A genius called Abdus Salam

An obituary

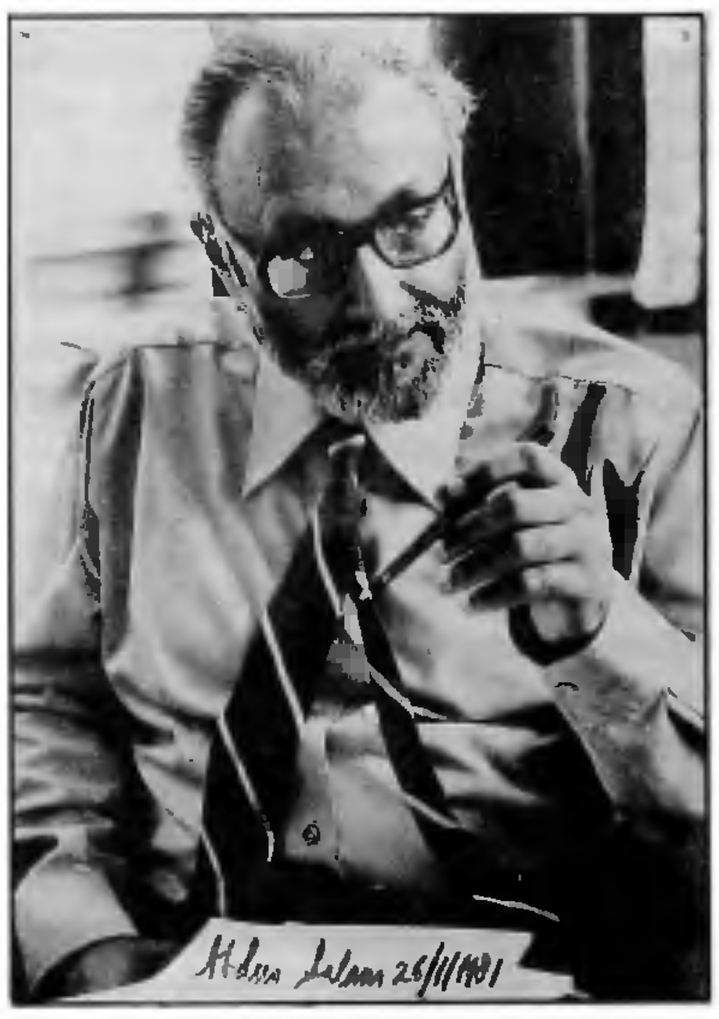
Professor Abdus Salam, one of the greatest geniuses of this century, died on 21 November 1996. He was awarded the Nobel Prize in Physics during 1979 for his Electro-Weak Unification theory along with Steven Weinberg and S. L. Glashow. After winning the Nobel Prize he came on a pilgrimage (Ziarat) to Qadian, the holy place for Ahmadias, in January 1981. He visited Guru Nanak Dev University, Amritsar and many other educational and scientific institutes in India. He was conferred Honorary Degrees by many universities and received warm welcome throughout India. When I met him in International Centre for Theoretical Physics, Trieste, Italy during my visit in 1990, he was suffering from a paralytic stroke and moved in a wheel chair. He was as busy as ever correcting the proofs of his paper 'The role of chirality in the origin of life'. He gave me a copy of this paper and confided that he was hoping for a second Nobel Prize in Biology. There are only half a dozen scientists who could score a double in the history of Nobel Prizes. Alas! his dream could not be realized.

Early life and work

Abdus Salam was born in Jhang (India), now a district town in the province of Punjab in the present day Pakistan, on 29 January 1926. He got his early education in Jhang High School and passed his matriculation examination by securing about 90% marks, creating a new record in Panjab University. He repeated this feat in B A and M A examinations also. He joined St. John's College, Cambridge in 1946 and scored a double first class first in both Mathematics and Physics Tripos, a rare feat in the history of Cambridge University. In 1949, he returned to Jhang and got married to his first cousin.

He returned to Cambridge and started off as a research student in experimental physics in 1949. Nevertheless, Salam once put it 'I knew the craft of experimental physics was beyond me – it was the sublime quality of patience – particularly patience with recalcitrant equipment of the Cavendish laboratory that I sadly lacked'. Soon he shifted to Theoretical Physics and started work on Quantum Field Theory with Nicholas Kemmer. He solved an intricate problem, renormalization of meson theories, for his Ph D thesis within five months but the university regulations did not allow him to submit his Ph D thesis before the completion of a three-year period. He was awarded the Smith Prize for the most outstanding predoctoral contribution in 1950 and sent off for six months to the Institute of Advanced Studies in Princeton, USA, where Albert Einstein worked since 1933. He was highly impressed by the greatest genius, the world has ever produced since Newton.

In 1951, Salam returned to Lahore and joined as Professor of Mathematics in



Government College and as Head of the Mathematics Department at Panjab University, Lahore. Salam landed in a country where there was not a single person with whom he could discuss his research problems. The nearest physicist with whom Salam could indulge in useful discourse was Homi Bhabha in Bombay and M. N. Saha in Calcutta. After the partition of India, things had changed. Once he travelled to Bombay to meet his friend Pauli, another great Nobel Laureate whom Einstein considered his successor, but on return he was asked to explain as to why had he gone to India without prior permission. He suffered complete isolation in Lahore and could not continue in the kind of environment prevailing in Pakistan if he was to remain in the forefront. During 1953, there were anti-Ahmadia riots in Lahore. Salam returned to Cambridge in 1954 when he was offered a lecturership in physics.

It was in the period 1956–57 that Salam made another astounding contribution. There exists a law known as the law of conservation of parity. It essentially states that if a particular process occurs in nature with a certain probability then its 'mirror image' is also a possible process that occurs with equal probability. It is also called law of left–right symmetry. In 1956, two Chinese-born American physicists, T. D. Lee and C. N. Yang, had proposed a hypothesis that left–right symmetry was violated in certain processes governed by the weak force. C. S. Wu, another great Chinese lady working in USA, experimentally established this hypothesis and was awarded the Nobel Prize for her experiment. Now it was the turn of Salam to prove that violation of left–right symmetry was connected with the zero mass of neutrino. It was the most beautiful mathematical concept, and in establishing it Salam was able to introduce a new type of symmetry that is now called 'chiral' symmetry. According to Salam's two-component neutrino theory, right-handed neutrinos do not exist in Nature. Neutrino always spins in one particular manner instead of the two possibilities expected on the basis of quantum principles. Salam's idea is validated by experiments and is a built-in feature of his Nobel-prize winning electro-weak theory.

In 1957, at the young age of 31, Salam was offered a chair in Theoretical Physics at the Imperial Science College, London, one of the leading scientific institutions in UK. Under his leadership Imperial College came to the forefront of elementary particle physics research and many budding physicists converged to him to seek his guidance. In 1961, Salam and his research students, J. C. Ward and Ne'eman, proposed a new scheme of classification known as Unitary Symmetry independent of M. Gellman. Salam was elected a fellow of the Royal Society in 1959 at the age of 33. He was perhaps the youngest scientist to be elected to this most prestigious society after Ramanujam, the great Indian

mathematician whom Salam adored as a young student in Lahore. In 1964, he was awarded the Hughes Medal for his research contributions. Commenting on this award, the issue of *Nature* (December 13, 1964) refers to Salam's work on the two component theory and unitary symmetry as contribution 'in the absolutely highest class'.

Grand Unification Theory

Salam never wavered in his conviction that the unification of the fundamental forces of nature was inevitable. He pursued this goal ceaselessly over the last four decades. Even as a young physicist Salam stuck to this conviction despite the fact that men of the calibre of Dirac and Pauli despaired of the task and discouraged him.

The history of unification ideas is as old as the history of science. Galileo and Newton established that the laws of physics are the same for the earth and the heavenly bodies unlike Aristotle and his followers who considered two different sets of laws operating in the celestial and terrestrial spheres. Faraday and Maxwell unified electricity and magnetism and this unification culminated in a new technological revolution in the world. Einstein was a great dreamer who unified space and time in his theory of relativity and thus the whole edifice of Newtonian physics was shaken. He also proposed a framework for unification of electromagnetism with gravitation. He spent the last four decades of his life searching for a unified theory that would explain everything from elementary particles and their interactions to the overall structure of the universe. But Einstein failed, not because he did not try hard enough, but because the attempt was ahead of its time.

Salam took up cudgels to unify electromagnetism with weak nuclear force. Salam was among the very first few privileged people to realize in the late fifties that the type of symmetry known as gauge symmetry must be the one relevant to all basic forces of nature and to unification. Quantum field theory views all fundamental forces as arising out of the exchange of messenger particles between interacting particles. The range of the force depends upon the mass of the messenger particle. A massless particle gives rise to a force of infinite range. Gauge symmetry further tells us that the gauge particles carry one unit of spin.

The fundamental equations of electromagnetism satisfy a gauge symmetry known as U(1) which requires one massless messenger identified with the photon. The electromagnetic force is left–right symmetric and its range is infinite. The weak force is very different from it. It is a thousand times weaker than the electromagnetic force and its range is incredibly small. Salam proposed that a gauge symmetry SU(2) could be relevant to weak force and its unification. SU(2) requires the existence of three massless messengers. Since the weak force has a very short range, the problem of generating masses of messenger particles was not fully solved until 1967 by Weinberg and Salam, in their Nobel Prize-winning paper. Weinberg and Salam independently of each other took the step of using the Higgs mechanism to predict the masses of two W^+ & W^- particles and Z^o in 1967. It was found that the particles would be about 100 times heavier than the proton. During early 1983, Carlo Rubbia and Van der Meer in CERN, Geneva announced the discovery of W^+, W^- and Z^o messenger particles. Their existence was predicted by the Salam–Weinberg–Glashow model which unified weak and electromagnetic forces. The trio shared the 1979 Nobel Prize in Physics after experiments carried out at CERN, Geneva and SLAC, Stanford, USA established the existence of 'neutral current' processes. However, the climax was reached with the discovery of three gauge messengers which led to vindication of 'Standard Model' proposed by Weinberg and Salam.

In 1972, Salam and Jogesh Pati introduced a bold idea for the unification of electro-weak and strong nuclear forces. Instead of regarding leptons and quarks as fundamentally distinct entities they put them together in a single family or multiplet. Such a scheme then allows a quark to convert to a lepton once in a while. Since a proton is made up of quarks this immediately led to the sensational idea that a proton could decay. The proton lifetime predicted for Grand Unification Theory, is about ten thousand billion billion billion years. Sensitive experiments are being conducted in the USA, the USSR, Japan, India and other places to test the proton decay hypothesis. So far the experiments have failed to detect the proton decay. Salam has also made contributions to 'Super-symmetry' and 'Superstring' theory in his search for the ultimate synthesis of electromagnetic, weak-nuclear, strong-nuclear and gravitational forces.

A prophet of Third World

The creation of International Centre for Theoretical Physics (ICTP) at Trieste, Italy in 1964, under the aegis of UNESCO and IAEA, Vienna, is another great step for unification of Third World scientists. Salam had himself experienced the isolation as a scientist in Panjab University, Lahore.

ICTP has imparted training to almost 50,000 visiting scientists from Third World countries since its inception. The International Centre started with a budget of 350,000 US dollars. During 1987 alone, ICTP welcomed 3,700 physicists and mathematicians to its various activities.

Training colleges and research workshops have been held at ICTP, Trieste on subjects such as physics of materials, alternative energy sources, fusion, reactors, geophysics, biophysics, neurophysics, laser physics, fibre optics, physics of oceans and deserts, soil physics, cloud physics – in addition to high energy physics, condensed matter physics, mathematics and cosmology. Since 1981, research workshops have been organized in developing countries, viz. China, India, Sri Lanka, Bangladesh, Ghana, Kenya, Sudan and Colombia.

Salam is regarded as one of the all-time great scientists, not only because of his scientific achievements but because of the overall impact he has made on the scientific community at present. He believes firmly: 'Scientific thought and its creation is the common and shared heritage of mankind'. However, in science, as in other spheres, this world of ours is divided between the rich and the poor. The richer half – the industrial North with an income of 5 trillion dollars, spends 2% of this – some 100 billion dollars – on non-military science and development research. The remaining half of mankind the poorer South, with one-fifth of this income of around one trillion dollars – spends no more than two billion dollars on science and technology.

Third World Academy of Sciences (TWAS) was founded in November 1983 at Trieste by Salam and a group of forty world-class scientists including nine Nobel laureates from Third World. During 1987–88, he personally visited a number of Third World countries and met various

Heads of States who promised their support. His strong conviction that the current poor status of Science and Technology in the Third World can only be improved substantially by the countries themselves, prompted him to establish the Third World Network of Scientific Organizations (TWNSO) in October, 1983. Salam was elected president and a joint declaration known as 'The Trieste Declaration on Science and Technology as an Instrument of Development in the South' was issued on this occasion. It was Salam's hope that the Network will eventually be an effective force in convincing the governments of the South to at least double their expenditure on Science and Technology and increase the number of scientists and technologists to the level of at least 1000 per million in each country before the end of this century. It is in this connection that he undertook his journey to Bangladesh, India and Pakistan despite his failing health.

If Trieste has become a Mecca for Third World Scientists over the years since its creation in 1964, Abdus Salam, Nobel Laureate and a genius from Punjab, was destined to play the role of a prophet of Third World scientists. May the mercy of Allah be on His servant!

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