

## Foreword

The year 2005 was celebrated worldwide as the centenary of Einstein's miraculous year, 1905, as well as for his life and work. During a period of twelve months (1905), he published five papers that changed the face of physics — two of which laid the foundations of the Special Theory of Relativity; a paper on the quantum nature of radiation in explaining the Photo-Electric effect; papers on the theory of Brownian motion, and on molecular dimensions and the calculation of Avogadro's number. In 1924, almost two decades after the miraculous 1905, and almost a decade after his famous theory of gravitation in 1915, Einstein was involved in another important discovery of 20<sup>th</sup> century physics — the birth of the new quantum statistics to become known as the Bose–Einstein statistics. It all began with a letter and a short article. A relatively unknown young man, Satyendra Nath Bose, from Dacca University in East Bengal (now Bangladesh) wrote to Einstein, claiming he had derived Planck's law for black body radiation without recourse to classical electrodynamics. Bose further wrote that if Einstein thought it was important, he would be grateful if he (Einstein) could arrange its publication in *Zeitschrift fur Physik*, as he, Bose, did not know German well enough.

Einstein translated the paper himself and got it published with a note added saying, "*Bose's derivation of Planck's law appears to me an important step forward. The method used here also yields the quantum theory of ideal gas, as I shall show elsewhere.*" Indeed in a matter of weeks, Einstein published his paper extending Bose's work to monoatomic gas and followed it up with another paper within months, predicting according to the new theory the possibility of a new state of matter, the Bose–Einstein condensate. Highlighting the importance of this development, Abraham Pais in his celebrated book, "*Subtle is the Lord,*" on Einstein says, "*For Einstein this period was only an interlude. He was already engrossed in his search for a unified theory. Such is the scope of his oeuvre that his discoveries in those six months do not even rank among his five main contributions, yet they alone would have sufficed for Einstein to be remembered forever.*"

Einstein's recognition of Bose's work had an immediate impact on Bose's life and career. He was granted study leave from his university for two years "*with a stipend, a separation allowance for the family, with sumptuous travel allowance with round trip fare.*" Although Bose was primarily a theoretical physicist at the time, he spent his first year abroad gaining first-hand experience working in the crystallographic laboratories of Maurice de Broglie and the radioactivity research laboratories of Madam Curie before going to Berlin to meet Einstein in October of 1925. Berlin was humming with the excitement of the dawn of the new quantum mechanics with the visits and seminars of Heisenberg and Schrodinger. Einstein introduced Bose to several prominent physicists including Otto Hahn, Lise Meitner, Fritz Haber and Walter Gordon. He came to know Hermann Mark and worked closely in his laboratories of X-ray crystallography.

Bose's two-year stay in Europe marked, in many ways, a turning point in his career as a teacher and researcher. He realized the importance of experimental research in the advancement of science. On his return, he occupied himself mostly with setting up an X-ray crystallography laboratory at Dacca University. He designed and built his own equipment, requiring that his

students do the same. On other fronts he devoted himself almost exclusively to teaching and guiding research. He also held various administrative positions as Department Head, Dean of the Faculty of Science and Provost. In 1945, he left Dacca to return to his alma mater, the University of Calcutta as the Khaira Professor of Physics. He retired from the University of Calcutta in 1956, spent a year as the Vice Chancellor at the Viswa-Bharati University and finally lived the remainder of his years in Calcutta until his death in 1974.

Bose, a brilliant and inquisitive scholar throughout his career, lived during a period of great change in India. He witnessed the partition of Bengal, his home in 1905. Instigated by Lord Curzon, one of the most imperialist viceroys of India, this action resulted in the rise of a strong nationalist movement against the British. Bose was one of a group of accomplished intellectuals motivated by national fervor to excel academically and creatively to prove their competitiveness with their counterparts in the western world. He was active politically throughout his life, serving on many committees to further scientific and industrial development in India after independence.

Bose was an inspiring figure to many outside of the physics community. His love for stimulating conversations, wide ranging interests in all human endeavors, his intellectual fervor, his scientific accomplishments beyond physics and not least, his association with Einstein established his legendary reputation in India.

I had the occasion to see S.N. Bose briefly in 1952 as a post-graduate student at the Banaras Hindu University working in the spectroscopy laboratory of R.K. Asundi. Bose's unannounced visit made us students gather quickly around the tea table. My only recollection is that we students sat quietly while two stalwarts (Asundi and Bose) conversed. I remember vividly a handsome, dark skinned Bengali with a head full of gray hair and dark penetrating eyes. We students were also invited on a traditional evening boat trip on the Ganges, yet we remained at a distance with no personal encounter.

Years later, in the 1970's, an anecdotal story came to me whilst writing *CHANDRA*, the biography of S. Chandrasekhar. Chandra recounted a story told by Sir C.V. Raman, his famous uncle during a boat trip on the Hugli River in Calcutta in 1928. Raman told Chandra how S.N. Bose, after attending Raman's lecture, was the first to recognize the importance of his discovery.

Bose presciently remarked to Raman, "You have made an important discovery. It will be known as Raman Effect and you will get a Nobel Prize."

As part of the Einstein centenary celebrations in 2005, I was privileged to present talks about the discovery of Bose–Einstein statistics at the American Physical Society meetings in Tampa, Florida and Lincoln, Nebraska, and at the invitation of the editors of *Physics Today*, I wrote a brief article, "The Man behind Bose Statistics," published in the October 2006 issue. That led to this assignment from Dr. K.K. Phua, of World Scientific Publishing Co., to edit a book on Bose, his life and his works. I have collected together all his physics and mathematical physics papers along with selected articles based on his lectures and addresses. Also included are some miscellaneous pieces translated from his Bengali writings. Some published articles by others provide a historical perspective on the discovery of Bose–Einstein statistics. The remaining articles reflect upon and shed light on Bose as a teacher, an intellectual and a national figure.