mention here. In the chapter dealing with resonance, semi-classical approaches are invoked to discuss a wide set of resonance phenomena, including NMR. In dealing with interactions, in the next chapter, the dipole approximation is invoked and then used to describe dipole transitions and the origin of the selection rules governing such transitions. An extension of this treatment is found in a discussion on transition rate calculations for laser excitation, normally not found in similar treatises. Subsequent chapters on multi-photon processes and coherence engage with applications of lasers in the control of atomic state populations – useful short treatments such as coherent population trapping that has applications in atomic clocks, and electromagnetically induced transparency, that have led to applications in slowing down light, or inversionless lasing, can be found here.

The last chapters on 'Spectroscopy' and 'Cooling and Trapping', are a literal tour de force of the research preoccupations of the author in his laboratory that more or less encompass a wide range of 'hot' topics. Covering some aspects of tools invaluable in a modern atomic physics research laboratory such as diode laser, and lock-in amplifiers, he moves on to a succinct treatment of Doppler-free spectroscopy. The basics of laser cooling and trapping, extended to realization of Bose–Einstein condensates are summarized here. Dipole traps and their analogous application in trapping larger microscopic objects in optical tweezers, also find a place here.

The Appendices make for thought-provoking and interesting extras, with ideas about the concept of the photon being one of 'philosophical' contemplation for the author. In this discussion of the concept of the photon, he presents ideas mainly from Taylor and Feynman, that a photon has no independent existence but rather one can conceive this through invoking both advanced and retarded fields. This concept is shown to have profound implications to the cause–effect relationship as perceived in classical formalisms. The other chapter is on Einstein's formulation of atom–radiation interaction through the A and B coefficients, with Einstein solving the puzzle like a detective. The pieces in the 'jigsaw puzzle' have but one crucial 'piece', namely the concept of stimulated emission missing to make for a coherent (pun intended) picture. Einstein is an armchair detective, the author argues, who through the brilliance of his gedanken (thought) experiments solves the puzzle, Sherlock Holmes' style. While such a reading of the history of discovery is interesting, the allegorical nature of this reading needs a mention lest it obfuscates the more complex process in the history of ideas, with many pitfalls and mistakes made, notwithstanding the genius intellect of an Einstein. Other chapters that form the Appendix include a discussion on conceiving the photon's interaction with gravity as in the gravitational red shift, and a simple discussion of the frequency comb technique that enabled ultra high precision measurements fetching Hall and Hansch the 2005 Physics Nobel Prize.

Problem sets with meticulously worked-out solutions that extend the ideas in chapters or bring in a particular concept not treated explicitly are introduced in adequate measure. As the author states in the preface, one of the reasons for this book was to share the elaborate notes that he made as a student in MIT, USA attending the course of an eminent spectroscopist. This is done well, although surely, other texts and papers in the subject were consulted in the process. An omission here is the lack of reference lists anywhere, perhaps left out to restrain the book's girth from exceeding its already sizeable number of pages. Finally, the book is well-written and bears a distinctive style of communication that is informal without sacrificing rigour. It is invaluable as an advanced postgraduate or Ph D-level textbook, and will doubtless be used in many courses across the world as it brings under one platform the many exciting and current topics of research in atomic and laser spectroscopy, that one often has to access through information scattered in different texts and references.

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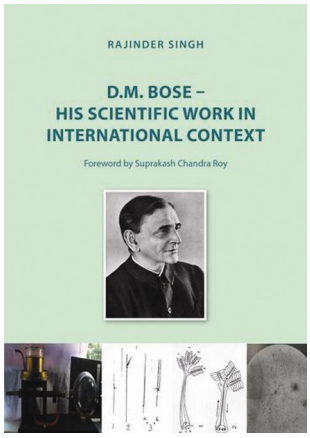

D. M. Bose – His Scientific Work in International Context. Rajinder Singh. Shaker Verlag, Aachen, Germany. 2016. 260 pp. Price: 21.90 Euro.

In the preface of this book, Rajinder Singh, the author and a well-established historian of science has given reasons for writing this book. S. C. Roy in his foreword reinforces the argument of the author by his remarks: 'In spite of his immense contributions to science, administration, education and many other areas like history of science, D. M. Bose is relatively unknown to many compared to his contemporaries. His scientific activities have been discussed sporadically, but have never been explored in totality. The idea of a book on D. M. Bose was proposed in 2010 during the 125th birth anniversary of Dr D. M. Bose when Rajinder Singh contributed a Cover Article in the journal *Science and Culture* of which I am the Editor-in-Chief'.

D. M. Bose was a reputed scientist at par with his colleagues and contemporary scientists like C. V. Raman, S. K. Mitra, M. N. Saha and S. N. Bose. His scientific contributions were of utmost significance internationally in the contemporary science of his time. His work on magnetism and discovery of artificial transmutation using cloud chamber while he was abroad, and his cosmic ray work in India with Biva Chaudhuri in discovering mu-mesons using half-tone Ilford plates are legendary. He was Director of J. C. Bose Institute founded by his uncle J. C. Bose, and tried expanding on his uncle's work to understand the physiological investigations in plants at a molecular level using biochemistry. This book presents the real worth of Bose in international context to justify its title. Another aspect revealed by the author is

significance of scientific contributions of Bose, which are at par in excellence with his contemporaries both in India and abroad.

The biographical facts given by the author show the brilliant career of Bose who went to Cambridge in 1907. He worked for some time with J. J. Thomson and C. T. R. Wilson at the Cavendish Laboratory and saw the development of the Wilson cloud chamber and the use of this technique of photographing the tracks of ionizing particles. In 1912, he obtained Diploma and B Sc (first class) in Physics from the Royal College of Science, London. On return to India, he was appointed Rashbehary Ghosh Professor of Physics, University of Calcutta in 1914. Soon after, he went to Germany to work on cosmic rays and radioactivity under E. Regener in Berlin. His Ph D thesis examiners were the famous German scientists, Max Planck and H. Rubens. Rajinder Singh has tracked down many interesting documents and the testimonial of Bose from the archives of Humboldt University, Berlin to establish many unknown facts about the scientist.

Bose modified the Wilson cloud chamber and studied the tracks of α- and H-particles using a polonium source wrapped in aluminium foil. The results obtained were in agreement with the Rutherford–Darwin theory of α-deflection. He studied β-particles using radioactive lead source. Bose proved that a single γ-particle can be made visible by ionization tracks in cloud chamber. He was the first person, who introduced the Wilson cloud chamber method in India and in cooperation with S. K. Ghosh studied the ionization tracks of the rest atoms of the radioactive elements. The results were shared with Rutherford in Cambridge, who accepted the interpretation of Bose and Ghosh.

The second chapter of the book deals with Bose theory of paramagnetism and discovery of a new photomagnetic effect (Bose effect). In the 1920s and 1930s, he was an authority in the field of magnetism. His status amongst the international scientific community can be judged from the fact that in 1929, Bose was asked by the Nobel Committee to send a proposal for the Nobel Prize as a nominator, a rare honour for an Indian scientist. The Welo–Bose rule 'that the magnetic moment of a complex is the same as that of the atom with the same number of electrons as the central atom of the complex, counting two for each electron pair binding the central atom to the co-ordinated units', was a landmark discovery of Bose. In the late 1960s, in the world of solid-state physics, 'photomagnetic effect' gained currency and reappeared in the scientific literature. 'The photomagnetic effect is the effect in which a material acquires its ferromagnetic properties in response to light.' At the Como Conference, Bose presented a paper entitled 'On the magnetic moments of ions of the transitional group of elements'. He was influenced by Albert Einstein during his Berlin days as was S. N. Bose during his visit to Germany. It is unfortunate that S. N. Bose was eulogized much more in India in comparison to D. M. Bose, who was a versatile experimentalist and designed his own apparatus for research investigations.

The third chapter is devoted to cosmic ray research at the Bose Institute. D. M. Bose was a pioneer in cosmic ray research in India. Bose and Biva Chaudhuri were the first to identify mu-meson tracks from the cosmic ray stars. Using the Blau–Wambacher technique, they observed the 'double tracks' and 5 and 12 prong multiple stars. Bose and Chaudhuri were indeed the first scientists who observed the meson track in photographic plates and measured the mass of this cosmic particle for the first time long before C. F. Powell and the measured mass (~200 m_e) is quite close to the accepted value (~216 m_e). So there are enough reasons to indicate that Bose and Chaudhuri missed the opportunity to get the Nobel Prize for their Mu-meson discovery.

The fourth chapter discusses the biological researches of D. M. Bose following the footsteps of his uncle, J. C. Bose, who in his investigations on plant responses postulated that irritability, conductivity, contractility and rhythmicity are common to all living tissues. However, his theories on plant physiology were highly disputed. D. M. Bose's contribution in biological sciences can be broadly classified in three categories: (i) development of biological sciences in Bose Institute and also in India; (ii) to interpret life processes in terms of physical and chemical principles to find an unifying concept and (iii) his contribution along with his co-workers in the field of plant motility and biology of plant responses. D. M. Bose was also critical of his uncle's theories. He discussed the prevailing theories of bioelectric potential in plant cells, stimulation/excitation processes in plants and animals; response of plants under artificial and natural conditions and inorganic models of response. Thus, D. M. Bose not only provided a fillip to researches of J. C. Bose, but also became the first biophysicist in India to start an interdisciplinary field of research as a role model for other Indian scientists.

The last chapter of the book is focused on Bose as Nobel Prize nominator and his invitation to the Como Conference. Rajinder Singh has tried to decode the mystification surrounding the controversy around the invitation letter. Another feature of this chapter which demands appreciation of the author is the discussion about the national status of both Boses, S.N. and D.M. during 1920s. His conclusion goes in favour of D.M. Bose who was selected Professor in Dacca University, in preference to S. N. Bose, who never did his Ph D. D. M. Bose was not nominated for the Nobel Prize during 1949 and 1950, and Powell got it for the discovery of pi-mesons in 1950. However, D. M. Bose became a nominator for the Nobel Prize in 1929, and he and S. K. Mitra both nominated M. N. Saha for the 1930 Nobel Prize, ignoring C. V. Raman, who won it with support of 10 distinguished nominators from outside India.

At the end, the author has given an exhaustive bibliography and list of publications of D. M. Bose, who published 58 research papers on diverse topics in international journals of repute. Bose wrote two books, one of these under the title *A Concise History of Science in India*. He also wrote many articles of national interest, obituary notes, book reviews, and popular science articles for *Science & Culture* during his directorship of Bose Institute. I appreciate the efforts made by Rajinder Singh in bringing out this volume on D. M. Bose to put him on a high pedestal, both in Indian and international context, which he richly deserves.

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