



## CONTRIBUTIONS OF PROFESSOR ABDUS SALAM AS MEMBER OF PAEC

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The contributions of Prof. Abdus Salam in Physics and for development of Science in Pakistan and developing countries are highlighted. In particular those which he made as a member of PAEC are discussed in some detail.

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### 1. Introduction

Professor Abdus Salam was born on January 29, 1926, in Jhang, one of the least developed areas of a developing country, Pakistan. Before leaving for England, his name was already a legend in Pakistan as, in the fierce competition of pre-partition India, he passed every examination at the Punjab University, Lahore, with the creation of a new record. Salam went to Cambridge in 1946 where he equally excelled and got double first in the Mathematics and Physics Tripos examinations of the University of Cambridge. He began research in the Cavendish Laboratory in 1949. His Ph.D thesis, published in 1951, contained important work in the quantum field theory of the electromagnetic force which made an immediate impact. He was at once recognized as a major contributor to the field.

Following a brief visit to the Institute of Advanced Study at Princeton, he came back in 1951 as Professor to his *alma mater*, Government College, Lahore, and Head of the Mathematics Department of the Punjab University. There in an environment, where he could not interact with fellow scientists working on exciting problems, the choice was between intellectual death or migration to the stimulating environment of a Western institution. He made the only choice available to an inquiring mind and returned to Cambridge as a lecturer in 1954 at the age of 30. This choice, however, left a deep impression on him and was behind his determination to create an institution to which physicists from developing countries could come as of right to interact with their peers from

industrially advanced countries without permanently leaving their own countries. How this came about in the form of International Centre for Theoretical Physics at Trieste, I will describe in some detail later.

Professor Abdus Salam has laid many of the foundations of present theory of particle physics, the physics of what lies at the heart of matter. The first one was his theory of neutrino (an elusive particle first postulated by W. Pauli in 1930 to solve the puzzle of energy conservation in radioactivity), which he formulated at the age of 31. In formulating this theory he introduced a new type of symmetry principle, called "Chiral symmetry". This symmetry principle played a crucial role in the subsequent development of a theory of weak interactions responsible for radioactivity without which the stars would not shine. The second and the most important of his contributions was his theory of unification of two fundamental forces of nature, weak (referred to above) and electromagnetic forces, for which he shared the 1979 Nobel Prize for physics with two Harvard University physicists, Steve Weinberg and Sheldon Glashow. "Until two decades ago," he explained to a group of academics and the country's President at the Quaid-i-Azam University just after the award, "physicists believed that there are four fundamental forces of Nature; the gravitational, the electromagnetic and the two nuclear forces, the weak and the strong. Two decades ago, my colleagues and I suggested that there were indications that the weak nuclear force was not really different from electromagnetic and that the

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two could interconvert, one into the other. We were searching for a unity, in the tradition of Newton, Maxwell and Einstein and the unified theory was formulated in its final form in 1967. The fact that we were seeking a unity among the seemingly disparate forces of nature, is part of our faith as physicists". This success gave an incentive to further work, to extend further the ideas of unification. Indeed, in 1973 Salam and Pati were the first to have the courage to put the idea that two apparently different types of fundamental constituents of matter, called quarks (which neutrons and protons and mesons are built of) and leptons (to which electron and neutrino belong), can be treated on an equal footing. This idea is now an integral part of grand unification theories, that would combine the symmetries of the strong and electroweak theories. The greatest remaining challenge to the theoretical physics is to bring gravity within the same framework as the other forces. Here, although Salam was not directly involved in the developments, yet maintained activity in this direction and one of the key ideas, called supersymmetry, in meeting the above challenge, was elaborated on in an elegant fashion by Salam and his collaborators.

## 2. Salam's Role as a Member of PAEC

Professor Abdus Salam was appointed as a part-time member of Pakistan Atomic Energy Commission in 1959. When Dr. I.H. Usmani took over as its Chairman in March 1960, Salam developed a very close association with him. Later when he was appointed as Chief Scientific Advisor to the President of Pakistan in 1961, he became an ex-officio member of the Commission and remained so until 1974. Although he resigned from this position in 1974, he never hesitated to advise the Commission on important matters. Mr. Munir Ahmed Khan, who had a great respect for Prof. Abdus Salam, was always responsive to Salam's advice. Munir Ahmad Khan's respect for Professor Abdus Salam was so great that he was one of the few important persons who received Salam's dead body at Lahore airport. When a memorial meeting was held in Trieste in Nov. 1997, Munir Ahmed Khan attended that meeting in his personal capacity (as at that time he was no longer the Chairman of PAEC), while nobody from the Commission officially attended that meeting, notwithstanding the fact that Prof. Abdus Salam remained its member for 15 years and did so much for the development of PAEC and its programmes, as I will discuss in the following paragraphs.

The Pakistan Atomic Energy Commission was revitalized in 1960 with Dr. I.H. Usmani as its Chairman (a bureaucrat with a Ph.D. in Physics who had a passion for science development) and Prof. Abdus Salam as its active member. Together they formed an admirable team of a scientist par excellence, very well recognized internationally, and a top administrator with a broad vision, knowing the intricacies of bureaucracy in a country dominated by bureaucrats, who helped to bring some dignity and respect for the scientific profession in Pakistan. It is through their efforts that a high-level scientific manpower base was developed in Pakistan. This was the time when PAEC embarked on the training of more than 500 young scientists in areas of experimental and theoretical physics, nuclear and radiation chemistry, health physics, biology, agriculture and engineering. Due to efforts and prestige of Prof. Abdus Salam a large number of young men were educated at advanced (Ph.D.) level in some of the best Universities of the world. These men by and large constituted Pakistan's major stock of trained manpower in the relevant disciplines, and advanced the programmes of the Commission.

During the same period, on the advice of Prof. Abdus Salam, the Space and Upper Atmosphere Research Commission (SUPARCO), of which he was the founding Chairman, was established by the Government of Pakistan. It was due to the confidence and respect which Prof. Salam enjoyed with President Ayub Khan, that a Nuclear Power Plant near Karachi (KANUPP) was approved by the President personally against the wishes of his own Government. Remember the famous remark of Dr. I.H. Usmani, which he made during the inauguration of First International Nuclear Physics Conference in Dacca in 1967: "There are fossils in Pakistan Government who would prefer fossil fuel". Dr. Usmani was never forgiven for this remark by Pakistan bureaucracy. The important point was that when a country intends to enter into a new technology like nuclear technology, economic considerations alone should not be a deciding factor.

Coming back to Professor Abdus Salam, I now mention his greatest contribution as a Member of PAEC, namely the proposal he made for the creation of International Centre for Theoretical Physics as a delegate from Pakistan at the Plenary session of the IVth regular session of the IAEA General Conference on 22<sup>nd</sup> September 1960, which resulted in his greatest creation – an institute

for the underprivileged. Let me quote from his remarkable speech:

“... Up to the present time the Agency’s main functions, have been the distribution of funds for equipment evaluation of safety standards, and award of fellowships... We feel, however, that this is not enough. We strongly feel that the Agency should henceforth place increasing emphasis on development of research in fields related to Atomic Energy. In this regard my delegation wishes to put forward a concrete proposal which I am glad to say has the sponsorship of a number of other delegations in this Conference. We wish to suggest that to start with the Agency may seriously consider helping with the promotion of research in theoretical physics.

It is not necessary for me to remind this distinguished audience of the basic role which theoretical physics, and theoretical physicists, have played in the development of atomic energy. The basic notion that atomic energy can be released in the service of men was the brain child of two of this century’s theoretical physicists – Albert Einstein and Niels Bohr. Even more pertinent perhaps is the fact that the very first nuclear reactor was assembled and actually constructed by a theoretical physicist – Enrico Fermi. The time has perhaps come when the Agency, in its turn, might pay back the debt by considering if it might sponsor an International Institute for Theoretical Physics.

Such an Institute needs no laboratories, and no costly apparatus. All that is necessary is a modest building, a library, and a few blackboards. We envisage that this Institute might work in areas connected with atomic energy – like nuclear theory, theory of elementary particles, reactor theory and thermonuclear fusion. The Institute would function primarily by awarding about fifty fellowships a year, half of these to senior physicists on sabbatical leave or other type of leave from their parent organizations. This is the pattern, which has successfully worked at the world-famous Institute for Theoretical Physics at Copenhagen and the most legendary Institute for Advanced Study at Princeton.

What is needed at this stage is that an active International Centre should exist, sponsored by an international body like this Agency. Only then can first-rate men from less privileged countries come periodically as of right to relive with their peers – the pioneers and thinkers of the international world

– and thus give of their best of creative research. Some delegates may apprehend that the cost of establishing such an Institute may prove to be beyond the resources of this Agency. Let me reassure them again that the major item of cost would be that for a modest building. The majority of fellowships would come from those already allocated to the Agency for pure research.

The Pakistani delegation is proposing to present a resolution on this subject and I very much hope it will meet the commendation of the Conference as a whole”.

The rest is history. The Board finally decided: “That an international centre for theoretical physics shall be formally established on provisional basis under the Agency’s auspices at Trieste if possible by 1 January or in any case not later than 1 July 1964 within the framework of the offer by the Government of Italy to provide facilities for it.

### 3. Salam’s Subsequent Role

Professor Abdus Salam provided a tireless and dynamic leadership for the subsequent development of the International Centre for Theoretical Physics (ICTP) which has touched the lives of so many physicists all over the World. The ICTP has played a major role in advancing the level of scientists in developing countries by overcoming the isolation of the scientists working there. The ICTP helps to provide an interaction between the best from the industrially advanced countries and the brightest from the developing countries so that the scientific contacts develop in mutually beneficial manner without the scientists of the South having to leave their countries. To-date roughly 10,000 scientists have visited ICTP. In the Salam memorial meeting held in 1997, the ICTP was rightly named after him.

Professor Abdus Salam was also instrumental in founding the Third World Academy of Sciences (TWAS), which is “now viewed as one of the world’s foremost organizations for scientific capacity building in the South and one of the leading voices for science – based on sustainable development in the developing world”. In a meeting in October 2003 held in Beijing, China, to celebrate the 20<sup>th</sup> anniversary of TWAS, glowing tributes were paid to Salam’s vision. This is what the President of TWAS, Prof. C.N.R. Rao said: “For the Founder of this Academy, Abdus Salam, the Nobel Prize was his greatest scientific reward and Abdus Salam International Centre for Theoretical

Physics (ASICTP) – now named after him – his most renowned creation. TWAS, however, is the institution that embodies his loftiest dreams: a tight-knit community of the developing world's most eminent scientists working together not only to advance the frontiers of science but to make science more relevant to society. It was, after all, the unity of scientific excellence and social good that served as Salam's most ambitious goal".

In 1974 Professor Abdus Salam visualized the need of an institution where experts from the industrialized nations and learners from the developing countries could get together for a couple of weeks once a year to exchange views on various subjects of current interest in Physics and allied sciences. He rightly comprehended the ever-widening information gap between the North and the South. He suggested to PAEC to organize such a forum. The-then Chairman of PAEC, Munir Ahmed Khan, not only accepted this suggestion but put his heart into it. It was the year 1976 when the first college was inaugurated at Nathiagali in the Pakistani Himalayas. Since then it has been regularly held without break and it is a great credit to PAEC to have continued its generous support for this college. It has acquired an important status in the calendar of scientific activities throughout the world. Twenty-nine extremely successful colleges have been held so far and the 30<sup>th</sup> one will be held from June 27 to July 10, 2005. Over 470 renowned scientists, including some Nobel Laureates, shared their knowledge and experience with nearly 900 foreign scientists from as many as 72 countries. About 6000 participants drawn from universities and colleges (nearly 15 percent of them graduate students) and R&D institutes from Pakistan have also benefited from this scientific discourse. The Nathiagali Colleges have provided an effective forum for scientists from developing countries and those from the developed ones to exchange information and ideas on a series of topics of current interest in physics and related fields, in

which recent advances have been made and breakthroughs achieved. These colleges have also served as a vehicle for initiating collaborative research between scientists working in various regions of the world. Many collaborative projects have thus been initiated through discussions held during the Colleges. Moreover, a number of young scientists, as well as students, have benefited by seeking guidance for their future plans. As a matter of fact, such type of international scientific gathering in a developing country like Pakistan presents a major step for the promotion of science in the Third World, a major aim Professor Abdus Salam had in his mind when he made his original proposal to PAEC in 1974.

When the Nathiagali College was started, it was Professor Abdus Salam's wish that in time it would develop into a full fledged Centre for physics on the pattern of Abdus Salam ICTP. It took almost thirty years for his vision to be translated into reality in the form of National Centre for Physics, which got its Charter from the Government of Pakistan in April 2004. Thirty years is a long time for this to occur, but there is a lesson in it: patience, persistence and above all sincerity of purpose do ultimately pay.

Freeman J. Dyson, whose programme on the renormalization of quantum electrodynamics Professor Salam completed as his first major contribution in physics, says: "..... in honour of my friend and hero Abdus Salam, founder and moving spirit of ICTP. Salam was great as a scientist, greater as an organizer, greatest as the voice of conscience speaking for the advancement of science among the poorer two thirds of mankind".

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