degree in Biology at Maharaja's College in **Trivandrum, Kerala** . He studied there from 1940–44 and earned a Bachelor of Science degree in **zoology**.

M.S. Swaminathan is married to **Mina Swaminathan,** whom he met in 1951 while they were both studying at Cambridge. They live in **Chennai, Tamil Nadu.** Their three daughters are **Dr. Soumya Swaminathan**, the Chief scientist of **World Health Organization,** Dr. Madhura Swaminathan, who is a Professor of Economics at the **Indian Statistical Institute, Bangalore** and Nitya Swaminathan, a Senior Lecturer in Gender Analysis and

Development at the **University of East Anglia.** Swaminathan and Mina have 5 grandchildren, Anandi, Shreya, Kalyani, Akshay, and Madhav.

EARLY LIFE:

Swaminathan then decided to pursue a career in agricultural sciences. He enrolled in Madras Agricultural College where he graduated as valedictorian with another Bachelor of Science degree, this time in Agricultural Science. He explained this career decision thus: "My motivation started with the great Bengal famine of 1943 when I was a student at the University of Kerala. There was an acute rice shortage, and in Bengal, about 3 million people died from starvation. All of our young people, myself included, were involved in the freedom struggle, which Gandhi had intensified, and I decided I should take to agricultural research to help farmers produce more."[6]

In 1947, the year of Indian independence he moved to the Indian Agricultural Research Institute (IARI) in New Delhi as a post-graduate student in genetics and plant breeding. He obtained a post-graduate degree with high distinction in Cytogenetics in 1949. He wrote the Union Public Service Commission exam and qualified for the Indian Police Service.[7]

He chose to accept the UNESCO Fellowship to continue his IARI research on potato genetics at the Wageningen Agricultural University, Institute of Genetics in the Netherlands. Here he succeeded in standardizing procedures for transferring genes from a wide range of wild species of *Solanum* to the cultivated potato, *Solanum tuberosum*. In 1950, he moved to study at the Plant Breeding Institute of the University of Cambridge School of Agriculture. He earned a Doctor of Philosophy (Ph.D.) degree in 1952, for his thesis, "Species Differentiation, and the Nature of Polyploidy in certain species of the genus *Solanum* – section Tuberarium." His work presented a new concept of the species relationships within the tuber-bearing *Solanum*. His Cambridge college, Fitzwilliam, made him an Honorary Fellow in 2014.

Swaminathan then accepted a post-doctoral research associateship at the University of Wisconsin, Department of Genetics to help set up a USDA potato research station. Despite his strong personal and professional satisfaction with the research work in Wisconsin, he declined the offer of a full-time faculty position, returning to India in early 1954.

Achievements:

- 1949–55 – Research on potato (Solanum tuberosum), wheat (Triticum aestivum), rice (Oryza sativa), and jute genetics.
- 1955–72 – Field research on Mexican dwarf wheat varieties. Teach Cytogenetics, Radiation Genetics, and Mutation Breeding and build up the wheat and rice germplasm collections at Indian Agricultural Research Institute IARI.
- 1972–79 – Director-General, Indian Council of Agricultural Research (ICAR), established the National Bureau of Plant, Animal, and Fish Genetic Resources of India.
  Established the International Plant Genetic Resources Institute (changed in 2006 to Bioversity International).
- 1979–80 – Principal Secretary in the Ministry of Agriculture, Government of India, Transformed the Pre-investment Forest Survey Programme into the Forest Survey of India.
- 1981–85 – Independent chairman, Food and Agriculture Organization (FAO) Council, Rome, played a significant role in establishing the Commission on Plant Genetic Resources.
- 1983 – Developed the concept of Farmers' Rights and the text of the International Undertaking on Plant Genetic Resources (IUPGR).President of the International Congress of Genetics.
- 1982–88 – Director General, International Rice Research Institute (IRRI), organised the International Rice Germplasm Centre, now named International Rice Genebank.
- 1984–90 – President of the International Union for Conservation of Nature and Natural Resources IUCN, develop the Convention on Biological Diversity CBD.
- 1986–99 – Chairman of the editorial advisory board, World Resources Institute, Washington, D. C., conceived and produced the first "World Resources Report."
- 1988–91 – Chairman of the International Steering Committee of the Keystone International Dialogue on Plant Genetic Resources,[14] regarding the availability, use, exchange and protection of plant germplasm.
- 1991–1995 – Member, Governing Board, Auroville Foundation
- 1988–96 – President, World Wide Fund for Nature–India WWF,Organized the Indira Gandhi Conservation Monitoring Centre.[16] Organize the Community Biodiversity Conservation Programme.[17]

- 1988–99 – Chairman/Trustee, Commonwealth Secretariat Expert Group, organised the Iwokrama International Centre for Rainforest Conservation and Development, for the sustainable and equitable management of tropical rainforests in Guyana. The President of Guyana wrote in 1994 "*there would have been no Iwokrama without Swaminathan.*"
- 1990–93 – Founder/President, International Society for Mangrove Ecosystems (ISME)
- 1988–98 – Chaired various committees of the Government of India to prepare draft legislations relating to biodiversity (Biodiversity Act) and breeders' and farmers' rights (Protection of Plant Varieties and Farmers' Rights Act).
- in 1993 Dr M. S. Swaminathan, headed an expert group to prepare a draft of a national population policy that would be discussed by the Cabinet and then by Parliament. In 1994 it submitted its report.
- 1994 – Chairman of the Commission on Genetic Diversity of the World Humanity Action Trust.[23] Established a Technical Resource Centre at MSSRF for the implementation of equity provisions of CBD and FAO's Farmers' Rights.
- 1994 onwards – Chairman of the Genetic Resources Policy Committee (GRPC) of the Consultative Group on International Agricultural Research (CGIAR), development of policies for the management of the ex situ collections of International Agricultural Research Centers.
- 1995–1999 chairman, Auroville Foundation
- 1999 – Introduced the concept of trusteeship management of Biosphere reserves. Implemented the Gulf of Mannar Biosphere Reserve Trust, with financial support from the Global Environment Facility (GEF).
- 2001 – Chairman of the Regional Steering Committee for the India – Bangladesh joint Project on Biodiversity Management in the Sundarbans World Heritage Site, funded by the UN Foundation and UNDP.
- 2002 – President of the Nobel Peace Prize-winning Pugwash Conferences on Science and World Affairs which work towards reducing the danger of armed conflict and to seek solutions to global security threats.[24]
- 2002 – 2005 – Co-chairman with Pedro Sanchezof the UN Millennium Task Force on Hunger,[25] a comprehensive global action plan for fighting poverty, disease and environmental degradation in developing countries.
- 2004 – 2014 – Chairman, National Commission on Farmers.
- Over 68 students have done their PhD thesis work under his guidance.

VII) H.J.Bhabha:

Early Life:

Homi Jehangir Bhabha was born on 30 October, 1909 to a wealthy Parisi family in Mumbai that was very influential in the west of India. His father was Jehangir Hormusji Bhabha, a lawyer.Initially Bhabha attended Cathedral School and he then enrolled for studies at Elphinstone College at the age of fifteen. This was followed by further studies at the Royal Institute of Science in Bombay.

Bhabha's father and uncle, Sir Dorab Tata, wanted him to study engineering at university so that Bhabha could take up a senior position at the Tata Iron and Steel Company on completion of his degree.In 1927, Bhabha began his studies at Cambridge University, studying mechanical engineering according to his family's wishes. Soon, however, Bhabha became more interested in theoretical physics, being influenced by physicist Paul Dirac.

After passing the Mechanical Engineering Tripos with first class Bhabha remained at Cambridge and with his family's approval began studying theoretical physics.In 1932 he passed the Mathematics Tripos, again with first class and he received his doctorate degree in nuclear physics from the University of Cambridge in 1934.

Contributions and Achievements:

Bhabha's first paper "The Absorption of Cosmic radiation" in 1933 earned him a three year Isaac Newton Studentship in 1934.

He worked alongside Neil Bohr in Copenhagen in addition to his research work at Cambridge. Bhabha published a paper in 1935, performing the first calculation to determine the cross section of electron-positron scattering.

Bhabha conducted research with Walter Heitler and in 1936 they made a breakthrough in the cosmic radiation's understanding by working on the cascade theory of electron showers. Their theory described how primary cosmic rays from outer space interact with the upper atmosphere producing observable particles at the ground level, making estimations of the number of electrons in the cascade process at different altitudes for different electron initiation energies.

In 1937, Bhabha was awarded the Senior Studentship of the 1851 exhibition.

With the outbreak of the Second World War in 1939, Bhabha returned to India accepting a position of reader of physics and establishing the Cosmic Ray Research Institute at the Indian Institute of Science in Bangalore.

In 1941, Bhabha was elected Fellow of the Royal Society. He also established the Tata Institute of Fundamental Research in Mumbai, becoming their director in 1945. He was a skillful manager and it was due to his prominence, devotion, wealth and comradeship with Jawaharlal Nehru, Prime Minister of India that he gained a leading position for allocating the scientific resources of India.

Bhabha become the first chairperson of India's Atomic Energy Commission in 1948. It was under his direction that the scientists of India made their way into making an atomic bomb ant the first atomic reactant was operated in Mumbai in 1956. Bhabha also led the first UN Conference held for the purpose of Peaceful Uses of Atomic Energy in Geneva, 1955.

It was then predicted by him that a limitless power of industries would be found through nuclear fusion's control. He promoted nuclear energy control and also prohibition of atomic bombs worldwide. He was absolutely against India manufacturing atomic bombs even if the country had enough resources to do so. Instead he suggested that the production of an atomic reactor should be used to lessen India's misery and poverty. A post in Indian Cabinet was rejected by him but he served as a scientific advisor to Prime Ministers Nehru and Lal Bahadur Shastri.

He realized the potential of India's large thorium reserves in addition to the country's small uranium deposits.

The total reserves of thorium in India amount to over 500,000 tons in the readily extractable form, while the known reserves of uranium are less than a tenth of this. The aim of long range atomic power program in India must therefore be to base the nuclear power generation as soon as possible on thorium rather than uranium..

Bhabha received many rewards and award from Indian as well as foreign universities and he was an associate of various societies of science including the American National Academy of Sciences. He was awarded Padma Bhushan in 1954, the third-highest civilian award in India.

Bhabha remained a bachelor during his life. His hobbies included painting, classical music and opera, and botany. He was killed in mysterious circumstances, aged 56, when Air India Flight 101 crashed on January 24, 1966 near Mont Blanc in Switzerland. In quantum physics, the cross section of electron-positron scattering was renamed "Bhabha scattering" in his honor.

VIII)**A.P.J. Abdul Kalam**:

Avul Pakir Jainulabdeen Abdul Kalam, (born October 15, 1931, **Rameswaram,** India—died July 27, 2015, Shillong), Indian scientist and politician who played a leading role in the development of India's missile and nuclear weapons programs. He was president of India from 2002 to 2007.

Kalam earned a degree in **aeronautical engineering** from the Madras Institute of Technology and in 1958 joined the Defence Research and Development Organisation (DRDO). He soon moved to the **Indian Space Research Organisation,** where he was project director of the **SLV-III,** India's first indigenously designed and produced satellite **launch vehicle.** Rejoining DRDO in 1982, Kalam planned the program that produced a number of successful missiles, which helped earned him the nickname "Missile Man."

From 1992 to 1997 Kalam was scientific adviser to the defense minister, and he later served as principal scientific adviser (1999–2001) to the government with the rank of cabinet minister. His prominent role in the country's 1998 nuclear weapons tests established Kalam as a national hero, although the tests caused great concern in the international community. In 1998 Kalam put forward a countrywide plan called Technology Vision 2020, which he described as a road map for transforming India from a less-developed to a developed

society in 20 years. The plan called for, among other measures, increasing agricultural productivity, emphasizing technology as a vehicle for economic growth, and widening access to health care and education.

In 2002 India's ruling **National Democratic Alliance** (NDA) put forward Kalam to succeed outgoing President **Kocheril Raman Narayanan.** Kalam was nominated by the Hindu nationalist (Hindutva) NDA even though he was Muslim, and his stature and popular appeal were such that even the main opposition party, **the Indian National Congress**, also proposed his candidacy. Kalam easily won the election and was sworn in as India's 11th president, a largely ceremonial post, in July 2002. He remained committed to using science and technology to transform India into a developed country. In 2007 Kalam left office and was succeeded by **Pratibha Patil,** the country's first woman president.

Kalam wrote several books, including an autobiography, *Wings of Fire* (1999). Among his numerous awards were two of the country's highest honours, the Padma Vibhushan (1990) and the Bharat Ratna (1997).