

Pran Nath Pandita (1949–2019)

Prof. Pran Nath Pandita, formerly of the North-Eastern Hill University (NEHU), Shillong, passed away on 12 June 2019 in Pune after a long illness. At the time of his demise, Pandita was an INSA Senior Scientist at the Centre for High Energy Physics (CHEP), Indian Institute of Science (IISc), Bengaluru. After his retirement from NEHU, Pandita was earlier DAE Raja Ramanna Fellow at CHEP for three years.

Pandita was born on 1 January 1949 in Srinagar, Kashmir. He completed his education in Srinagar through his school years and all the way up to his doctorate. He obtained his Ph D from Kashmir University under the supervision of Prof. Y. Singh in 1975, working in the area of scattering phenomena and deep inelastic reactions. After carrying out postdoctoral work in Kashmir University, Pandita was a Visiting Fellow for two years at the Tata Institute of Fundamental Research, Mumbai. He then joined the Department of Physics at the then fledgling NEHU in 1979, and served there until his retirement three and a half decades later. He served as Head of the Department as well in the years close to his retirement. Pandita considered his teaching activities to have been sacrosanct, and wished to be remembered for his lifelong devotion and commitment to teaching. During the years of his service, he practically taught every single course that was offered by the Department, and helped in designing and running teaching laboratories as well. In the course of duties at NEHU, Pandita guided P. Francis Paulraj to his Ph D. Pandita had been an active member of all the academic bodies of NEHU, and also played an important role in the inner life of the teaching community there and commanded a great deal of respect among the students, faculty and non-teaching staff at the University. It may also be noted that Pandita's reputation of being a committed teacher led to his being invited to lecture at several national schools, and researchers across the country have been influenced by his clear and concise style of lecturing.

Pandita carried out research in the frontier areas of elementary particle physics for several decades, and also had an abiding interest in statistical mechanics. In the latter area he has noted publications on the behavior of relativistic

Bose gases, including his most publication (*Physical Review*, 2014, **D89**, 032110).

In the area of elementary particle physics, although his early training had been in collisions and deep inelastic physics, his later years were almost completely devoted to the exploration of the properties and study of supersymmetric theories, which are an attractive and popular extension of the observed world of elementary particle physics. Although such theories have been in vogue for nearly half a century now, there have been no experimental signatures of supersymmetry. Supersymmetric theories have generally been motivated by the



existence of the Higgs mechanism of the Standard Model (SM), which predicted the existence of the Higgs boson, which was experimentally detected at the Large Hadron Collider (LHC) in 2012. Thus Higgs physics goes hand in hand with supersymmetric extensions of the SM. It may also be borne in mind that supersymmetric models provide natural candidates for dark matter, which are known to exist in the cosmos, but make their presence felt only through their gravitational interactions. Pandita carried out a large part of his research in the recent couple of decades in and at the crossroads of these three subfields.

Pandita wrote a seminal paper along with K. Grassie on the production of photinos in electron-positron collisions, at a time when the so-called Minimal Supersymmetric Standard Model (MSSM) was just being formulated. Thus, the work is considered a standard benchmark in the field of application of supersymmetric models in collider phy-

sics. (Grassie, K. and Pandita, P. N., *Physical Review*, 1984, **D30**, 22.)

This early work proved to be a defining paradigm for Pandita, as he spent the rest of his research years in either probing the theoretical consistency of supersymmetric models, and/or searching for signatures of supersymmetric models either in the direct production of such particles in collider environments, or to search for their imprint in the cosmos through the properties of the dark matter candidates present in these models, or in the interplay between all these features.

Pandita was also keenly involved in the area of Higgs physics and in probing the properties of the Higgs boson(s) in the SM or in extensions thereof. Recall that the boson discovered at the LHC could be one of several Higgs bosons that are actually present in nature. It may yet be that the SM is only a low-energy effective theory of a larger theory, indeed that of the MSSM. Or perhaps other supersymmetric extensions of the SM, as there is no precise guiding principle for what such a grander theory could be. The MSSM for instance, had a prediction that the mass of the Higgs boson in its low-energy SM reduced version could not be larger than that of the Z-boson, which weighs about $91 \text{ GeV}/c^2$. In the early 1990s, several groups asked how stable was this bound and it was shown that the bound could rise to about $130 \text{ GeV}/c^2$ when radiative corrections were computed, taking into account the important top-quark pairs running around in quantum loops, as the top-quark turned out to be much heavier than originally thought. At that time, Pandita, in NEHU, single-handedly worked out the corresponding bounds in a somewhat embellished extension of the MSSM, known as the Next-to-Minimal Supersymmetric Standard Model (NMSSM), which are perhaps the most important results of his scientific career. It is heartening to note that the experimentally measured value of $125 \text{ GeV}/c^2$ respects these bounds, but is close to the saturation values. Such studies have given credence to the supersymmetry paradigm which survives until today. Pandita's noted publications are published in *Zeitschrift fuer Physik* (1993, **C59**, 575) and *Physics Letters* (1993, **B318**, 338).

In the years that followed, Pandita established several collaborations in the country and overseas, and worked with several prominent experts. Our first meeting took place at a workshop organized at the Saha Institute of Nuclear Physics in 1992, at a time when the prediction for the mass of the top-quark in supersymmetric unified models exceeded the experimental bounds. Soon afterwards, the top-quark was discovered at Fermilab with a mass in accordance with such predictions. At this time, Pandita and I started our discussions and in 1995, we carried out investigations of the NMSSM in a theoretically interesting limit, which was first published in *Physics Letters* (1995, **B353**, 70). Later we carried out investigations on the signatures of embedding supersymmetric models in unified theories, and also in those where some discrete symmetries were broken and the renormalization group properties of couplings in such models. We also collaborated on the signatures of invisible decays of the Higgs in the recent past. During his visits to Bengaluru while in service at NEHU and later as a member of CHEP, Pandita worked actively with young members of the group, including students and postdoctoral fellows.

Pandita established a larger number of collaborations in the country, with scientists and students and postdoctoral fellows at TIFR (Mumbai), Physical Research Laboratory (Ahmedabad), Institute of Mathematical Sciences (Chennai), to name a few examples. He also spent

considerable amount of time at the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, both as a Senior Associate and as a member of some of their advisory bodies. He had collaboration with the group of Katri Huitu, as well as several other members of the Helsinki Institute of Physics, Finland, and worked closely with PhD students. His work was on the phenomenology of supersymmetric models. With Per Osland (Bergen University, Norway), he worked on the measurements of the couplings of the Higgs in various supersymmetric models. (See for instance, Osland, P. and Pandita, P. N., *Physical Review*, 1999, **D59**, 055013.)

Pandita was well recognized for his scientific achievements. He received the India Research Award of the University Grants Commission; the Alexander von Humboldt Fellowship, Germany and the J. C. Bose National Fellowship of the Department of Science and Technology, New Delhi. He was a Senior Associate of the Abdus Salam International Centre for Theoretical Physics, Trieste, Italy, as well as of the IUCAA (Pune). He was elected a Fellow of all the three national science academies in India.

Pandita as a respected member of the academic community was often invited to serve on bodies of various academic institutions and on selection committees. A man of unflinching integrity, he spoke his mind fearlessly. He was fastidious in his habits and a perfectionist. As a man who loved his work and as one who was devoted to his research, it is probably fit-

ting that he passed away at a time when he was still active in research. He was also an active participant in workshops, and conferences and seminars, and was known to ask incisive questions. One of the truest ways of paying homage to and honouring his memory would be for us to carry out our work with great integrity and also pursue the dream of finding simplicity and economy in the laws of nature, and also to fulfilling his dream of determining what is the definitive extension of the SM. In his lifetime, he pursued the popular paradigms of the MSSM and the NMSSM, but he knew as we all do, that nature alone will be the final judge and arbiter of all our ideas and our fancy. It can only be experimentally determined and fixed, and until that time, we should participate in honing theoretical as well as experimental tools in this quest.

Pandita was a native of Kashmir, and had post-retirement plans of settling down in Jammu. His premature demise has to this last part remaining unfulfilled. Pandita is survived by his wife, daughter, and two grandchildren. A fiercely private person, towards the end of his life, he was taken care of by his immediate relatives at their family home in Pune. He will be sorely missed.

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