

# Professor Daulat Singh Kothari: An Amalgam of Science and Spirituality

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## **Abstract**

*Professor Daulat Singh (D.S.) Kothari was a household name in Indian education when I started my teaching career in Lyallpur Khalsa College, Jalandhar in July, 1963. My first contact was established with D.S. Kothari during a Summer School on History of Science, perhaps the first of its kind in India, in Sept. 1975 organised by Indian National Science Academy (INSA) in New Delhi under his patronage. He was impressed by my presentation "Cosmological Ideas in Science and Sikh Religion". He was chairing this session and asked me to translate my book "Brahmand Di Rachna" into Hindi for wider circulation in India. Another fall out of this presentation was my nomination as Member of UGC (University Grants Commission) Panel on History of Science, even when I was a young Lecturer in Punjabi University, Patiala. All other members were Senior Professors of Indian universities.*

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## **EARLY EDUCATION AND INFLUENCE OF PROFESSOR SAHA**

D.S. Kothari was born on July 6, 1906 at Udaipur, Rajasthan (India), where his father was headmaster of a high school. He completed his school education in 1922 from Maharaja Shivajirao School of Indore. After his matriculation he came back to Udaipur and entered the Intermediate College. In his Intermediate Examination, which he passed in 1924, he stood first in the Rajputana Board. He was awarded distinction in all science subjects, including physics, chemistry and mathematics. The Maharana of Mewar granted him a monthly scholarship of Rs.50 for pursuing higher studies after his excellent performance in the Intermediate examination.

Daulat Singh took his B.Sc. degree from University of Allahabad in 1926 and the M.Sc. in physics from Allahabad in 1928. It was at Allahabad in 1924, as a first year undergraduate student, that he came into contact with Professor Meghnad Saha, Head of Physics Department, who was his teacher. Saha was impressed by Kothari's diligence and brilliance. Saha not only taught him physics but also got him interested in the history of science and philosophy. As Kothari himself recalls [1], Saha came to Kothari's

room in the Jain hostel one day in the evening of February 1927 and enquired whether he intended to appear at the competitive Indian Civil Services (ICS) examination for government service. Those days, University of Allahabad was considered as a beehive for ICS aspirers in India. Saha was greatly pleased when told by Kothari that he had no such intention, and immediately offered the post of a demonstrator in the physics department. Saha himself dictated the application which Kothari submitted the next day. Kothari got the offer in July 1928 as soon as his M.Sc. results were announced.

Kothari worked as demonstrator at Allahabad for nearly two years. He was awarded a United Provinces (now Uttar Pradesh) government scholarship to pursue higher studies at University of Cambridge in England. He sailed for England in Sept. 1930 hoping to work under Prof. Ernest Rutherford, to whom Prof. Saha has already communicated. It is interesting to recall that the Indian High Commission in London had first fixed his admission at University of Oxford against his wishes. In his characteristically modest way Kothari says that 'through the confluence of lucky coincidences', he was able to get the admission changed to University of

Cambridge [2]. At the University of Cambridge, Kothari worked under Lord Rutherford, Peter Kapitza and RH Fowler at the Cavendish Laboratory. It was here that he came into contact with S. Chandrasekhar and their life-long friendship started. At Cambridge, Kothari was motivated by the great masters to delve deep in to the new physics and mathematics before taking up his Ph.D. thesis. But, thanks to a strongly worded letter from Professor Saha in 1932, Kothari changed his mind. In 1933, he got his Ph.D. from University of Cambridge and returned to India to rejoin his post in University of Allahabad (Figure 1).



*Fig. 1: Professor D.S. Kothari.*

### **FOUNDER OF PHYSICS DEPARTMENT AT UNIVERSITY OF DELHI AND DEFENCE SCIENCE ADVISOR**

In 1934, again at the insistence of Prof. Saha, Kothari joined University of Delhi as Reader in Physics. There were no post-graduate courses in science subjects at Delhi and just two teachers in Physics to cater to the needs of under-graduates. Kothari had to start from a scratch in creating infrastructure for teaching and research. He was made professor and head Physics department in 1942 for starting M.Sc. classes. One of the traditions that he set up was that every faculty member, be he a theoretician or an experimentalist, should participate in the laboratory supervision of students [3]. He

always made it a point to teach at least one subject to the first year B.Sc. class. He would switch frequently from English to Hindi to communicate more effectively. I used to follow Kothari in my lectures to convey the concepts of Physics in Punjabi, for better comprehension to my students.

The era of 1926–1932 was the aftermath of the quantum mechanics revolution in Europe, which had changed the face of physics; Professor Kothari and his colleague from Allahabad, R.C. Majumdar had felt the impact of this revolution when they were abroad in Europe. As a consequence, University of Delhi became the first and foremost to teach the methods of quantum mechanics and quantum field theory at the M.Sc. level. In later years, F.C. Aulack, A.N. Mitra, S.N. Biswas and L.S. Kothari were appointed Professors in Theoretical Physics during 1960s and the Physics Department improved significantly as a centre of teaching and research in India.

In 1948, Professor Kothari was offered the post of Defence Scientific Advisor to the Government of India. He accepted it but after laying down some rather unusual conditions. One of them was that he would continue to draw the same salary of Rs. 1250 as that of a university professor and not the enhanced one of Rs. 2000, he was entitled to as Advisor. The other was that he would continue his teaching assignment in University of Delhi [2]. He continued his teaching till the late sixties even though he was involved in other heavy duty engagements in the Ministry of Defence. He kept in touch with students by meeting them once a week even after his retirement in 1961.

During his term as Defence Scientific Advisor, he was on leave from the university for the period 1949 to 1951. After his return to the University in 1951, he continued at the university till he became Chairman of the UGC in 1961. This change took him to the national level in the fields of both science and education. So from 1934 to 1961, he had full time association with the University of Delhi, out of which for about 20 years he was involved in post-graduate teaching and research. Though he was not involved in full-time teaching after 1961, his influence and

guidance to the department continued in varying degrees till his death in February 1993.

Among the many traditions established by Professor Kothari at Delhi, two may be mentioned. Every faculty member, be he trained in theoretical physics or experimental physics, had to participate in the laboratory supervision of students at B.Sc. or M.Sc. level. This was based on the advice of the famous scientist Lord Rutherford to Professor Kothari when he was returning from Cambridge, UK, to India. Lord Rutherford urged Kothari to keep using his hands (in the laboratory) even if he was doing theoretical work.

The second tradition was partially due to the advice that the famous Danish physicist, Niels Bohr, gave to Prof. Kothari. He stressed the importance of an atmosphere where even the younger members could express their opinion freely. A very large degree of freedom and autonomy characterised the functioning of the Physics department at Delhi in contrast to the functioning of some other science departments at Delhi and other places. In following Bohr's advice, Prof. Kothari must have been helped by his own humility and innate confidence.

Professor Kothari was a natural and highly gifted teacher; in fact he should be described as a superb teacher-learner. He often stressed and strongly believed in the necessity for 'a teacher to be always a student and keep learning'. He was highly sensitive to the atmosphere among listeners. His switch-over from English to Hindi, to drive home a point, was very noticeable and effective in communication. The importance given by him to teaching is illustrated by an oft retold incident. Once when he was interrupted during a class with the message that the 'Defence Minister wishes to speak to him on phone', he told the messenger politely to inform the caller that he (Professor Kothari) was busy in a class and would call the Minister after the class was over.

## **ROLE AS AN EDUCATIONIST IN INDIA**

Prem Kirpal, a former Secretary in Ministry of Education, has narrated the episode how Prof. Kothari was appointed the Chairman of UGC

[4]. When Dr. VS Krishna, the then Chairman of UGC, died after a severe heart attack during a meeting being held in the office of Education Minister, a race started between would be candidates there and then. By chance, Dr. S. Radhakrishnan, the Vice President of India happened to visit to condole the death of this gentleman. Dr. Radhakrishnan advised the Minister to announce the appointment of Daulat Singh Kothari who was not in the race among several aspirants for this post. That is how Kothari was appointed the Chairperson of University Grants Commission in 1961, where he had the longest stint of 12 years and worked till 1973. It was during this tenure that he was appointed Chairman of the Education Commission (1964–1966); the report of this Commission, generally known as the Kothari Commission report, was a landmark in the annals of education in our country.

According to Prem Kirpal, "Little was known of Kothari beyond the scientific circles of Defence Science and the University of Delhi, but the world of education welcomed the appointment of a scholar and teacher known and respected for his learning and dedication to teaching and research. Kothari's leadership of the Indian Education Commission was a remarkable achievement, made possible not only by his vast experience and commitment to education, but also by the moral and intellectual qualities of a rare human being, deeply imbued in the spirit of service and compassion, derived from the nature of science and the essence of the cultural experience and traditions of India. Simplicity and humility were combined with a lofty idealism and a rare sense of duty and service in the person of Kothari".

Among the many recommendations of the Commission, Kothari put special emphasis upon the following for bringing about an educational revolution in the country:

- (a) Introduction of work-experience and social service as integral parts of general education at all levels of education;
- (b) Stress on moral education and inculcation of a sense of social responsibility;
- (c) Vocationalization of secondary education;
- (d) Strengthening of centres of advanced study and setting up of a small number of major

universities which should aim at achieving the highest international standards;

(e) Special emphasis on the training and quality of teachers for schools;

(f) Education for agriculture, and research in agriculture and allied sciences; and

(g) Development of quality or pace-setting institutions at all stages and in all sectors.

The report of the Education Commission was hailed as a landmark of educational development in India and other developing countries. At home its recommendations got bogged down in the vagaries of a system which was not congenial to performance and implementation. After many years, he felt concerned that what was expected had not been achieved. According to him, the missing link was the decline of character. He said that if he were to prepare the Report now, it would aim at 'Education and Character Building'. Once character is built, development will follow automatically.

### **HONOURS AND AWARDS**

Honours and awards came in plenty to Professor Kothari. In 1962 he was awarded Padma Bhushan and in 1973, Padma Vibhushan. He was the General President of the Indian Science Congress in 1964. In 1966 he was chosen for the Shanti Swarup Bhatnagar Award of the Indian National Science Academy (INSA). In 1973 he was elected Foreign Member of the USSR Academy of Sciences, Moscow. During 1973–74, he was the President of the INSA, New Delhi. In 1978, he was awarded the Meghnad Saha Medal of INSA. Professor Kothari was a Fellow of the Third World Academy of Sciences, Trieste, Italy; a member of the Pugwash Conference, and a recipient of the award of the National Federation of UNESCO Associations in India. He was made the first Chairman of Commission for Scientific and Technical Terminology, Govt. of India.

Many universities awarded honorary degrees to him; these include University of Roorkee, Aligarh Muslim University, University of Udaipur, Guru Nanak Dev University (Amritsar), and University of Leningrad (USSR). He also made it a point that as long as he was the Chairman of the UGC he would not

accept any honorary degree from any Indian University. He was invited to deliver convocation addresses from 40 universities of India, and a number of Memorial Lectures from all over India. He served as Chancellor of the Jawaharlal Nehru University (JNU), New Delhi from 1982–1992, a rare honour for an educationist.

### **AN AMALGAM OF SCIENCE AND SPIRITUALITY**

He was an outstanding physicist, an educationist with a vision, an inspiring teacher, the architect of defence science in our country, and, above all, a great human being who symbolized the noblest traditions of Indian culture. He combined in himself profound scholarship, simplicity to the point of asceticism, humility, soft-spokenness, warmth, enlightenment, tolerance, as well as a passionate and abiding concern for the welfare of humanity. A true Jain, Kothari meticulously followed the principles of Right Conduct involving the practice of Ahimsa, Satya, Asteya and Aparigraha. He was deeply read in the Upanishads, the Gita, Buddhist and Jain scriptures. He believed in a holistic approach to the individual, science and society. On relation of Science and Religion, he used to say: "Science provides an understanding of and control over Nature. But it is moral and spiritual insight which gives a meaning and purpose to life, individually and collectively. In the end both science and religion are to be judged by their achievements, and not by their pretensions or their promises." He subscribed fully to Einstein's dictum: "Science is lame without religion, and religion is blind without science".

After his retirement from the UGC he decided to read the Gita in the original. Because of his deep understanding of quantum physics, he was able to see and appreciate its close link with ancient Indian thought. He wrote and lectured extensively bringing out this synthesis. Some of his typical articles in this field are: 'Atom and Self' (Meghnad Saha Medal Lecture, 1978); 'The Complementarity Principle and Eastern Philosophy' (Niels Bohr: A Centenary Volume, 1985); 'Complementarity Principle: Physics and Beyond' (NPL, Technical Bulletin, 1989); and 'Some Thoughts on Mind, Matter and

Complementarity' (Physics Education, 1974). According to Prof. Kothari, "The most profound, rich and fundamental of all complementarities is that of **matter** (brain) and **consciousness** (mind)". He argues at length to show that an understanding of complementarity existed in Indian culture. He used to say that the core of the ethical-spiritual insights propounded in the Upanishads, Buddhism and Jainism rests essentially on the complementarity approach to the problems of life and existence.

In the last few years he had started a discussion group with some members of the department, on philosophy and physics. His interest in the relationship between Vedas, Upanishads, Gita, *Syriadvad* of Jain texts and the ideas of modern science merits a full discussion elsewhere. He was one of those who believed in a holistic approach to the study of Individual, Science and Society. I had the privilege to participate in one of his discourses on 'Science and Spirituality' at his residence in University of Delhi in 1992, a year before his death. I visualized him as an inspiring teacher like ancient *rishis* or gurus of India.

In honour of Professor Kothari, the University of Delhi has established the D.S. Kothari Centre for Science, Ethics and Education. Sir John Kendrew, Nobel Laureate, delivered the first Prof. D. S. Kothari Memorial lecture on November 18, 1995. Prof Feroz Ahmed (former Professor, Dept. of Physics) served as Co-ordinator of the Centre from 1997–2005 during which period he edited four volumes of Professor Kothari's essays on a variety of themes. Presently, Professor Meenakshi Thapan, Department of Sociology, is the Co-ordinator of the Centre. The activities of the Centre include organizing lectures and workshops, including the D.S. Kothari Memorial Lecture, publishing working papers, books and other material on themes close to Professor Kothari's interests: science, ethics and various related aspects of education in India.

### A CRITICAL EVALUATION OF PROFESSOR KOTHARI AS A SCIENTIST

In my estimation, Professor Kothari deserves to be rated among the topmost Indian scientists of

pre-independence era. He started his research activity as a student of M.Sc. Physics at University of Allahabad, like C.V. Raman, and published 3 papers in 1928, including one in Nature. Professor MN Saha complimented Kothari: "His method for determining the ratio of charge to mass of electron has now been adopted in all Indian laboratories (I have no knowledge of laboratories abroad)". His first independent (single author) paper was published abroad in 1929, wherein he studied in detail Doppler-Fizeau effect considering light in the form of light quanta and not waves [5].

In 1930 he went to Cambridge to work with Lord Rutherford at Cavendish Laboratory. Here he made many notable contributions to quantum statistics, properties of degenerate matter, internal constitution of stars and other related topics [6]. For example, he computed opacity coefficients of electron degenerate matter using a rigorous quantum mechanical treatment and showed that energy flow in degenerate stellar cores is mainly due to thermal conduction and not by radiative process. His theory of pressure ionization found wide applications from white dwarf stars to planets. Some of the important conclusions were:

- (a) Ionization can take place at high densities, owing to pressure, even at zero temperature;
- (b) It is possible for hydrogen to go over into metallic phase in the core of cold dense bodies composed mostly of hydrogen; and
- (c) No cold body can be more massive than Jupiter, i.e., around one hundredth of the mass of the sun.

Dr. Kothari's work on pressure ionization was an important contribution to our understanding of matter under high pressures and found wide ranging applications in Physics and Astrophysics. When it was established in 1936 that the neutron mass exceeds the mass of the proton by a small amount, Dr. Kothari, for the first time, realized the significance of this fact in Astrophysics. In his landmark paper, 'Neutron Degeneracy and White Dwarfs', he established the existence of an upper limit for the pressure exerted by degenerate electron gas. He also showed that hydrogen containing White Dwarf stars must have a radius less than about  $6.4 \times 10^6$  m.

Kothari and his colleagues, F.C. Aulack and R.C. Majumdar, introduced other interesting ideas in statistical mechanics. They studied Fermi-Dirac and Bose-Einstein gases in uniform field of force, thermodynamics of relativistic Fermi-Dirac gas, etc. Dr. Kothari studied the nature of spectrum of non-equilibrium radiation and called it non-degenerate radiation. He conjectured that departures from black-body radiation observed in stellar studies could be accounted for by his theory. Similar distribution was later observed while studying the thermodynamics of grey atmospheres.

He established close connection between statistical mechanics and Ramanujan's results on partition of numbers. Among other topics investigated were hole theory of the liquid state, bounded harmonic oscillator, kinetic theory of rubber, Fermi's theory of particle production, Riesz potential, colour centres in solids, armour penetration, radiation and sensation of pain, etc. He guided a number of teachers and research scholars in fields like plasma physics, magneto-hydrodynamics, quantum electrodynamics, relativistic quantum statistics and encouraged them to publish their results independently.

Two attempts were made to get Kothari nominated as Fellow of Royal Society (FRS) but both times he was not elected to achieve this prestigious award. Rajinder Singh [7] has tried to trace the history of his nominations for FRS and came to the conclusion that despite his important contributions to research, he failed to qualify due to tough competition from other nominated astrophysicists during the years of his nomination. The other reason may be attributed to low grade publications made during his later years when he was burdened with other administrative responsibilities assigned by the Govt. of India.

Kothari was a great orator and in great demand as a speaker in universities and social organisations. During Guru Nanak Fifth Centenary Seminar at Punjabi University, Patiala, he delivered the Presidential address on Sept. 5, 1969: "Guru Nanak's main contribution—Universalization of Religion".

Some of his important contributions were compiled as books.

"Nuclear Explosions and Their Effects" published by the Publication Division, Ministry of Information and Broadcasting, Government of India, New Delhi has gone through several editions. The book has been translated into German, Russian and Japanese. His other popular books are "Atom and Self" and "Knowledge and Wisdom", both collection of Lectures delivered during his long innings [8, 9]. I have also paid my tributes to Kothari in my book on Indian Scientists "Saade Vigyani" in Punjabi medium [10].

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