

most useful in studying the hard scattering region of hadrons, corresponding to high energy and scattering angle, in terms of the constituent quarks and gluons.

When I joined Udgaonkar as a PhD student in 1964, I had already published a paper on the dispersion relation analysis of a meson–nucleon (KN) scattering amplitude. But he explained to me that this is a well-explored technique, whose merits and limitations are pretty clear by now. So he suggested me to work instead on Regge pole model, which was still relatively new and hence potentially more interesting. But after having suggested this field, he left it entirely to my own devices to explore it to find suitable problems and their solutions. However, he used to sit down with me to go through the drafts meticulously to check the results and help me in improving their presentation, highlighting the main points with precision and clarity (without ever consenting to put his name as co-author, of course). I am indebted to him on four counts. First, Regge poles remained a thrust area of particle physics till the mid-seventies. Secondly, independence in research gave me confidence to enter the new era of particle physics in terms of the above-mentioned quarks and gluons, which took over the field thereafter. Thirdly, the presentation skills I learned from him were essential for making global impact in an intensely competitive field like particle physics, particularly from a remote place like India. Last but not the least important, the lesson I learned from him was to readily give to your younger researchers the benefit of your experience and expertise, while maintaining a strict code for co-authorship.

Udgaonkar had a multidimensional personality, of which I have only described one—like one of those seven blind men who went to see the elephant. Let me conclude with one reflection. In a wider sense Udgaonkar has been a teacher to many of us spanning many age groups and disciplines. If we live by the lessons we learned from him and pass them on to the younger generations through our deeds, that will be the best tribute we can pay to his memory.

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B. M. Udgaonkar's remarkable career in physics, particularly in particle physics, has been described by D. P. Roy. His equally remarkable career in science education began around the late nineteen sixties. I was a Research Scholar in the TIFR Theory Group during 1964–69 and his pedagogic ability as well as interest in educational and social issues were



apparent to me while he mentored me in research. Soon he and some of his distinguished colleagues at TIFR felt motivated to look beyond the Institute and interact closely with the educational system outside. They started regular meetings with the municipal school teachers in Mumbai; lectured them informally to enrich their content knowledge, helped them develop innovative demonstrations and experiments, and also undertook to write materials. The activities gained considerable momentum in a few years and it was felt necessary to put them in an institutional framework. Thus was established under the leadership of Udgaonkar and his close colleague V. G. Kulkarni, the Homi Bhabha Centre for Science Education (HBCSE) in 1974 as a unit of TIFR. Another noteworthy offshoot of similar activities at TIFR at that time was the formation of the Bombay Association of Science Education (BASE) which continues to carry out valuable educational activity in Mumbai.

Udgaonkar was, of course, always concerned about science education at the tertiary (college/university) level. He took much interest in the academic affairs of University of Mumbai and encouraged and supported the University to establish its Department of Physics in 1971, headed by another TIFR colleague M. C. Joshi. In the same year was formed the Indian Physics Association (IPA), of

which he was the founder President. He wrote extensively on university science education; his editorials in IPA's bulletin *Physics News* were noted for their perceptiveness and breadth. He was a member of the University Grants Commission (UGC) from January 1973 for three years, and was responsible for several UGC initiatives for improvement of science education in colleges and universities in the 1970s. His efforts led to the establishment of the Western Regional Instrumentation Centre (WRIC) at the University of Mumbai. Besides his honours and recognition in science, he had already by 1970s made a mark on the national scene in the education sector. He received the Hari Om Trust Award of the UGC for work at the interface of science and society in 1985; and the Padma Bhushan in 1985. He was widely regarded the 'conscience keeper' of the scientific community in India.

It was characteristic of Udgaonkar that he did not let his status as an eminent scientist and educationist, come in the way of direct contact with the stakeholders in education. He was approachable to everyone; students and teachers from the city and elsewhere freely turned to him for advice on their problems and even grievances. As early as 1968, he and his colleague Yashpal started weekly discussion sessions at TIFR for local college undergraduates on 'Feynman Lectures in Physics'. A few other TIFR colleagues including some PhD students were also part of the effort. Several meritorious students of Mumbai colleges were drawn to this Study Group; many of them are now accomplished scientists in India and abroad. His passion for teaching showed up again when his initiative led to the TIFR–Pune University collaborative MSc programme in physics, though for reasons beyond his control, it could not be sustained for long.

Udgaonkar was truly a man of many parts. Besides science and education, he engaged deeply with the issues surrounding global disarmament, security and peace for almost three decades. He was an early entrant of the Pugwash Movement and a member of the Pugwash Executive Council (1987–97). In this capacity he firmly put forward his nuanced views on these delicate and complex issues and explicated our country's concerns and viewpoint. The Pugwash led by Joseph Rotblat received the Nobel Prize for Peace in 1995.

Bhalchandra M. Udgaonkar was born on 14 September 1927 in Karad, Maharashtra. He was an outstanding student in his school and college years, obtaining the first rank in MSc from the then Royal Institute of Science, Mumbai. He began his research career in 1949 at the Tata Institute of Fundamental Research (TIFR), Mumbai under the guidance of Homi J. Bhabha. After some publications in elementary particle theory in the fifties, Udgaonkar was drawn into the newly emerging Indian atomic energy programme. He was sent for training at the French Atomic Energy Commission, Saclay for 18 months (1953–55), and on his return was actively involved in building up the core reactor theory group of what is now the Bhabha Atomic Research Centre. Around 1960, Udgaonkar returned to his earlier interest: particle physics and built the theoretical physics group at TIFR, which soon acquired international reputation. He made pioneering contributions to Regge pole theory and the bootstrap approach in particle physics. In the late sixties, he turned to the problems of science education at the school, college and university levels. Through his extensive writings and leadership abilities, he soon emerged as the top science educationist of the country. He was instrumental in setting up the Homi Bhabha Centre for Science Education (HBCSE) in 1974, now a National Centre of TIFR.

Udgaonkar was a Fellow of the Indian Academy of Sciences and the Indian National Science Academy. He was also member of the University Grants Commission (UGC) in the seventies; member of the Pugwash Executive Council (1987–97); first President of the Indian Association of Physics (1971–73); President of the Indian Academy of Social Sciences (1988–89), etc. He received the Hari Om Trust Award of UGC (1985) and the Padma Bhushan in 1985.

On the personal front, he bore with great fortitude the loss of both his parents in his early college years. His son, Jayant, is now an accomplished scientist at the National Centre for Biological Sciences, Bengaluru. Tragically, he lost his daughter Geeta while she was pursuing advanced studies in USA. A 'Geeta Udgaonkar Award' was instituted in her memory in 1983 at TIFR for the best Ph D thesis of the year in physics.

After his retirement in 1991, Udgaonkar regularly visited HBCSE at its Anushaktinagar campus until a few years ago. He passed away on 21 December 2014. A.K.

But it is the genesis and nurture of the Homi Bhabha Centre for Science Education that we must turn to for his lasting educational contribution. Early on, he had recognized in V. G. Kulkarni, a colleague at TIFR, a person with exceptional flair for science education and communication at the grassroots level. His enduring and excellent rapport with Kulkarni, the founder Director of the centre, helped this nascent unit of TIFR grow into a full fledged institution under the TIFR umbrella (aided by the DAE) by 1981. Eventually HBCSE became a National Centre of TIFR in science education. Some of the early projects at HBCSE carried out by Kulkarni under the benign guidance of Udgaonkar were remarkable in their intense involvement with rural schools (including the Tribal School network) in Maharashtra. The insights and experiences gained from this extensive field work have informed HBCSE's later work in school science education. There was considerable materials development too; HBCSE's early books for children, several of them written by a senior member of HBCSE (R. G. Lagu) were then perhaps among the best of their kind written in our country.

Udgaonkar, much like his mentor H. J. Bhabha, had a liberal and flexible approach to the institution building efforts at HBCSE. He was the chairman of the HBCSE management committee from its inception to his retirement; yet he never interfered in its day to day work and let the Centre evolve naturally as newer and

newer members joined HBCSE. In the mid-1980s, HBCSE forayed into post-school science education sector. He encouraged HBCSE to participate in the national level textbook writing effort at the senior secondary level at NCERT, even as the Centre continued to be involved with NCERT's and the Maharashtra State's textbook writing programmes at the primary, middle and secondary school levels. It pleased him much that an undergraduate Study Circle in physics had been initiated at HBCSE in 1985, much along the lines he had initiated in the 1970s. The Circle was the precursor to the now well-known Olympiad and undergraduate nurture programmes of HBCSE.

Meanwhile, science education was gradually acquiring the status of a separate scholastic discipline globally. He encouraged research and scholarship in this new discipline at HBCSE, stressing both its cognitive and socio-cultural dimensions, which eventually led to the establishment of a regular Graduate School in science education that is now a part of TIFR-Deemed University. The School now attracts several bright eclectic scholars pursuing Ph D in science education.

Though his professional life was largely confined within the matrix of the Govt and Govt-aided institutions, Udgaonkar assiduously networked with the several notable NGOs in the country, known for their high quality science education and science communication work. He had personal rapport with the leaders of this

movement; many of them regarded him as their 'Guru' and would often seek his advice and support. He played the role of a motivator in one of the best-known voluntary science education initiatives of the country since Independence: the Hoshangabad Science Teaching Program (HSTP), later to be expanded into the Eklavya. He was the National Convenor of the Bharat Jan Vigyan Jatha (1987) in which numerous people's science organizations participated. He was the President of the Marathi Vidnyan Parishad (1982–91).

I had an unbroken association with Udgaonkar for the last half a century, first as my teacher along with Virendra Singh (my Ph D supervisor), and later in different capacities. I have many personal reminiscences about him – far too many to write here. The invariants of his personality in the diverse contexts and circumstances of my meeting with him were his civility and dignity in manner; and balance, moderation and patience in attitude. He viewed science education in its totality, emphasizing access and equity as well as excellence. In an age marked by fragmentation and conflict, his was a voice reaching out to bridge the divides. This makes his illustrious career all the more extra-ordinary.

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