BAJI VINAYAK THOSAR

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B. V. Thosar

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(1913-1998)
Elected Fellow 1977

FAMILY BACKGROUND AND EARLY EDUCATION

BAJI VINAYAK THOSAR was born to Vinayak Narayan Thosar and Savitri Thosar on April 3, 1913 in Khamgaon, District Buldana in Maharashtra. He was married to Shalini Thosar and was blessed with two sons, Ravindra and Satish, and two daughters, Suneela and Aruna. He grew up and was educated upto school level at Khamgaon, passing the Matriculation examination in 1929, standing third in the whole province of Central Provinces and Berar and first in Berar. During his school days (7-14 years) he also had training in classical music. He joined the Science College, Nagpur after matriculation and passed his B.Sc. in 1933 and M.Sc. in Physics (specialization in Spectroscopy) in 1935. He was Editor of the college Magazine, President College Union, Secretary Scientific Society and often selected for inter collegiate and interuniversity debate. During his college days at Nagpur he had great influence of Raman who was then posted at Nagpur, and used to borrow simple devices like tuning fork etc. from the college laboratory to pursue his research interests on Indian percussion musical instruments. Thosar later joined Raman's group at IISc, Bangalore during 1935-37. He obtained his Ph.D. in 1949 in Nuclear Physics from the University of Birmingham under the guidance of Professor PB Moon.

PROFESSIONAL AND RESEARCH CAREER

Just after his M.Sc., Thosar got a chance to work with Professor Raman at IISc. Bangalore in 1935 on an EM scholarship. He was asked by Raman to observe the light scattering effect in some gems. Here his specialization in Spectroscopy and his training to observe Raman effect in liquids for his M.Sc. degree was very useful. He worked for about a year or so and returned to Nagpur to take up a teaching position. During vacations he visited IISc for his research. He continued his work on light scattering from ruby crystals at Nagpur.

Professor Thosar's academic activity spans the years 1937-81 which was the period when a major transformation took place in the Science and Technology scene of the country. He started his academic career at the Science College, Nagpur (1937-1951) and served as a member of the physics teaching staff as Assistant Professor, teaching physics both at undergraduate and post-graduate levels. In between he had spent a year (1938-39) at the Marconi School of Wireless Communication at

Chelmsford, England on a KEM scholarship for a course on Wireless Communication. He again left in October 1946 to join the Nuffield laboratory at Birmingham and completed his thesis work in Nuclear Physics. In a Conference in Nuclear Physics at Birmingham in 1948 he first met Dr. HJ Bhabha who had just founded TIFR and was looking for people to establish different disciplines in physics, particularly nuclear physics. This meeting with Bhabha enabled him later to get a position at TIFR. He returned back to Science College Nagpur towards the end of 1949.

It is truly remarkable that Thosar carried out very important piece of work at Nagpur with meager experimental facilities available then in the country and that too during his spare time after completing his teaching assignments. He published a series of eleven papers, (mostly alone and some with junior colleagues and students) in reputed journals like *Zeit für Physik*, *Phys Rev* and *Phil Mag*, all internationally renowned journals.

He joined the Tata Institute of Fundamental Research, Bombay in 1951 as a Reader. The Institute was then in its inception stage. He was asked by Bhabha to start Nuclear Physics activities at the Institute. During his academic term at the Institute he established a very active research group in Nuclear Spectroscopy from scratch with the help of young research workers around him. He pioneered work on Positron Annihilation studies in India, specially positronium decay in molecular materials. He also inspired, encouraged and helped younger colleagues to strike new lines of work on their own. He initiated, guided and encouraged many new research areas such as Beta Ray Spectroscopy, borderline areas between Nuclear physics and Solid State Physics such as Moessbauer Spectroscopy, Positron Annihilation, Low Temperature Physics, Nuclear Orientation, etc. A striking example of this is the use of nuclear decay as probe to do condensed matter research, "Nuclear Solid State Physics", the term often quoted by Thosar.

Thosar rose to become full Professor at TIFR. He also served as Dean, Physics Faculty for several years (1964-1970). After his retirement in 1978, he continued as Emeritus Professor till 1981. He was elected as Fellow of the Indian Academy of Sciences, Bangalore (F.A.Sc) in 1959, Indian National Science Academy (FNA), New Delhi, in 1977. Thosar presided over the Physics Section of Indian Science Congress in 1969. He was the Founder member of the Maharashtra Academy of Sciences and served as Vice President and President (1982-85). He was also awarded the Raman Centenary Gold Medal in 1988.

Thosar had widely traveled and visited several laboratories abroad besides presenting several papers in International Conferences. During his visits to various laboratories abroad, he always thought of initiating new activities at TIFR, which were being developed there. He was thus able to supervise the building of an iron free electron spectrometer for ESCA studies and a low energy ion accelerator for ion implantation and channeling studies.

He co-edited, along with PK Iyengar, a book on *Moessbauer Spectroscopy*. He also wrote a book *Growing up with Science in India* narrating his experiences encountered as a scientist in his long academic career.

He authored about 20 radio talks and articles on different topics, in particular, social and philosophical aspects of science. He was also a contributing Editor of *Society and Science*, a journal of Nehru Science Centre, Bombay.

SCIENTIFIC CONTRIBUTIONS

Some of his research contributions are summarized below:

(A) Luminescence

Professor Thosar carried out luminescence studies of ruby at The Indian Institute of Science, Bangalore. He continued further studies of ruby at Nagpur using spectrographs available in the College. He measured degree of polarization of each of the prominent emission lines R_1 and R_2 from ruby. These results and further studies were published in prominent journals between 1938 and 1942. As is well known several decades later ruby lines were the first in which "Laser" phenomenon was discovered.

(B) Nuclear Physics

Thosar's Ph.D. thesis work during 1946-49 was carried out under the supervision of Professor PB Moon in Birmingham. He designed and built a new type of Beta-ray spectrometer where the focusing of charged particles was done by the electrostatic field between two coaxial metal cylinders separated by accurately machined dielectric spacer. The electric fields between the two cylinders were varied in the range of few kilovolts, thus focusing beta particles of different energies. This served as a velocity selector for low energy electrons, about 100 keV or so. This region of the beta-ray spectrum emitted by different isotopes was at that time not well explored. In those days the commonly used beta-ray spectrometers used a magnetic field for focusing and were suitable for higher energy range of electrons. Just after the war, nuclear reactors were in the process of being built and were going to produce whole new range of radioactive isotopes. With this spectrometer he studied beta-ray spectrum of Au-197 isotope and obtained very interesting results about internal conversion of gamma rays. This work was continued at TIFR where he designed and constructed a modified electrostatic spectrometer using hemispherical electrodes for focusing electrons.

A number of Nuclear Physics projects were developed such as Gamma-ray Spectroscopy, fast gamma-gamma coincidence technique, gamma-gamma angular correlation, nuclear lifetimes. Using these techniques many decay schemes radioactive nuclei were investigated.

Soon after the discovery of non conservation of parity in β-decay, several groups got involved in measuring the longitudinal polarization of beta electrons. The V-A theory of β-decay interaction expects the degree of longitudinal polarization to be –v/c. Lee and Yang had predicted the non-conservation of parity in beta-decay and that the beta particles emitted by radioactive nuclei should exhibit longitudinal polarisation proportional to v/c in the case of 'allowed' decays, v being the velocity of electron and c, that of light. Efforts were made by several workers to establish small deviations from the – v/c rule particularly in the first forbidden transitions. Thosar along with his students initiated such experiments using the cylindrical electrostatic field spectrometer built by him at TIFR. The degree of longitudinal polarization of beta electrons emitted by several radioactive nuclei, such as ^{86}Rb, ^{144}Pr, ^{60}Co, ^{147}Pm and ^{115m}Cd was measured by the method of Mott Scattering from a thin gold foil; the longitudinal polarization was converted into transverse polarization by bending the beta electrons by a cylindrical electrostatic spectrometer. Measurements were done at several velocities of the emitted electrons by accelerating them. The results showed that the –v/c law was obeyed in all cases except ^{115m}Cd where a 15% deviation from the –v/c rule was observed and was attributed to Nuclear Structures or Coulomb effects.

(C) Nuclear Spectroscopy

Thosar and his group made important contributions in the studies of a number of radioactive decay of many nuclei using Siegbahn-Slatis intermediate image spectrometer and also scintillation and solid-state detectors. A thorough study of decay schemes for many nuclei such as ^{199}Au, decay of ^{156}Eu and ^{117}In were carried out. A programme of determination of internal conversion coefficients of gamma-rays from nuclei was undertaken. The most important contribution in this area was k-shell conversion coefficients of pure E2 transitions in some deformed nuclei, namely, $2^+ \rightarrow 0^+$ transitions in even nuclei: ^{166}Er, ^{170}Yb, ^{176}Hf, ^{186}W, and ^{160}Dy. Some important results are described in detail below.

During the early sixties extensive investigations were carried out in several laboratories on the possible nuclear structure effects on internal conversion process. The conversion coefficients of E2 transitions are, however, practically unaffected by finite size effects, which was confirmed by experimental results. However, there existed some experimental evidence that in some even-even rare earth nuclei the conversion coefficients of the $2^+ \rightarrow 0^+$ transition were higher by about 15% to 20% from the corresponding theoretical estimates. As the nuclei in this region are deformed it was thought that the nuclear deformation might affect the E2 transitions. Thosar and his group carried out careful experiments to measure conversion coefficients of E2 transitions in several even-even nuclei in the rare-earth region using β-γ, γ-γ and X-γ coincidence techniques. The measured K-conversion coefficients after applying necessary corrections in the experimental procedure agreed with the theoretical estimates within errors of 6% suggesting that the nuclear deformation has no effect on the internal conversion process. These studies were further supported by more careful work in other laboratories.

The information about K-shell conversion coefficients can also be obtained from the measurement of K-X rays yields produced by the K-ionization via Coulomb excitation of the deformed nuclei by a-particles. Thosar and his group did such measurements using the Van de Graff accelerator at BARC, Mumbai. X-ray yields were measured in Sm, Tc, Ce, Sm, Gd, W, and Pb. and showed that there was no measurable excess of X-ray yield from deformed nuclei as compared to spherical nuclei. These results further corroborate the result that deformation has no effect on internal conversion coefficient for prior E2 transitions.

Thosar and his group also investigated the level structure of several nuclei using β-γ coincidence techniques. In particular the establishment of a rotational material band in the excited state of ^{117}In. It caught lot of attention of nuclear physics community during that period.

(D) Positron Annihilation

Professor Thosar initiated the use of positron annihilation lifetime measurement as a tool to study Solid State Physics. His group had developed the technique of measuring nuclear lifetimes using fast γ-γ coincidence technique in the region of sub-nanoseconds. This technique was utilized in measuring lifetimes of positronium atoms in triplet state in very wide range of materials both in liquids and solids. The object of these studies was to see how this triplet state or orthopositronium lifetime changes in different types of molecular materials or crystals and also in liquids at various temperatures. It was seen that these values of lifetimes could be correlated with the viscosity of a given liquid at different temperatures and with density. Such a correlation was observed for unassociated and polar liquids also, but not in case of associated liquids, in which the presence of hydrogen bonds apparently influences the annihilation process. The *ortho*-positronium lifetimes were measured in Teflon and polyethylene irradiated by γ-rays and in polystyrene irradiated by thermal neutrons. Some measurements were also carried out in a cholesteric liquid crystal.

All these studies led to the development of an empirical "free volume" model to explain the correlation between the intensity and the long lived component in the decay of *ortho*-positronium. The model could explain a number of results and was well accepted internationally.

Thosar's group can claim credit for initiating research on positron annihilation in India and for promoting this work which was undertaken by a number of centres in the country.

(E) Science and Spirituality

During his academic life at Nagpur, Thosar came in fairly close contact with Ramakrishna Mission Branch there. He was a regular reader of Samarth Ramdas's Dasbodha and the works of Swami Vivekananda. In fact he writes in his book "A real quest for the true meaning of the concept in Vedantic philosophy germinated at the base of my mind from my undergraduate years". He devoted more time in philosophical thoughts and deeper reading of the works of Aurobindo, Tagore and Swami Vivekanand, many decades later, soon after his retirement from TIFR. He wrote a series of four articles in *Society and Science*, a journal of Nehru Centre, during the years 1980-83 on how these spiritual thinkers have reacted to science and the scientific method of acquiring knowledge about the universe around us.

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