S. P. Pandya (1928–2019)

Professor Sudhir Pradyumna Pandya, former Director, Physical Research Laboratory, Ahmedabad passed away on 30 June 2019. He was born on 11 July 1928 in Nadiad, Gujarat. He did his B Sc from Bombay University and M Sc from Delhi University in 1950. After working as DAE research associate for three years, he went to Rochester University, USA for a Ph D degree. He joined Physical Research Laboratory (PRL) in 1957 and nucleated the theoretical physics group. He continued at PRL till his superannuation in 1987. He served as Deputy Director during the years 1973–1982 and as Director during 1983–1987. He was one of the founding members and Fellow of Gujarat Science Academy (GSA), President of the Indian Association of Physics Teachers (IAPT), Fellow of Indian National Science Academy and Indian Academy of Sciences. He received Vikram Sarabhai award from the Gujarat state in 1994. He is survived by his wife (Harshidaben) and two sons (Abhijit and Pravir), both acclaimed professionals in their respective fields.

Pandya was an accomplished nuclear physicist, a passionate teacher and an able administrator. He was simplicity personified. He influenced the lives of many students, physicists and colleagues through his deep knowledge, kind nature and willingness to help. We try to present different facets of Pandya, as a humane and caring teacher, as an exceptionally talented scientist, and as a person dedicated to science outreach based on our personal interaction with him.

Pandya carried out outstanding research work in theoretical nuclear physics. His work on nuclear shell model, nuclear interactions, deformed nuclei and so on are widely acclaimed. His four long-lasting contributions are recalled here. The first major research result he produced, known with his name as 'Pandya transformation', is a theorem connecting the spectrum of two nuclei A and B of some special type[1]. This provided significant tests of the nuclear shell model before the proponents of shell model were awarded the Nobel prize. As the story goes, soon after this work by Pandya, his thesis adviser J. B. French went to Pittsburgh to give a lecture and there, for the first time French coined the phrase 'Pandya transform' and this created history.

More interestingly, after deriving the transformation law, Pandya went to his thesis adviser and showed him the result. Then, French asked him to take the measured spectrum of a nucleus A (^{38}Cl) and using the transformation law, construct the spectrum of the nucleus B (^{40}K) to verify if this agrees with the experimental levels of B. Pandya was baffled by this suggestion as he has derived

an exact mathematical formula and obviously, they have to agree. He still carried out the exercise as suggested and as expected the results agreed with experiment. But there was a small discrepancy. This led to his second important contribution. The crucial point here is that Pandya transform assumed nuclear forces are two-body in nature. As a result, the small difference between theory and experiment led to giving a bound on the three-body force in nuclei[2], and only in the last two decades that nuclear physicists recognized the importance of three-body forces in nuclei.

French recalled this in his letter to PRL on the occasion of Pandya's superannuation in 1988 (*Collected Works of Prof. Pandya* – a volume brought out by PRL). The idea of any small deviation from an exact theory implies existence of a new phenomenon that is missing in the theory was used by French with his collaborators many years later to derive a bound on time reversal non-invariant part in nuclear force[3].

Pandya's third important contribution was that he along with three physicists from USA, based on large number of numerical shell model studies with a variety of effective interactions for nuclei with $A = 18$–22, brought out a mammoth article of more than 100 pages in *Advances in Nuclear Physics*[4]. This has been a standard reference in nuclear structure research. The deep knowledge in nuclear shell model led Pandya to develop a shell model-based model for deformed nuclei (most atomic nuclei are in fact deformed generating collective motion). This is called 'deformed shell model' and it was introduced in 1973 by Pandya along with Nair and Khadkikar[5]. This was the fourth major contribution of Pandya. Several investigations of this model were carried out by PRL scientists in the 70s and early 80s. However, its importance was established when this model was applied to exotic nuclei in the mass region $A = 60$–90 during 1984–95 by Pandya in a series of papers with his collaborator R. Sahu from Berhampur.

Interestingly, once Pandya gave a seminar at the University of Rochester (New York) on deformed shell model presenting some of the results he obtained with Sahu. After the talk, some Professors of the Physics Department started discussing with him about the results and one of them asked him a pointed question – who made all the calculations? that deformed shell model by construction is computational in nature. Pandya being sharp, replied 'there is still respect for gray hair in India'. From 1977, R. Sahu collaborated with one of us (VKBK) and wrote a book where 50% of the book is devoted to deformed shell model[6].

Abhijit Pandya, son of Pandya mentioned that his father, above all was a teacher and he liked teaching most. This was indeed true as experienced by many of his students including his research students and collaborators. Pandya had a unique style of teaching and lecturing. He would use the most appropriate anecdotes to bring home the message that he wanted to convey – be it a formal teaching or a general lecture on a variety of topics.

According to his students, writing research papers together with Pandya was an occasion to learn so much on diverse areas. Usually, the work would trigger with some recent experimental results on energy bands for which there was a possibility of providing a theoretical basis using Shell Model, and then make predictions. Besides utter clarity in physics, his extreme care in making a concise presentation in English, in proper use of phrases and right use of punctuation symbols ensured that they never got any comments from the reviewers about language or style of writing. He enjoyed doing physics and he had a special liking for mathematics. He was sharp and precise in his conversation, and in addition to his scholarly and outstanding qualities, he was so much humane, compassionate, and always had a contagious smile.

Meeting Pandya in his office required good planning and maintaining decorum for his students. However, he was a transformed personality out of his office in the informality of the corridor, in the sense that he freely cut jokes, and laughed loudly and, everyone around him talked so freely on diverse areas, including music, sports, politics, education system, simplicity as well as whims and fancies of great scientists, universities versus national laboratories, and many such matters of contemporary interest. Listening to experiences and views of Pandya was indeed a treat and a great learning experience. It was for this reason that the research scholars in theory stream at PRL had developed a special connection and liking for the corridor of 4th floor, especially near the lift and water tap area, where everyone could join together.

Pandya was a pleasant person to work with and students got his untiring guidance. Informality and intimacy marked Pandya's relationship with his students. His relationship with his students continued beyond the Ph D thesis and his involvement with students was for a life time. He took personal care of his students. He took keen interest in career development of his students as personally experienced by two of the authors (YRW, VKT) who were fortunate to be among his early students.

Post-retirement, he concentrated on an interest that he preserved for so long namely, publishing books on diverse areas of science. Pandya along with one of the authors (DPA) edited a book *Science, Ethics and Society: Essays on Science*. The book was based on a collection of Pandya's talks and was published by Gujarat Science Academy. This book was well received and as P. K. Kaw aptly remarked, this book was '*… a delightful set of essays from an insightful scientist*'. In this book Pandya addressed topics and issues relevant to science today, and it was like his '*Man ki baat*'. In one of his essays Pandya emphasized the role of curiosity as a driving force of scientific discoveries and inventions. His memory was razor sharp that took care of every minute detail with finer nuances.

Pandya was a prolific writer in physics and astronomy and he wrote in both English and Gujarati. He was a communicator par-excellence. He encouraged the formation of Indian Society of Atomic and Molecular Physics (ISAMP) that is now a vibrant society. He regularly addressed the school children on topics of elementary physics and astronomy.

Pandya was always keen to further the cause of science and normally donated every penny beyond his frugal personal needs, for such purposes. In memory of his father the late Principal Pradyumna A. Pandya, he had instituted the P. A. Pandya Endowment Lecture Series, the P. A. Pandya Memorial Fund for scientific publications, etc. and an annual Award for school science teachers in Gujarat. He also instituted the Best Teacher Awards at the Gujarat Science Academy to recognize the fact that teachers are the makers of the societies and their ethical and intellectual content. These awards have now become hall mark of recognizing talents in creative teaching. His commitment to such activities was so intense that he sat through all the selection process himself – almost till his last days. Named after his father, Pandya treated these contributions as his '*pitru-tarpan*', his way of paying homage to his father and many emulated him later.

Pandya devoted more time after his formal retirement in promoting science education and popularization and he gave popular talks on various aspects of modern physics. It was a treat to listen to him narrating the early developments in quantum mechanics or nuclear physics. He used to quote in his lectures about the famous book, *Thirty Years that Shook Physics* by George Gamow. 'Quantum mechanics is not difficult as such; it is unfamiliar' – he would remark. One of his favourite topics was the discussion of the proposal of electron spin, put forward by Ulhenbeck and Goudsmit in 1925. Pandya would describe in an interesting way, how their experienced teacher–mentor was reluctant to accept the strange idea, but had encouraged the two young men to go ahead with it.

For the generations of teachers and students in Gujarat, Pandya was a fatherly figure. He had encouraged and attended academic seminars and workshops, etc. in Gujarat and elsewhere. He was a most sought-after speaker in such meetings. Once when he was asked about the impact of all these academic activities, he had said, 'To me the word *impact* feels like a blow of a hammer! If you too feel such a blow in your inner self and if you start thinking in a new direction, then the impact is felt well.'

Pandya gave memorable lectures in the annual IAPT Conventions held in 2010 (Rajkot) and 2016 (Gandhinagar) and it was through his motivation that a meeting of science writers (mainly in physics) was held at Science City Ahmedabad in March 2009. Participants were asked to prepare and bring articles in the meeting. In his concluding remarks Pandya asked, 'What will be the impact or the follow up of this meeting?!' And then he suggested that all the articles received must be edited properly in the form of a book. What emerged was not a book as such, but the maiden volume of *Pragaami Tarang* (meaning *progressive wave*), the annual Gujarati magazine of physics and related areas. He continued to inspire and financially support this annual publication, and it is due to his encouragement that the magazine is being brought out regularly by RC-7, IAPT since 2009.

His moral support to bring science writers to write in a semi-technical popular style, in Gujarati motivated many. In the first volume he wrote in his message 'I believe, as did Prof. D. P. Khandelwal (founder of IAPT) that teachers are the foundation of any educational process. We should devote as much efforts as possible to improve the knowledge base of teachers as also the educational resources available to them.'

In view of his failing eye-sight with the progressing age, Pandya used to take help of his students (and also his wife) for writing articles. In his article on the 100 years of the discovery of atomic nucleus, he brought out the excitements of the epoch making discovery, and also made a pertinent remark, 'Scientific

discovery now-a-days is not just an individual endeavour, as it used to be in the past. Individual originality and creations have been replaced largely by collective work aided by complex giant instruments, which call for funding, and this brings into the loop, the administrative authorities and Governments to play their roles.'

Pandya was a respected '*gurunam guru*' amongst the physics fraternity of Gujarat and will be remembered fondly for long times to come. A few would match his personal contribution to the science in Gujarat, and the state of Gujarat will remain ever indebted to this simple, affable, unassuming yet gargantuan persona of Science in Gujarat. *Sudhirbhai, you are immortal for all of us. You will always be by our side, and taking care of us.*

Benchmark contributions of Pandya and his colleagues.

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Anand Swarup Arya (1931–2019)

Professor Anand Swarup Arya was born on 16 June 1931 in Ambehta (Saharanpur, UP) in India. He breathed his last on 1 September 2019 at the age of 89 years. His passing is a national loss and his absence will be felt as long as memories last.

Arya obtained his Bachelor's degree in Civil and Master's degree in Structural Engineering from University of Roorkee (UOR) and Ph D from University of Illinois, USA in 1961. He was honoured with Distinguished Alumnus Award by the University of Illinois as well as by UOR.

UOR became Arya's *Karma Bhumi* for 35 years, where he became Head of Earthquake Engineering Department in 1971 and Pro-Vice Chancellor in 1988. Upon retirement in 1989, he continued as Professor Emeritus. His work was so profound that he captured national imagination as a renowned engineer, an adorable teacher and a much sought-after engineering consultant. By the time he left the university, he had already bagged Khosla National Award (1980), ISET Jai Krishna Award (1982), FICCI Cash Award (1986) and National Design Award (1987).

Arya's expertise spanned the disciplines of earthquake engineering, soil dynamics, geotechnical engineering and structural engineering. For over half a century, he contributed immensely towards developing India's indigenous expertise in earthquake disaster prevention and mitigation aiming at the safety of structures ranging from common man's housing to multi-storey buildings, bridges, dams, petrochemicals and nuclear power plants. He also served as a consultant to the Ministry of Railways, Nuclear Power Corporation, Central Water Commission and the Government of Gujarat.

Arya nursed the foundation of earthquake engineering in India laid by the legendary Jai Krishna. In the process, he and his teams achieved many firsts. The birth of Indian Society of Earthquake Technology (1962), the establishment of a Post Graduate Course in Earthquake Engineering (1963), the publication of the first Indian Standards IS:1893 on Design Earthquake forces, and IS:4967 Seismic Instrumentation for River Valley Projects are just a few examples.

His focus was always on finding apt solutions to the real life problems. When the Koyna dam developed cracks after the Koyna earthquake of 11 December 1967, he and S. K. Thakkar addressed the broader issue of strengthening all the vulnerable masonry dams in the state of Maharashtra.

When the Bharuch earthquake struck on 23 March 1970, and the holding down bolts of two of the 14 piers of Narmada bridge got sheared off, Arya's team set out to explain the failure by conducting lateral load and vibration tests.

When the Latur earthquake struck Maharashtra in 1993, India faced the huge challenge of post-disaster reconstruction and rehabilitation. Impressed by Arya's advocacy for simple retrofitting techniques, the World Bank came forward to fund a major project involving seismic retrofitting of nearly 200,000 houses.

Arya's retirement came about the same time as the UN Resolution 44/236 declaring 1990s as the International Decade of Natural Disaster Reduction (IDNDR). The prime goal of IDNDR was to improve national capacities to mitigate the effects of natural disasters. Arya represented India as a Member of UN Scientific and Technical Advisory Committee of IDNDR.

So substantial was his contribution to the cause of Disaster Risk Reduction (DRR) that, during IDNDR, Arya was honoured with the coveted DHA-Sasakawa Disaster Prevention Award by Yasushi Akashi, the then Under-Secretary-General for Humanitarian