

## Abdus Salam (1926–96)

AMONG the great intellectual achievements of this century is the theory of elementary particles that has come to be known as the Standard Model. It represents the cumulative effort of many profound and imaginative thinkers whose common motivation was to find some glimmer of understanding as to what the physical world is made of and how it works. This kind of endeavour is very much in the European tradition, and much of the work was carried out in the wealthy universities of Europe and North America. But among the creators of this intellectual system there are some from other, less wealthy parts of the world. One such is Abdus Salam, who died on 21 November. Salam made a major contribution to the creation of the Standard Model. For this work he shared the Nobel prize with Steven Weinberg and Sheldon Glashow in 1979.

The Standard Model is the best existing mathematical description of the physical phenomena that take place on subnuclear scales. Its predictions have been confirmed to a high degree of accuracy. The main element in the construction of the model is a type of field theory known as Yang–Mills theory. In the 1950s Salam, together with J. C. Ward, was one of the first to appreciate the significance of Yang–Mills theory in the description of weak nuclear forces.

Then in 1962 an important theorem, due originally to Goldstone, was proved by Salam, Weinberg and Goldstone. Its extension and application to models of the Yang–Mills type by Higgs, Kibble and others led to an understanding of how the Yang–Mills vector particles can become massive. This was the last ingredient needed for the construction of a unified theory of weak and electromagnetic interactions, and the electroweak theory of Weinberg and Salam soon followed.

Abdus Salam was born in 1926 into an ordinary family in the village of Jhang in Punjab, in what was then British India. His father was a deeply religious person and placed great emphasis on education; and he was the single most formative influence on Salam during his education in Pakistan. Salam was educated at the government college in Lahore, at St John's College, Cambridge, and at the Cavendish Laboratory, where he obtained his PhD in 1952. In 1957 he was invited by Blackett to occupy the chair of theoretical physics and to create a theoretical particle physics group at Imperial College, London. In 1959 he was elected fellow of the Royal Society.

A guiding principle during his entire

active life was that of symmetry. During the early 1960s, together with Gell-Mann and others, he emphasized the group-theoretical classification of hadrons. Salam's contribution, together with John Strathdee, to a rather abstract form of symmetry known as supersymmetry is well known. In 1974 and 1975



they invented a mathematical framework of supersymmetry known as super-space. As an aside, it may not be well known, even among the experts, that several terms in common use by physicists, such as electroweak theory, astroparticle physics and supersymmetry, were invented by Abdus Salam.

Also in the mid-1970s, Salam and Robert Delbourgo were the first to formulate a possible violation of the equivalence principle in general relativity, due to the quantum effects of chiral fermions. This work strongly influenced the development of gravitational instants by Stephen Hawking and others. Salam and Jogesh Pati were among the first group of theoreticians to propose the idea of a grand unified theory encompassing electroweak and the strong nuclear forces, and that in such models the proton may be unstable.

The idea of creating an international centre where scientists of all nationalities and political creeds could interact was rooted in Salam's experience of being isolated from world science in Pakistan. Due mainly to his efforts, the International Centre for Theoretical Physics (ICTP) at Trieste, Italy, was established in 1964 under the aegis of the International Atomic Energy Agency and with the support of the Italian government. It was directed by Abdus Salam from 1964 until December 1993.

Even if he had not been such a creative and influential scientist, Salam would have been remembered for the creation of the ICTP and for his charismatic leadership. The centre has had a significant impact on the development

of science in that large part of the world where, perhaps due to social and political conditions, the basic sciences are almost completely ignored. The ICTP is, and has been, a meeting point for physicists of all cultures and religions. For example, during the Cold War it was one of the few institutions where scientists from the Soviet bloc countries could meet and collaborate with their Western colleagues.

The ICTP has overcome many seemingly insurmountable difficulties to become as well established as it is now. Only a person of Salam's moral and intellectual power, fired by a dedication to the well-being of the neglected part of humanity, could have made this enterprise survive. His relentless efforts on the political front are legendary. He has talked with some of the most important political leaders of his time, from John F. Kennedy and Zhou En-lai to François Mitterrand and Margaret Thatcher.

Abdus Salam was elected to membership of prestigious societies in 24 countries, including the US National Academy of Sciences, the Royal Swedish Academy of Sciences and the USSR Academy of Sciences; he was made an honorary KBE in 1989 and was an honorary member of seven other important national orders in four continents; he received 45 Doctor Honoris Causa awards in 28 countries, and nine medals for his contributions towards peace and the promotion of international collaboration, including the Atoms for Peace Award. Salam also founded the Third World Academy of Sciences and was its president until 1994.

During the last years of his life Salam suffered from a neurological disorder, progressive supranuclear palsy. This was perhaps the only significant battle, among so many, that he fought but did not win. He bore the illness with grace and tranquillity. He accepted with equal humility the great gifts that enabled him to act so effectively in science and for the Third World, and to face the vicissitudes of illness.

It was difficult not to be impressed by the forceful but deeply humane personality of Abdus Salam. He had a genuine respect for others and a very intelligent sense of humour. What he generously gave to others were his time and inspiration, perhaps the most valuable gifts that such a singular person could offer to his fellow human beings.

Seif Randjbar-Daemi

*Seif Randjbar-Daemi is at the International Centre for Theoretical Physics, 34014 Trieste, Italy.*