SATYENDRANATH BOSE

A Centenary Tribute

THE ASIATIC SOCIETY

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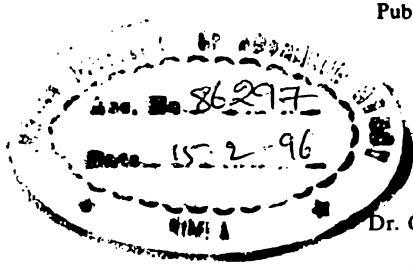

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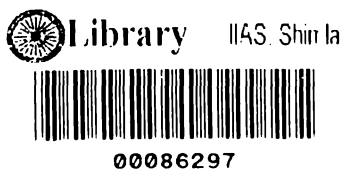

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FOREWORD

It is, no doubt, superfluous to point out that India's scientific heritage dates back to antiquity. And, the first signs of an attempt to codify the sciences are found in the most ancient Indian texts – the Vedic and the Brahmanic texts – between 1500 and 500 B.C. But, even then, unfortunately, for various historical reasons, India had gradually passed through a torpid period, spanning nearly five centuries from the late twelfth century onwards, in relation to her study in sciences.

The history of the reinvigorated scientific investigations in India, precisely on modern lines, started with the foundation by Willian Jones of the Asiatic Society in 1784. In his inaugural address, Jones stated ornately the objectives of the Society. He emphasised on the genuine spirit of research in oriental literature, history, philosophy and other subjects of humanities. He equally laid stress on study and investigations in sciences. In consonance with the objectives of the Society, many of India's learned societies and research institutions owe their origin to the Asiatic Society.

The Asiatic Society acted as the foster father of Indian Museum, Trigonometrical Survey of India, Geological Survey of India, Indian Meteorological Department, Zoological Survey of India, Botanical Survey of India, Indian Science Congress and National Institute of Sciences (now, Indian National Science Academy). In fact, for over 25 years, the office of the Indian Science Congress Association and for nearly ten years, the office of the National Institute of Sciences were housed in the Asiatic Society.

The role of the Asiatic Society in initiating scientific equiries in India also encouraged the foundations of the premier medical college of Asia – Calcutta Medical College, the premier centre for researches in tropical diseases in Asia – Calcutta School of Tropical Medicine, the Archeological Survey of India, and the Survey of India.

For about four decades, the Society's *Journal, Memoirs and Proceedings* were the premier vehicles for publications of scientific research papers in India. The Society also encouraged Pundit Madhusudan Gupta, the first Indian medical practioner who dissected, for the first time in India, a human cadaver, to publish his works in the Society's Journal. The Chief Computer of the Trigonometrical Survey of India,

a great mathematician, Radhanath Sikdar had also published his papers in the Society's Journal.

Among the architects of modern sciences in India, Ashutosh Mookerjee, P N Bose, J C Bose, P C Ray, U N Brahmachari, C V Raman, M N Saha, S N Bose and B S Guha had very close links with the Asiatic Society. The first and also some of the early research papers of many of them were published in the Society's Journal and Proceedings.

Very recently the Asiatic Society has introduced for the first time in India, one-year Certificate Course in History of Sciences.

In conformity with its tradition and achievements, the Asiatic Society celebtrated the birth centenary of M N Saha, J C Ghosh, J N Mukherjee and B S Guha. The Society also published a volume – *Meghnad Saha in Parliament* – a tribute to Saha on the occasion of his birth centenary, and brought out a publication – *The Asiatic Society and Anthropological Studies in India* – a birth centenary homage to B S Guha who was the founder-Director of the Anthropological Survey of India and the first Indian General Secretary of the Asiatic Society.

This publication - *SATYENDRANATH BOSE : A Centenary Tribute* – was planned in a very short time to pay our homage to Satyendranath Bose whose 'Bose Statistics' revolutionised the quantum physics. Jyotirmoy Gupta, Journalist, has compiled and edited this publication.

I should gratefully acknowledge that without the untiring efforts and initiative of the Society's Treasurer Professor Anil Sarkar, this volume could not have been possible within this short period.

We are deeply indebted to a very affectionate student of Satyendranath Bose, Professor Partha Ghose of S N Bose National Centre for Basic Sciences, Calcutta for his beautiful and lucid Introduction to our publication – *SATYENDRANATH BOSE : A Centenary Tribute.*

Since Satyendranath Bose was an embodiment of 'Two Cultures' – science and humanities, we decided to reprint 'A World of Bose Particles' by E C G Sudarshan, an eminent mathematical physicist. Sudarshan himself is a unique personality. He is a physicist by vocation and philsopher by avocation. Himself a sanskrit scholar, Sudarshan can synthesise 'Two Cultures' in one creative world of comprehension.

By the same yardstick, two articles of Suniti Kumar Chatterji and Nirendranath Ray, two distinguished personalities of the world of humanities who were also very close to Satyendranath Bose, have been reprinted. These two articles, which are becoming inaccessible, reflect

their personal impression about him. A poem of Bishnu De, who had also a very close link with Satyendranath Bose, is included on similar justification.

The article of Ujjal Kumar Mazumdar, a noted professor of Bengali literature, exhibits to an extent the impression of the present generation of men of letters about Satyendranath Bose.

S N Bose : Biographical Resumé covers chronologically an account of Bose's life. It also reflects to a certain measure events and developments in the contemporary world of theoretical physics, especially the quantum physics. Barring a paper – *'A Simple Example for Theorem of Vijayaraghavan' (Journal of the London Mathematical Society, vol. 12, p. 250, 1937)* by M N Bose, S N Bose and T Vijayaraghavan, the dates, names and years of publication of all other scientific papers of S N Bose have been mentioned in the Biographical Resumé.

Since it is a publication of the Asiatic Society, S N Bose's Presidential Address at the Asiatic Society's Annual General Meeting in 1968 has been included in the publication.

Dr Chandan Roychoudhuri
General Secretary

22 February, 1995

INTRODUCTION

Satyendranath Bose was one of those few scientists whose name is associated with that of Einstein and who firmly put India on the scientific map of the world in the 1920's through his seminal work on quantum statistics in 1924. Bose's paper came as a shot in the arm for Einstein's light-quantum hypothesis which was just beginning to be accepted in Europe, after nineteen years of skepticism, through the experimental investigations of A H Compton. Einstein enthusiastically welcomed Bose's new counting method for photons (light-quanta) which made them lose their identity but reconciled the concept of light-quanta with Planck's law. He wrote three papers within the next six months showing that Bose's novel method, when slightly extended to material atoms, yielded the correct quantum theory of ideal gases. The new counting method came to be known as the Bose-Einstein statistics. Later, the famous Italian physicist, Enrico Fermi and independently, the famous British physicist, PAM Dirac proposed an alternative new statistics called Fermi-Dirac statistics. Particles whose behaviour is described by the Bose – Einstein statistics have since been named after Bose and are called 'bosons'; particles whose behaviour follows the Fermi-Dirac statistics are called 'fermions'. All fundamental particles discovered so far in cosmic rays or in the gigantic atom-smasher machines are found to be either 'bosons' or 'fermions'. It has also been found that Bose statistics is fundamentally responsible for the superconductivity (loss of all eletrical resistance) of certain materials as well as the superfluidity (loss of all viscosity) of certain liquids like helium-4 at very low temperatures. Bose's work has now come to be accepted as a corner-stone of the edifice of modern physics, and its impact has been felt right across its entire gamut.

Bose was born in Calcutta on 1st January, 1894. His father, Surendranath, was an accountant in the Indian Railways and was the joint founder of the Indian Chemical and Pharmaceutical Works which was started before the famous Bengal Chemicals of P C Ray. Bose was a brilliant student right through his career and came first in the Intermediate Science, BSc (Mathematics Honours) and MSc (Mixed Mathematics) examinations of the Calcutta University. His classmates

included other luminaries of Indian science like M N Saha, J C Ghosh, N R Sen and others.

The division of Bengal by Lord Curzon in 1905 provoked strong protests from Hindus and Muslims alike. Surendranath Banerjee organized raksha-bandhan among the Hindus and Muslims on the streets of Calcutta and Rabindranath Tagore composed patriotic songs. The incident left a deep impression on the mind of young Satyendranath and a quiet resolve to shake off the burden and ignominy of foreign domination and exploitation.

When Asutosh Mookerjee, the Vice-Chancellor of the University of Calcutta, himself a gifted mathematician, founded the Univerisity College of Science with the help of generous donations received from patriots like Taraknath Palit, Rashbehari Ghosh and others to create chairs in physics, applied mathematics, chemistry and botany, the condition was laid down that only Indians with adequate qualifications could be appointed to those chairs. P C Ray was appointed the first Palit Professor of Chemistry and Dr Ganesh Prasad the first Ghosh Professor of Applied Mathematics. Dr D M Bose and Dr S P Agharkar were appointed Ghosh Professor of physics and botany respectively, but they went to Germany for higher studies and got interned there during the First World War. C V Raman was still then working as an accountant in Government service and had not made up his mind to accept Asutosh's offer of the Palit chair in physics. The British did not take kindly to these developments. What science could the Indians teach? Bose was then trying to get a scholarship to go abroad for higher studies but failed to get one because those days the Palit scholarships were only given to bachelors and Bose was already married by then.

He also failed to get a job. It was at this time one day that Asutosh Mookerjee summoned Bose, Saha and Sailen Ghosh and offered them a monthly stipend of Rs 125 if they could start the postgraduate course in physics. They took up the challenge. Inexperienced as they were, Bose, Saha and Ghosh set about organising a new postgraduate department. Saha was given the responsibility of teaching quantum theory and Bose was asked to teach relativity. They had first to learn German (Saha already knew some German) and French and get acquainted with the latest works of Einstein, Planck, Wien, Bohr, Boltzmann and Kirchoff. Most of the books and journals were in German and were not available in India during the war. They found out that Dr Bruhl of the Bengal Engineering College at Shibpur had a very good library

which had the books of Planck, Boltzmann, Wien and others. They barrowed these books and started studying them. The seniors in the chemistry department were skeptical about their abilities and advised Asutosh Mookerjee to wait until D M Bose returned. But Asutosh Mookerjee was determined and had faith in the youngsters. P C Ray who was also initially skeptical was won over by him with the help of J C Ghosh, a classmate of Bose and Saha, who had by then already worked out the initial steps of his famous theory of electroytic conduction and earned P C Ray's confidence. Thus started in 1917 the first postgraduate classes in applied mathematics, physics and chemistry in the University of Calcutta in parallel with the courses that were offered by the Europeans at Presidency College. Bose and Saha had to teach applied mathematics as well but received no additional allowances for that.

D M Bose returned from Germany in 1919, and Raman also decided to resign from his accountant's post and join the new department. He immediately asked the young assistant to help him in his research in optics. Bose and Saha were more at home with mathematics than experiments. So they continued their collaboration in mathematical phycics. They translated Einstein's paper on relativity theory which the Calcutta University published with a forward by P C Mahalanobis in 1919. They also wrote a couple of joint papers on the equation of state which were published in the British journal, Philosophical Magazine. Saha also worked on radiation pressure, thermal ionization and astrophysics and won wide acclaim. He was awarded a scholarship to go abroad.

It was at this time (1921) that a new University was started at Dhaka in East Bengal (now Bangladesh). The new Vice-Chancellor, Mr Hartog had heard about Bose's talents and offered him the position of a Reader in physics. After teaching four years in his alma mater, Bose departed for Dhaka, causing some concern to Asutosh Mookerjee.

It was in Dhaka in early 1924 that Bose completed his famous work. While teaching quantum theory he had felt the need for a logically more satisfactory derivation of Planck's law (which ushered in quantum theory in 1900) then was available in the works of Planck himself, Einstein, Debye, Ehrenfest and Pauli. Saha visited Dhaka towards the end of 1923/early 1924 and had extensive discussions with Bose on this question and drew Bose's attention to some recent papers of Einstein and Ehrenfest and Pauli. Soon Bose found an ingenious solution by treating radiation in thermal eqilibrium with matter as a gas of photons

and applying the methods of statistical mechanics as adapted by Planck to suit the requirements of the new (quantum) theory. This implied that photons were 'indistinguishable', unlike any other particles scientists had come across. Bose sent his paper for publication to Philosophical Magazine. Not hearing from them for a while, he sent a copy to Einstein for his opinion with the request to have it translated into German and published in the famous German journal, Zeitschrift für Physik. Einstein was so impressed he immediately translated the paper himself and added a footnote in which he said, 'In my opinion Bose's derivation signifies an important advance. The method used here gives the quantum theory of an ideal gas as I will work out elsewhere'. However, he deleted an important suggestion from the paper concerning the 'spin' (or an intrinsic 'handedness') property of the photons which later came to be universally accepted. Einstein's papers that followed acknowledged Bose's novelty and stimulated the rapid development of wave mechanics by Schrödinger. Together with Louis de Broglie's paper on wave-particle duality, Bose's paper stands at the turning point between the old quantum theory of Planck, Bohr and Einstein and the new quantum mechanics of Heisenberg, Schrödinger, Dirac, Pauli, Jordan and Born.

On the strength of a postcard that Bose received from Einstein expressing his appreciation of Bose's work, the University of Dhaka granted him two years study leave to go to Europe. When Bose arrived in Paris in October 1924, he found he was already a famous person and was welcome wherever he went. He worked with Paul Langevin, Maurice de Broglie and Madame Curie for a year or so before going to Berlin to meet Einstein in late 1925. By the time he arrived there Heisenberg had already written his first paper on matrix mechanics. Unfortunately, Bose and Einstein differed on certain matters concerning the further development of the theory.

Bose had written a second paper on radiation in thermal equilibrium with matter in which he proposed a new hypothesis for the probability of fundamental processes which differed from those that Einstein had proposed in 1917. (Bose did not consider it necessary to introduce 'induced emission' as an independent process to arrive at Planck's law.) Einstein also translated this paper into German and had it published in Zeitscrift für Physik, but this time he added a fortnote in which he expressed his disagreement with Bose. (According to Einstein, Bose's hypothesis was in contradiction with the 'correspondence principle'.) Bose came to know of Einstein's disagreement after his arrival in Paris.

He worked on a third paper in which he accepted Einstein's criticism and treated photons and the electromagnetic field from a new standpoint (in which 'spontaneous emission' did not figure as an independent process). This was somewhat similar to the ideas put forward by Bohr, Kramers and Slater in 1924 which was, in a sense, a forerunner of modern wave mechanics. Although Langevin thought it worth publishing, Einstein did not. Bose did not pursue the matter further. He did not take part in the rapid development of quantum theory that followed. Instead he visited as many laboratories as he could to learn at first hand the new developments in radioactivity and x-ray crystallography which would be of great practical importance to India on his return.

On his return to Dhaka he devoted his entire time to building up the new department and initiating work on crystallography. He was soon promoted and became a Professor on the strength of strong letters of recommendation from Einstein, Langevin and Hermann Mark. During his stay in Dhaka until 1945 Bose worked in various areas such as chemistry, spectroscopy, statistics and mathematical physics.

In 1945 he returned to his alma mater as Khaira Professor of physics. He worked extensively in chemistry, x-ray spectroscopy, crystallography, thermoluminescence and Einstein's unified field therories on which he published five papers (four of which were written in French) during 1953-55.

On his retirement in 1956 he was appointed Vice-Chancellor of Visva-Bharati, Santiniketan. He was disappointed with his experience there because his efforts to introduce research in the pure sciences were frustrated. He was elected a Fellow of the Royal Society (London) in 1958 and made National Professor of Physics in 1959. He was a nominated member of the Rajya Sabha from 1952 to 1958.

Tagore came to know of Bose when he met Einstein in Germany 1930. On his return to India Tagore established contact with him. He dedicated his only book on popular science, *Visva Parichaya* to Bose. Bose was a great admirer of Tagore and with him shared the conviction that a sound basic education can only be acquired through the mother tongue. He founded the *Bangiya Vijnan Parishad* in 1948 to spread the message of science among laymen and to promote the use of the mother tongue in science communication by the publication of a popular science journal, *Jnan-o-Bijnan*. He worked untiringly and with evangelic devotion to his cause in the face of widespread apathy and even ridicule.

Bose was truly a renaissance figure whose interests spread far

beyond his own specialism. His encyclopaedic knowledge enabled him to feel equally at home with theorists, experimentalists, poets, painters, historians, linguists and musicians. They all turned to him for advice in their own subjects. Like the Buddha whom he specially admired, he combined prodigious mental faculties with deep compassion for fellow beings. He was first and foremost a great patriot who believed he could serve his country best by demonstrating to the world that intellectually Indians were second to none, and by devoting his life to building up the scientific infrastructure in his country. He breathed his last on 4th February 1974 in his ancestral home in North Calcutta.

Partha Ghose
S N Bose National Centre for Basic Sciences
Calcutta

8 February 1995

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যাঁকে চেনা মনের একটি জয়,
মানবিক বড় অভিজ্ঞতা।
আশ্চর্য সে মন, ব্যাপ্তি যার সর্বদিকে,
শিল্পে, সাহিত্যে, বিজ্ঞানে, সঙ্গীতে, অথচ
প্রত্যহের জীবনসম্ভোগে—এমন কি জর্দাপানে,
ধূমপানেও কিংবা ধূমপান ছেড়ে! অসামান্যে সাধারণ।
এ মনের বিপরীত মামুলি বিজ্ঞতা;
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মাহাত্ম্যের কেল্লা নেই, অবারিত দ্বার।
মান্যের ভারিক্কি আত্মপ্রীতি নেই, উদাস উদার;
সরকারী বা সাংবাদিক জেল্লা নেই,
নেই দুনিয়ায় কিছু বা কাউকে বর্জনের নীতি।
সকল বিষয় আর মানুষের নির্বিশেষ সন্ন্যস্ত সম্প্রীতি,
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তথা নিরপেক্ষ দৈনন্দিনে
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জানিনা এ অতিমস্তিষ্কের জটিলতা
কোথায় পেয়েছে তার আত্মভোলা, বেহিসাবী,
নির্বিকার, সাত্ত্বিক প্রসাদ।
অথচ হৃদয়বত্তা এখানে দুর্লভ কি নির্বোধে কিবা মূর্খে,
এখানে যে দিন যায় সত্তা বেচে কিনে সফলে বিফলে
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আমাদেরই কলকাতায় এ জাতক আশৈশব প্রতিভায় অগ্নিময়,
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অমর্ত্য শিশুর শতায়ুই খুব স্বাভাবিক।

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* বিজ্ঞানাচার্য সত্যেন্দ্রনাথ বসুর ৭০তম জন্মদিবস : শ্রদ্ধাঞ্জলি

** বিষ্ণু দে (১৯০৯—১৯৮২) বিখ্যাত কবি, প্রাবন্ধিক ও সমালোচক। দীর্ঘকাল ইংরাজী ভাষা ও সাহিত্যের অধ্যাপনা করেছেন। 'সাহিত্যপত্র', 'পরিচয়' প্রভৃতি পত্রিকার সঙ্গে ঘনিষ্টভাবে জড়িত ছিলেন। 'সাহিত্য একাডেমী' ও 'জ্ঞানপীঠ' পুরস্কারে ভূষিত।

A WORLD OF BOSE PARTICLES*

E C G Sudarshan**

The study of the nature of light has been essential to our understanding of the physical universe. Planck[1] heralded quantum theory at the turn of the century. Einstein[2] built on that foundation and advanced the notion that light propagated and interacted as quanta. Bohr[3] showed that the quantum hypothesis leads to an understanding of the characteristic line spectrum of hydrogen. Following the observation of Ehrenfest[4] that the energy of field excitations should be quantized, Debye[5] rederived Planck's radiation law. Einstein[6] gave yet another derivation of Planck's law based on radiative equilibrium resulting from the simultaneous consideration of induced and spontaneous emissions, a method which was an adaptation of the Boltzmann[7] derivation of the equilibrium distribution from the collision equation. Debye[8] used the notion of quantization of elastic vibrations to account for the specific heat of solids. Altogether it was increasingly suggestive that the radiation inside a cavity should be thought of as a photon gas.

In 1923 Compton[9] discovered the change in wavelength of X-rays scattered by free electrons; Compton and Debye[10] were both quick to identify the effect as the demonstration of the elastic collision between a photon and an electron.[11] Pauli[12] had even used the Compton effect in discussing the equilibrium of electrons in interaction with radiation. But none of them had a theory of the photon gas.

The crucial step in the identification of black body radiation as a photon gas was taken by thirty-year old Satyendranath Bose. In a short

* Reprinted from SCIENCE TODAY, January, 1974.

** A theoretical physicist of international fame, E C G Sudarshan (b. 1931) is a former Director of the Institute of Mathematical Science, Madras. He was also associated with the University of Rochester, Syracuse University and the University of Texas at Austin.

He proposed 'tachyons' (hypothetical particles moving faster than light). He has published more than 200 scientific papers. His publications include 'Elementary Particle Physics', (with R E Marshak) 'Fundamentals of Quantum Optics', and 'Classical Dynamics'.

In recognition of his fundamental contribution to the understanding of the weak nuclear force, and particularly for his part in the formulation of the 'V-A theory' of Marshak and Sudarshan, he has received a special award from the Third World Academy of Sciences in Trieste, Italy.

(4-page !) paper[13] published in 1924 he showed that photons had a startlingly "new" property of being strictly identical ! This led to a new expression for the thermodynamic properties of an assembly of photons in contrast to what one would have calculated on the then accepted basis, the so-called Maxwell – Boltzmann statistics. But with the modification that Bose introduced into the calculation we obtain the correct thermodynamics of the photon gas. And that one step was the basis of the new synthesis between the wave and particle properties of photons, and, with it, the foundations of quantum field theory. After Bose's paper came an avalanche of developments : the extension of Bose's theory to particles of arbitrary mass and non-zero chemical potential by Einstein[14], the Fermi[15]–Dirac[16] statistics for electrons, the quantization of the electromagnetic field by Heisenberg and Pauli[17], and quantum electro-dynamics by Dirac.[18]

To put Bose's synthesis in its proper setting it is good to recall that there were two items of unfinished business, one regarding photons as particles and the other concerning statistical mechanics of identical particles. In both cases uneasy make-shift solutions were generally accepted instead of definitive solutions. In the old dichotomy between particles and waves there were highly persuasive arguments on both sides but it was thought that a crucial experiment was the determination of the relative speed of light in two media with different refractive indices. It appeared that if light consisted of particles, the speed in the optically denser medium should be greater; if it consisted of waves, this speed should be lesser. Fizeau's[19] experiment on the speed of light in water thus seemed to find definitively for the wave theory! Yet, what of the postulated photons? How do we reconcile the notion of a photon with its discrete momentum and energy to its lesser speed in water than in air? We must conclude that photons may be particles but they do not behave as particles are naively expected to behave. A revision of the concept of a particle ought to be made.

The other item of unfinished business is even older. It concerns itself with the statistical mechanics of identical particles. In calculating the partition function and the entropy, one finds that the entropy is not a strictly additive quantity : when we "mix" two volumes of an ideal gas at the same temperature and pressure the resultant entropy is larger than the sum of the two entropies. This Gibbs paradox[20] shows that such a collection of identical particles is not a satisfactory model for an ideal gas. Instead of heeding this warning signal[21] people "fixed" the trouble by an ad hoc procedure in dividing the partition function

by the factorial of the number of particles, thus condoning the Maxwell-Boltzmann statistics. The genuine need for a reexamination of the implications of the strict identity of the particles was not appreciated till Bose, three decades yet to be born.

Elementary particles were originally introduced as the stuff from which the world was made. They were to be immutable entities. But the photon was clearly an entity which could be created or destroyed. Where does a photon come from and where does it go? And how can we really understand creation and destruction? What is the implication of strict identity of photons? In what sense and to what extent can we think of light as a collection of photons? All these questions were answered at one stroke by Bose who asked us to consider the many-photon states to be counted as states with equal probability. Photons were thus particles alright, but particles for which strict identity was to be recognized by considering as distinct only those cases in which the distribution of photons over phase cells were distinct.

Photons thus became nothing but levels of our underlying field. Creation or destruction of photons is then merely a "movement" of the field. Photons are then manifestations of the potentialities of the radiation field : the dichotomy between the field and the particles thus ceases. Two have become one :

bahūnām janmanāmante
jñānavān mām prapadyate
vāsudevaḥ sarvamiti
sa mahātmā sudurlabhaḥ[22]

Automatically the embarrassment of the Gibbs paradox is resolved : the paradox was just telling us that the strict identity of particles must be taken into account. But if photons are but the difference between levels of the radiation field, they are identical! And the processes of creation and destruction of photons is to be thought of as the change in the state of the field, the "motion" of the field. If we have equations of motion of the field, we have the means of describing the creation and destruction of photons. It took two more years for Heisenberg and Pauli[17] to write down the equations of motion for the radiation field and another year for Dirac[18] to construct a theory of the emission and absorption of photons. In Dirac's work the oscillators of Planck were at last identified. The formulation of the equations of motion of the electromagnetic field had still unsatisfactory features. The final form of the dynamics of the radiation field awaited the coming of age of Gupta[23], eighteen years later.

In the course of his work on the quantum theory of radiation Dirac introduced the now familiar notions of creation and destruction operators which increase or decrease the number of quanta in a state. These creation and destruction operators, introduced as the operator coefficients of the quantized field operator, do not commute with each other but instead satisfy a commutation relation which transcribes the commutation relations between field quantities as formulated by Heisenberg and Pauli[17]. Dirac[24] had already discovered that the commutator bracket in quantum mechanics was the natural analogue to the Poisson bracket in classical mechanics. It then reaffirms the Bose hypothesis that photons obey the Bose statistics. The quantized radiation field describes the same system as the totality of many-photon states provided photons obey Bose statistics.

A year after Bose discovered his statistics Pauli[25] enumerated the Exclusion Principle obeyed by electrons. So strict identity did not automatically imply Bose statistics. In another year Jordan[26] laid the foundations of a quantum field theory for particles obeying the Exclusion Principle and in the succeeding year Jordan and Wigner[27] completed this work. The corresponding statistics was worked out by Fermi[15] already in 1926. Einstein[14] amplified and extended Bose's work to make a statistics for ideal gases. He included the chemical potential appropriate for a gas in which the total number of particles are conserved; and allowed for a more general energy-momentum relation for the particles.

Both Bose's Theory, including Einstein's extension, and Fermi's Theory were essentially statistical theories and dealt with complexions of the field. The actual construction of the wave functions which are respectively symmetric and antisymmetric in the many-particle lebels was done by Dirac[18]. To find the relations between particle type and the statistics which obeyed it was left to Pauli[28] who showed that integral spin particle obeyed Bose statistics and half-integral spin particles obeyed Fermi statistics. In modern relativistic quantum field theory this spin-statistics theorem is one of the most fundamental results.

In 1935 Yukawa[29] advanced the meson theory of nuclear forces and the meson field. In the four decades since that time mesons of a variety of kinds have been identified and seen to play essential roles in nuclear interactions. They are all Bose particles. Wherever they form multiplets constituting representations of internal symmetry and groups like isospin the Bose property holds for the multiplet provided we include the interval symmetry labels also. As far as modern particle

physics is concerned, the language employed in unreservedly quantum-mechanical and the symmetry or the antisymmetry is built into the structure of the theory. This is automatically assured by employing the quantised field to formulate the kinematics of the theory. If the dynamics is also formulated in terms of quantized fields the required symmetry conditions on the many-particle states automatically obtain. If some other formulation of the dynamics is employed we must make sure that the symetry properties of the many particle states and guaranteed.

This symmetry has the immediate consequence that in any state containing two or more particles of the same field the state should be symmetric under the interchange of identical particles. Thus two spinless Bose particles, say two pions of the same charge, can be only in a state of relative even angular momentum. A spin one object cannot therefore decay into two spinless identical particles. Two photons of the same polarization cannot be in a state of orbital angular momentum one. In this manner a number of "selection rules" can be deduced for particle reactions and decays.

Already at the statistical level the identification of only complexions as states of equal probability implies that an ideal Bose gas would have a tendency to have two particles in the same phase cell more often than in the case of a classical gas in which the particles are distinguishable. This positive distance-correlation can be quantitatively computed. A similar situation obtains in particle physics. Other things being equal like Bose particles tend to be positively correlated; the angular correlation of pions of like charge in the multipion annihilation of nucleon-antinucleon systems exhibits such an effect.[30]

The manifestations of Bose statistics in particle physics goes beyond this. In relativistic quantum field theory the creation and destruction operators are the coefficients in the expansion of the field operator in terms of a complete set of negative and positive frequency wave functions. Therefore, we expect a symmetry under the interchange of the positive and negative frequency parts of a field operator. It turns out that indeed such a formal symmetry exists in the transition amplitudes in quantum field theory : it is called Crossing Symmetry[31]. If we make use of Crossing symmetry we see an extension of Bose symmetry even in the modified interchange of particles in the initial and final states!

This extension of Bose symmetry is very closely related to the notion of causality in relativistic quantum field theory. Earlier we referred to the work of Heisenberg and Pauli[17] and subsequent generalizations in which the field quantities themselves were treated as dynamical vari-

ables and commutation relations formulated for them. The implications of these commutation relations for measurability of field quantities was studied in detail by Bohr and Rosenfeld[32] in 1933. The fact that field quantities separated by space-like distances commute was interpreted to mean that such measurements are compatible and do not disturb each other. This is at times interpreted also in terms of the unavailability of any particles in this theory which travel faster than light which could carry disturbances from one location to another. This circumstance is referred to, by abuse of language, as "causality". A close examination of the mathematical steps involved show that the extension of Bose statistics through crossing symmetry is necessary to maintain causality.

Bose statistics is not an impressed property of some species of particles but something which is inevitable if on the one hand the particles are truly identical and on the other the theory is to be approximated by a classical field theory in the limit of large number of quanta[33]. This second condition is a natural extension of Bohr's Correspondence Principle[34]. We expect therefore that intense light beams should behave more or less classically.

What is however remarkable is that apart from this "classical limit" there is a remarkable possibility of a classical description of optical phenomena even in the case of weak illumination. Thus the behaviour of a field of illumination even if it is so weak as to contain no more than a single photon at any one time can nevertheless be described in the language of classical coherence theory[35]. In particular the classical theorems of partical coherence and intensity interferometry are valid for quantum optics with only minor alterations. With the discovery of the Optical Equivalence Theorem[36] the synthesis of the field theory and the theory of photons obeying Bose statistics is completed.

When Bose advanced his hypothesis the only species of elementary particles that were identified were the electron, the proton, the neutron and the photon. Of these only the photon obeys Bose statistics. The photon number is not conserved and it is a zero mass particle. Both these impart special characteristics to the statistics of photons. Among the Bose systems available then was Helium. In this case the particle number is conserved; and the particles are nonrelativistic. So we need to extend Bose's ansatz. To conserve the particle number we have to introduce a non-zero chemical potential. For photons the chemical potential is zero. In the case of an ideal Bose gas with non-zero chemical potential there is a critical temperature below which a finite fraction of the gas condenses into a single quantum state. This condensed phase

discovered by London[37] should exhibit superfluid properties; and London suggested that superfluid helium should be related to this Bose-Einstein condensation phenomenon.

Einstein arranged for the translation and publication of Bose's paper[13] on the statistics of photons and added a remark endorsing it as "substantial progress". Both in his original letter to Einstein and in his subsequent correspondence Bose addresses the great man as "teacher" and accords him great respect; and that is as it ought to be. It is in the definition of the teacher that he removes all the doubts of the student and weld his understanding into a harmonious unity : such a teacher is the one worthy of adoration.

nirasta sarvasandehaṁ
ekīkṛtya sudarśanam
rahasyam yo darśayiti
bhajāmi gurumīśvaraṁ[38]

Einstein does not seem to have told Bose how his theory could be extended to a theory of ideal Bose gases by introducing a chemical potential and making use of a general energy-momentum relation. Instead Einstein formulated this extension in one of his papers.[14] And when Bose sent him another paper[39] on the equilibrium of matter in interaction with radiation he got that, too, translated and published, but this time with a critical comment. This question concerns the equilibrium of radiation when it is in interaction with matter and being continually emitted and absorbed. In 1915 for the special model of a Bohr atom coupled to radiation Einstein[40] had shown that we could get Planck's distribution provided the emission rate contained one term proportional to the number of photons in the phase cell times the spontaneous transition rate. This additional term is called stimulated or induced emission. This special model was extended to many-level systems by Einstein and Ehrenfest[41] in 1923. Pauli[12], on the other hand, had studied the scattering of light by electrons and showed that if the Compton effect was taken into account the Planck distribution was steady. Bose[39] proposed to take up the general case and showed that in his formulation both the Pauli processes and the Einstein-Ehrenfest processes were included as special cases. This by itself should have met with general acceptance and acclaim. But Bose did point out that instead of Einstein's assumption of a stimulated and a spontaneous transition rate for absorption it is possible to consider only the spontaneous transition rate for emission *provided* the absorption rate is

taken to be not proportional to the number of quanta per phase cell but this number divided by this number plus one. Now, as far as radiative equilibrium is concerned this ansatz is as good as the Einstein ansatz[40] since only these ratios do come in! So it would have been quite possible for Einstein to add such a footnote to Bose's paper and call attention to the positive general features of Bose's formulation. But he chose otherwise; no question of "removing all confusions and welding items of knowledge into a harmonious perspective to enable him to penetrate the secrets!"[38] Three years later Dirac[18] constructed his theory of emission and absorption of radiation; and the Einstein ansatz of stimulated and spontaneous emissions was seen to be a natural consequence of the matrix elements of creation and destruction operators. But Bose did not write on radiation theory ever again.

Bose's work stands out as one of the central columns supporting the edifice of modern physics. His great achievement has inspired and fostered us all. And, Bose continued to inspire and foster creativity and class amongst us all who are his students and followers. But most of us, in remembering this giant amongst us rarely ever think of the courage and dignity of one who must have felt such keen disappointment in the lack of generosity and appreciation from him whom he considered his master. Neither Gupta's crowning formulation of quantum electrodynamics[23] nor the work on quantum optics[36] has failed to find a secure place in theoretical physics. Nor have great men been too generous with appreciation of the work of a man who did not complete even thirty years when his finest work was announced. In a nation where the intellectuals are not often eager to recognise and honour originality it requires a courageous man to be ahead of his peers. To such a person Bose is an inspiring example in dignity and courage.

dukheṣu anudvignamanāḥ
sukheṣu vigataspṛhaḥ
vitarāga bhaya krodhaḥ
sthitadhir munirucyate[42]

Bose laid the foundations for our understanding of strictly identical particles and recognition of the many boson states to be simply different states of the field. Creation and destruction become then modifications of this field; and the field enters the centre stage. The field-particle dichotomy is ended, the Gibbs paradox and the Boltzmann ad hoc assumtions are both resolved and a new comprehensive notion of indistinguishability emerges. In Dirac's work three years later we see the fulfillment of the vision engendered by Bose.

ksetrajñam cāpi mām vidhi
sarva kṣetreṣu bhārataḥ
ksetrakṣetrajñayor jñānam
yattad jñānam matam mama[43]

This is the fiftieth anniversary of Bose's great contribution; and such is its greatness that it is difficult to think of a world without Bose quanta.

The poet-devotee of kṛṣṇa describes this aptly :

sāndrāndāvabodhātma kamanupamitam kāladeśāvadibhyām
nirmuktam nityamuktam nigamāsatasahasreṇa nirbhāsyamānam
aspaṣṭam dṛśyamātre punaruru
puruṣārthātmakam brahmatatvam
tattavat bhāti sakṣāt gurapavanapure
hanta bhāgyam janānām.44

REFERENCES

1. M Planck, Verh. Deutsch. Phys. Ges. *2*, 237 (1900)
2. A Einstein, Ann. Phys. Lpz. *3*, 22 (1905)
3. N Bohr, Phil. Mag. 26, I, 476, 857 (1913); *27*, 506 (1914); *29*, 332; *30*, 394 (1915)
4. P Ehrenfest, Phys. Z. *7*, 528 (1906)
5. P Debey, Ann. Phys. Lpz. *33*, 1427 (1910)
6. A Einstein, Phys. Z. *18*, 121 (1917)
7. L Boltzmann, Wien Ber. *66*, 275 (1872)
8. P Debye, Ann. Phys. Lpz. *39*, 789 (1912)
9. A H Compton, Phys. Rev. *21*, 483 (1923)
10. P Debye, Phys. Z. *24*, 161 (1923)
11. A Einstein, Phys. Z. *18*, 121 (1917)
12. W Pauli, Z. Phys. *18*, 272 (1923)
13. S N Bose, Z. Phys. *26*, 178 (1924)
14. A Einstein, S. B. preuss. Akad. Wiss. 261 (1924); 3(1925)
15. E Fermi, Z. Phys. *36*, 902 (1926)
16. P A M Dirac. Proc. Roy. Soc. *A 112*, 661 (1926)
17. W Heisenberg and W. Pauli, Z. Phys. *56*, 1 (1929); *59*, 168 (1930); L. Rosenfeld, Z. Phys. *63*, 574 (1930)
18. P A M Dirac, Proc. Roy. Soc. *A 114*, 710 (1927); "Principles of Quantum Mechanics," Oxford (1935)
19. A H Fizeau, Comptes Rendus *29*, 90 (1890)
20. J W Gibbs, "Elementary Principles in Statistical Mechanics," Collected Works, New Haven (1948)
21. E C G Surdarshan and J. Mehra, Int. J. Theoret. Phys. *3*, 245 (1970)
22. Bhagavad Gītā VII. 19

23. S N Gupta, Proc. Phys. Soc. *63*, 681 (1950); *64*, 850 (1951)
24. P A M Dirac, Proc. Roy. Soc. *A 110*, 561 (1926)
25. W Pauli, Z. Phys. *31*, 765 (1925)
26. P Jordan, Z. Phys. *44*, 473 (1927)
27. P Jordan and E. Wigner, Z. Phys. *47*, 631 (1928)
28. W Pauli, Ann. Inst. H. Poincare *6*, 137 (1936); Phys. Rev. *58*, 716 (1940)
29. H Yukawa, Proc. Phys-Math. Soc. Japan *17*, 48 (1935)
N Kemmer, Proc. Roy. Soc. *A 166*, 127 (1938); H. Frohlich, W. Heitler and N Kemmer Proc. Roy. Soc. *A 166*, 154 (1938)
30. T Kalogeropoulos, Ph. D. Thesis, University of California, Berkeley (1959)
31. J M Jauch and F Rohrlich, "The Theory of Photons and Electrons", Addison-Wesley, New York (1955)
M Gell-Mann and M L Goldberger, Phys. Rev.
32. N Bohr and L Rosenfeld, K danske Vidensk, Selsk., Math-Fys. Medd. *XII*, 8 (1933)
33. M Planck, Ann. Phys. Lpz. *37*, 642 (1912)
34. N Bohr, K denske Vidensk. Selsk. Nat. Mat. Afd. *VIII*, 1 (1918)
35. F Zernike, Physica *5*, 785 (1938)
E Wolf, N Cim. *13*, 1165 (1959)
E Wolf and L Mandel, Rev. Mod. Phys. *37*, 231 (1965)
L Mandel and E Wolf, Phys. Rev. *149*, 847 (1966)
36. E C G Sudarshan, Phys. Rev. Ltrs. *10*, 277 (1963); C L Mehta and E C G Sudarshan, Phys. Rev. *138*, B274 (1965)
37. F London, Phys. Rev. *54*, 947 (1938)
38. Gurugīta, dialogue between Siva and Pārvatī
39. S N Bose, Z. Phys. 27, 384 (1924)
40. A Einstein, Phys. Z. 18, 121 (1917)
41. A Einstein and P. Ehrenfest, Z. Phys. 19, 301 (1923)
42. Bhagavad Gītā II, 56
43. Bhagavad Gītā XIII, 3
44. Melpattūr Nārāyaṇa Bhattatiri : Nārāyaṇīyam, opening stanza.

Satyendranath Bose*

Suniti Kumar Chatterji

It is a matter of congratulation for his students, friends and relations and for the country at large that we are enabled to celebrate the 70th birthday of Professor Satyendranath Bose. His career as a scientist has not only brought outstanding *kudos* to Indian science all over the world, but his life and achievement have been an inspiration for at least two generations of scientists in India.

Professor Bose is a person who is not confined to the laboratory alone. In many ways he may be described as one of the architects of modern India, particularly through science and culture. In his own special field of physics, Professor Bose has made outstanding contribution, and it is a matter of great pride and happiness for us to find in him one of the colleagues and interpreters of the great Einstein, whose discoveries have brought in a new interpretation of and has given a new value to the physical universe. Albert Einstein has been one of the greatest minds in history and to have obtained his approbation and his scholarly friendship would be the greatest glory for any one. Professor Bose was for a number of years connected with the University of Calcutta in its College of Science, and here he was one of the brightest stars in a galaxy of scientific workers, among whom one might mention particularly the late Dr. Meghnad Saha. He shifted the venue of his teaching and research activities to the University of Dacca, where also he had a number of eminent colleagues, and the late Professor J C Ghosh was one of them.

Professor Bose is my junior by about four years, and in addition to the affection which I feel for him as for a younger brother, I hold him in the highest esteem as a leader in Indian Science and as one who has a remarkable all-inclusive mind, which takes note of the human sciences-the humanities and culture as much as it has made the world of physical sciences its own. I have noted this with admiration that some of our finest scientists are at the same time most successful stu-

* Eminent linguist and scholar Professor Suniti Kumar Chatterjee's (1890-1977) homage to Satyendranath Bose on the ocassion of his 70th Birthday Celebrations held on 1 January, 1964 in Calcutta.

dents of Philosophy, History and the Arts. The Late Prof. Meghnad Saha's interest in literature and the humanities is very well known. Late Professor K S Krishnan, a distinguished disciple of Professor C V Raman, was also a sanskrit scholar and a student of *Visishtadvaita* Philosophy. We hear of eminent physicists and other scientists in Europe also developing an interest in such abstruse subjects such as Indian Philosophy besides aspects of European classical studies. Einstein had among his accomplishments that of a violinist of a rare type. So Albert Schweitzer is euqally great as a physician and a philanthropist on the one hand, and as a master organ player on the other. As one who has spent his whole life in humanistic studies, I can testify to the great qualities of Professor Satyendranath Bose, National Professor of India in Physics, Indian History, Indian Culture and Linguistics. It has been my very great privilege to know him rather intimately from the end of his college days. I had just taken my M.A. degree in 1913, and I was at that time attending German classes in our University. As far as I remember, I had in those clssses as fellow students both Meghnad Saha and Satyendranath Bose. I knew him as a brilliant student of science, and also a student of literature and linguistics, I had a very wholesome respect for those of our fellow students, senior or junior, who were passing through an exact and an exacting discipline of a physical science. So when I met him as a junior in our common class, I could only have a feeling of respect for his mental and scholarly attainments in science, which of course have gone on increasing without my being in a position to understand his achievements properly.

Then, he and I along with a number of other friends, found ourselves in a literary coterie, which was started by that brilliant literary scholar of Bengal, Pramatha Chaudhuri, nephew-in-law of Rabindranath Tagore, and husband of the illustrious Indira Devi Chaudhurani (daughter of Rabindranath's second elder brother, Satyendranath Tagore, I.C.S.), namely the *Sabuj Patra* group. Pramatha Chaudhuri was a barrister and a brilliant scholar of English, and like Jyotirindra Nath Tagore, another elder brother of Rabindranath his wife Indira Devi was a very fine French scholar and admirer of French thought and culture. In his journal, he sought to concentrate all modernisitic and integrating tendencies in the domain of literature and art in Bengal and India. Our regular Sunday meetings or soirees in the residence of Pramatha Chaudhuri were vertiable "feasts of reason and flows of the soul", and among a number of persons who became quite celebrities in literature and politics, Satyendranath was one. Here I had occasion to know more of the man and the scholar.

After my return from Europe when I was printing my big book on *The Origin and Development of Bengali Language* I had occasion to show him some portions of the file of the printed book, and also occasionally some proofs, and I remember he made some very pertinent suggestions, which I was glad to incorporate in my book, and as far as I remember I gratefully made a reference to this in the Introduction of my book. After Satyendranath had joined the University of Dacca, I had occasion to meet him at least twice a year for some years, as I would be going there to take part in Dacca University M.A. *viva voce* Examinations. Satyendranath has friends among musicians and singers also, and he had picked up a rare accomplishment, he is a very good *Esraj* player. In that way he has followed the footsteps of his great friend Professor Einstein. In a recent caricature by Rebati Bhusan Ghosh, which appeared in a leading Bengali Journal, of a number of Bengali literary and educational celebrities gathered in an animated conversation amongst themselves, Satyendranath Bose has been depicted there, and rightly enough, as being engrossed in playing his *Esraj* with a number of appreciative friends seated close to him. I am glad that I have also been honoured by being given a place in this fine rendering of the personalities of a number of well-known people in the literary and scientific domain in Bengal.

Satyendranath is nothing if not serious, but he has also a sense of humour and an ability to laugh, even when the joke is against himself. His affability of manners and pleasant way of talking as well as his innate and palpable sincerity have made him a friend of all and sundry. But inspite of all this gentleness of character and outward manner, he can also be very strong and assertive. This was brought home to us when years ago he had difference of opinion in some academic matter with the "Tiger of Bengal", as he was called, the great Sir Ashutosh Mookerjee, the builder of the University of Calcutta; who was for over two decades the uncrowned king of the University of Calcutta and in the domain of education in Bengal. It required great courage in a young Professor who had as yet to build up for himself a parmenent niche in the Hall of Fame to speak out his mind before Sir Ashutosh, inspite of the expostulations of anxious and well-meaning friends, to stick to his own views. After this incident he went to Dacca and his subsequent career as a scientist and as a Professor in science is very well known, he did not suffer, thanks to his own innate worth, by this transfer of the scene of his activities.

I can recall another incident which is not known to the outside public, which demonstrated Satyendranath's courage. A very well-

known revolutionary worker in British times fighting for the freedom of India, the late Abani Mukherjee, was a friend of mine and we were neighbours in Calcutta for a good many years. He was a participant in a move to import arms from America into Bengal during the First World War, and he went out of India to meet the ship which was bringing these arms to India. The arrangements failed and he was arrested, and after that we were told, he was condemned to death after a summary trial. While waiting for his execution at Singapore, he managed to make his escape to Sumatra, and he lived incognito for some years in Sumatra and Java working as a cooly in rubber plantations. Then, before the First World War was over, he managed to make his escape to Holland, and then through Germany he found himself in Russia. He was present during the Russian Revolution, and later on he went to America. When I was in Berlin in 1922, by an accident I met him, and the old ties were revived. I heard his whole career, it sounded like a romance. While in Berlin, he said he would come to India once again and try if India would be responsive to preparations for an armed rebellion once again. I tried to persuade him that the days of armed rebellion were gone and it was Mahatma gandhi who was the leader of the Indian people, he repudiated violence of any sort, and it was his doctrine of *Ahimsa* with peaceful non-cooperations that had captured the mind and heart of Indian people. Nevertheless, shortly after my return to India towards the end of 1922, I found that he had smuggled himself in a German ship into the Indian soil, and the first person he came to see in the darkness of the night was myself. He was accompanied by a German sailor. I did not know what to do, because he had a price on his head, and if the British C.I.D. got any inkling of his presence it would mean certain death in the gallows for him. I had to take a few friends in confidence and Satyendranath was one of them. Abani Mukherjee stayed in Calcutta. He went underground, but he managed to meet his own brothers who helped him. The police did not have any idea of his coming to India till the last moment. In the meanwhile he travelled through certain parts of India and tried to renew old contacts; and after a couple of months moving about in this way he came and saw me, and was almost in tears because he found that the mentality had completely changed and he found himself among "new faces and other minds". Some even suspected that he was a spy in the employment of a foreign government. He managed also to meet his brothers. How he accomplished it I do not know. But somehow he was able to smuggle himself out of India again and was back in Germany. From Berlin I got a letter from him telling

me his finanial straits. His brothers wanted to send money, and Satyendranath who was going to Germany once again readily undertook task to hand over this money in Berlin to Abani Mukherjee. This he was able to do. All these show his innate sympathy for the fighters for the nations's freedon; and the coolness and quiet courage with which he took the whole affair made a profound impression on me.

Satyendranath is convinced that the highest education in science in any country could and should be given through the medium of the mother tongue. We fully agree with him, but at the same time we maintain that there is still a very great need to cultivate English as a link language, to keep our unity in science, culture, and politics, with the other linguistic areas in a great polyglot nation like India. But I must hasten to add that he is not of a segregationist mentality, he is not like those who would remove English from the Indian scene; and as a practical man of science he will go in for bilingulalism in our higher scientific education, so long as the Indian scientists do not feel sure of themselves in their mother tongues. But he would like the greatest support to be given to the mother tongue. Herein everybody would agree with him. But he did not simply stop by just giving his verbal support to an idea and an ideal. He is the founder of a society in Bengal which seeks to propagate the study of science through the Bengali language, and this society publishes a journal which is certainly the most important one of its kind in any Indian language.

Satyendranath, as said before, is not a hermit who lives in loneliness within the sacred parecincts of his laboratory. He takes interest in all institutions and associations, conferences and meetings where matters of public interest, particularly in the educational and scientific uplift of India, are discussed : emphatically his soul is not like a star taking its pride in dwelling apart. He is very easily accessible and very simple in his accessibility. That is why he is one of our most popular men in Bengal among specialists in science, and that is why the whole country is rejoicing at the fact that Satyendranath Bose, National Professor, co-worker with Einstein, is still a force for good in our public life, and is trying to bring to the minds of men in Bengal the dry white light of reason, not detatched from the warmth of a feeling for the advancement of his people in their own language and culture.

PROFESSOR S N BOSE*

(An impression of his personality)

Nirendranath Ray

Born on the New Year's Day of 1894, Prof. Satyendranath Bose completed the seventieth year of his life on the 1st January 1964. And appropriately enough, his friends, admirers and students organised on that date a solemn and joyous evening in Calcutta on behalf of the people of Bengal as a whole. And in this connexion it was planned to bring out a commemoration volume with contributions from the rest of India and the world outside. The present article records the impressions of one who, unfortunately himself not a man of science, had the rare blessing of being in close proximity to Prof. Bose and his faimly for over half a century.

At the very outset, it affords him unbounded pleasure to record that Surendranath Bose, Satyendranath's father, lived to see that memorable day in his son's life. Surendranath was then 96, and his mental faculties were still more or less alert. He remembered that Satyendranath, his first child, was only about three months, a Bengali astrologer gave him a brief outline of the new-born baby's future course of life, in which it was said that inspite of serious and life-long defective vision this child would win wide fame through extraordinary powers of intellect. Surendranath himself had a keen aptitude for mathematical thinking which because of his father's early death could not find full fruition. He became a qualified accountant and later in life held responsible posts in the Executive Engineering Department of the East India Railways. He was also interested in other branches of science and was the joint founder of the Indian Chemical and Pharmaceutical Works, a modest affair no doubt which still exists, but it came into being earlier than the more famous "Bengal Chemical" of Acharya Prafullachandra. His passion for philosophical studies was no less remarkable. He read

* Reprinted from SATYENDRANATH BOSE 70th Birthday Commemoration Vol. 1., 1964.

Nirendranath Ray (1896-1966) was an eminent professor of English Literature. Since his childhood he was very close to Satyendranath Bose who used to treat him as his younger brother. A pioneer of progressive literary movement in Bengal. Ray was also one of the founders of noted Bengali monthly – PARICHAY.

thorough the *Yoga-bashistha* and the Gita many times over and at the same time was quite at home among the dialectical speculations of Hegel and Marx. He breathed his last on 2nd June, 1964.

Satyendranath's mother had died earlier, in 1939. Her life as a young wife was the story of a ceaseless struggle against ill-health and inadequate income to maintain a middleclass home. With only a nominal school-education, she had extraordinary ability in managing domestic affairs and was remarkable for her warmth of heart and a high sense of dignity in life. Satyendranath was her only son and she had after him six daughters in succession. It is lamentably true perhaps in these days also that sons in family are preferred to daughters. Once being twitted on this profusion of daughters she retorted with a proud smile, "I would rather bear a dozen daughters than another son who is not worthy of being a brother to Satyen Bose". Satyen Bose, by the way, is the familiar shortened form of the full name of the Professor by which he is endearingly known all over Bengal. She felt happy beyond measure when she came to know that Rabindranath himself had sought Satyen Bose out of Dacca, invited him to Santiniketan and dedicated to him his book on science in Bengali. The parents were proud of their son, and the son is no less grateful to the memory of his parents.

But about anything else in his boyhood it was the spirit of the times that moved him most. He was a schoolboy in the lower forms when he came under the direct impact of what is now known in history as the Swadeshi movement in Bengal. In 1905, when Satyen Bose was only eleven, just standing on the threshold of his intellectual career, Lord Curzon declared the partition of Bengal, and this act was quite characteristic of him. Even in Oxford as a student he earned the dubious distinction of being known as a "very superior perzon". Coming to India as the Viceroy his imperial inclinations found congenial soil for his love of pomp and grandeur, for the exercise of power with a haughty egoism. Because of high reasons of state as he understood them he had no hesitation in riding rough-shod over the feelings of million of Bengalis to live in unity in a single homeland. This Curzonian Draconism was a rude shock specially to the English educated intelligentsia of Bengal who looked upon the Queen's Proclamation as their political magna carta. This autocratic surgery on the body of Mother Bengal resulted in undreamt of consequences. This was a rousing call to Bengal's manhood to fight against political slavery and economic exploitation. All the patriotic teachings since the days of Rammohan, through Bankimchandra and Vivekananda, took on a concrete shape

and became a living source of inspired sacrifice. What Rabindranath wrote about the historic heroism of the Sikhs was a superb imaginative anticipation of the coming explosion of heroism among the contemporary youth of Bengal :

To us has dawned the Day
When million souls free onward roll,
Have none whom debt to pay;
When Life and Death both serve like slaves,
Make hearts undaunted gay;
By Punjab's five great river breaks
the Dawn of a newer day.

All bliss it was for the Bengalis in that dawn to be alive, to be a young student was, indeed, the very heaven. This patriotic idealism was the most potent influence in the formative years of young Satyen's life. The dominating motto of his thought and action can be found in a quatrain of our foremost woman poet, Sm. Kamini Roy :

To be solely self-engrossed
Is not the destined end of human birth;
We all live for all of us
And each one for our brothers on earth.

A splendid effect of this patriotic idealism on young Satyen was his passion for truth and an intense and limitless thirst for knowledge. The unknown astrologer's forecast was not slow to manifest itself; his eyesight was indeed dim, but his memory and insight exceptionally keen. To him may be applied what Francis Bacon once said about himself, "I have taken all knowledge to be my province". In 1907, he was removed by his father from the local school to the Hindu School of glorious traditions where he came into contact with formidable rivals in class and teachers who did not fail to recognise his merits. The veteran Headmaster, Rasamaya Mitra, and specially the senior teacher of mathematics, Upendralal Bakshi gave him encouragement in every way. As a teacher Upendralal was even in those days what may be called "Science-intoxicated" and he found in Satyen his ideal pupil. After once examining his answer paper Upendralal in his crazy way proudly awarded 110 out of 100, because Satyen had succeeded in the allotted time in correctly solving all the questions set in the question paper without excluding any of the alternatives. His enthusiastic forecast about Satyen Bose's future career was that he would one day be as great in mathematics as Pythagoras or Laplace. After passing out of the school,

Satyen came to Presidency College in 1909, and took up the newly created science course in the Intermediate even though he had done remarkably well in History and Geography as well as Sanskrit. Here again he had a similar tribute from his examiner, but this time, strangely enough, it was in English. Prof. H M Percival was then the towering figure among all the teachers of English in Calcutta. In the year of his retirement from Presidency College in 1911, he voluntarily examined the answer papers of the second year students both in Arts and Science. Along with the first boy in the Arts section Satyen got 60 out of 100. But on Satyen's answer paper Prof. Percival put in + 10, with the added exclamation – This boy is a genius! He wanted to see Satyen before he left the college, and gave him his blessing when they met. Those were the glorious days when teachers really taught and took interest in the qualitative differentiation of merit among students.

The science department of Presidency College then had what may be called star-studded staff, including legendary figures like Jagadishchandra and Prafullachandra. And among his class-mates he could count Meghnad Saha, Jnanchandra Ghosh, Jnanendranath Mukherjee – to name only a prominent few. This extraordinary batch of science-students had a common link, a common purpose – the inspiration of patriotism derived from the Swadeshi movement of 1905. In his final M.Sc. examination in 1915, Satyen Bose came out with an expected first, but also with it he won a set of marks in all the eight papers which, as far as is known, is yet a record unbeaten. These young scientists had only to some extent fulfilled the vision of Rammohan for introduction of European science into our academic studies. They had also before them the inspiring examples of the two great Acharya with whom they could come into personal contact. But the future before them presented a prospect blank and bleak. Of course each one of these successful scholars could get a secure berth in the official services under the British rulers and this is exactly what they did not want. Out of a patriotic zeal they were eager as far as they could to follow knowledge like a sinking star far beyond the utmost bounds of human thought. They were receiving vague and indirect scraps of information about the tremendous developments of science in Germany which were not then satisfactorily treated in English text-books with which they were thoroughly familiar. Scientific journals even in English were only irregularly available on account of the war then prevailing. On their own they had already begun to learn French and German. But the greater difficulty was that modern science was not a matter of books and journals only; laboratories and instruments were indispensable. It

seemed to them that by taking their excellent degrees in the Master of Science examinations they had entered into a blind alley the only way out of which was to retreat. It was at this juncture that Sir Asutosh Mookerjee appeared as their Saviour in the field of University education in Bengal.

It is an interesting fact for us to remember that Sir Asutosh entered Bengal's educational politics in 1904 as an ally of Lord Curzon against the fight for radial demands for a full-fledged national education led by men like Rabindranath and Aurobindo. For many years he persistently resisted the claim of the mother tongue to be the medium of education. But in course of time his luck prevailed. There was disintegration in the nationalist camp. Huge amounts of money that were specifically meant by Taraknath Palit and Rashbehari Ghosh for laying the foundation of a national university free from British control thus fell into the hands of Sir Asutosh. With his hands thus strengthened he could use his Bismarkian genius to transform an official body like the University of Calcutta into an institution largely autonomous, thus defeating the original purpose of Lord Curzon. As a student Asutosh was a mathematical prodigy of his times. He published original papers of real merit and wrote a treatise on the Conic Sections that for a long period was the only recognised text-book on the subject. It can be said that the constructive period of his university administration began when he laid the foundation of the University College of Science on 27th March, 1914. In 1915 a group of young M.Sc. scholars approached him to open postgraduate classes in modern Mathematics and Physics, along with Chemistry that was already there. Needless to say, this group included Meghnad Saha, Jnanchandra Ghosh and Satyendranath Bose. Sir Asutosh gave them a patient hearing. He knew the necessity as well as the difficulties quite well, and after discussion with them agreed to their proposal on the condition that these young aspirants must prepare themselves beforehand for such a responsible undertaking. They were given stipendiary scholarships with facilities for procuring journals and working in laboratories. In 1917, post-graduate classes in Mixed Mathematics and Physics were opened, the department of Chemistry was reorganised and three of them, Saha, Ghosh and Bose were appointed Lecturers.

Thus began a new phase in Satyen Bose's life. The second great influence on his intellectual make-up was the new Physics. Curiously enough, this new Physics had also made its startling *debut* into the world of science in 1905, when Einstein firmly established the con-

clusions of Planck, already formulated in 1900. To the students of science in India these revolutionary developments were more or less heresays, in the absence of original documents written mostly in German, as well as of properly equipped laboratory to carry on their researches. Sir Asutosh did his best to foster the spirit of enquiry and research among the students and teachers of the Postgraduate department. The previous lonely efforts of Jagadishchandra and Prafullachandra now became an organised activity. In a few years the University of Calcutta came to be a well-known name in the scientific world.

When world-fame almost overnight came to Satyen Bose in 1924, he was not a member of the teaching staff of his own University. In 1921, he was offered Readership in the newly-established Dacca Univeristy and he took it. It was difficult to explain this choice. A hundred per cent Calcuttan by birth and residence, he had hardly any tangible reasons to leave Calcutta for Dacca. Increased salary and a lift in status? Throughout his life these considerations have never influenced his course of action. The fact seems to be that he was feeling too cramped in the over-crowded College of Science in Calcutta. In Dacca he expected greater room to carry on his free excursions into all allied subjects, taught in the University. The consequences have justified his choice. He sent a brief article in English of not more than six typed pages to the great Einstein on *Planck's Law and the Light-Quantum Hypotheses.* This slight thing from an obscure Indian Scientist of a hitherto unknown University, however, at once caught his attention. He himself translated it into German for publication in the famous *Zeitschrift für Physik,* with a post-script declaring its importance and possibilities. What followed next is now a part of the history of physical thought well-known to students of science all over the world.

What is not so well-known is that Satyen Bose from Dacca in the same year had sent to Einstein another paper, a longer one and more fundamental on Thermodynamic Equilibrium in Radiation-Field in the Presence of Matter. This paper also Einstein took the trouble of translating and publishing in German as soon as he received it. But this time in his postscript he expressed his disagreement with Bose on certain points contained in his article. The unfortunate consequence was that this paper failed to attract world attention. When Bose and Einstein met in Berlin they discussed this paper face to face and as it happened neither could convince the other. The question is still open. This paper is not very much under discussion today among physicists, because the main current of modern physics has turned to other channels. But

inspired by the words of Bhababhuti that the world is vast and time infinite, Bose in his heart of hearts still cherishes the hope that some day by someone similarly minded his stand on this question will be ultimately vindicated. The problem still haunts his mind and it will be the crowning glory of his life if he can succeed in doing the vindication himself.

To the eternal credit of the Dacca University, Satyen Bose was sent on his European tour at its expense for two years when he was only an M.Sc., without higher academic degree to his credit. At first he went to France, lived in Paris for about a year, worked in the laboratory of the illustrious Madame Curie and became known to the great galaxy of physicists including Langevin, de Broglie, Joliot and others. Then he went to Berlin where Einstein included him in the famous 'Colloquium'. While in Berlin the news reached him that the highest post in the Physics Department of the Dacca University had fallen vacant, and his friends urged him to apply for it. In view of his lack of higher degree they suggested to him to secure a testimonial from Einstein. This is the kind of job for which Bose is most inept. Most hesitatingly he explained the situation to the world's foremost physicist. When Einstein understood what was expected from him he said in wonder – what you have already done for physics speaks for itself. Should not that suffice? And it is said, he wrote about Bose to the effect that – his coming here has been to our benefit. So Bose returned to Dacca as Professor and Head of the Physics Department in 1926. He lived there for about twenty-five years of his life, loved and respected by his colleagues and students as well as the general public of East Bengal. But he returned to Calcutta as Khaira Professor of Physics in 1945.

Then came the new partition of Bengal in 1947, the formation of two sovereign, independent governments of India and Pakistan – a cut, a wound that went much deeper than ever contemplated by Lord Curzon. Though now settled in Calcutta, Bose could not accept this act but with a bleeding heart. He loves Bengal as he knew her from his boyhood through maps and travels; he loves her history and literature, her arts and music, her political and economic aspirations. So long as a man is a Bengali, the differences in religious creeds mean nothing to him. The image of India that he carries in his heart stands for India of pre-independence days. Our independence has lost much of its meaning to him – because of the partition. He is happy in this that the world of mathematics and physics over which his imagination roams un-

restrained does not recognise such senseless barriers. The only difference that science recognises is that between what is objectively proved and not proved. His feelings on men and matters are strong and deep. Poetry he loves, and can respond to it with all his being when he finds in Sanskrit, Bengali and English, in French, German and Italian the best specimens of the art with an undoubted humanistic content. He has no patience with those poets whose claim to fame rests only on clever contortions of the medium of language. But in his human dealings he seldom allows his subjective emotions get the upperhand over his rationalism. All that was rational in our ancient and mediaeval culture he welcomes with open arms. "Off all human beings ever born, I believe I revere Gautam Buddha most" – he once declared. His faith in the ultimate glory of humanity is based on a relentless pursuit of objective truth, the spirit of inquiry that is embodied in science, the service to mankind from the stand-point of irresistible social evolution to higher and higher levels of existence. He knows the immense "power of a lie", that is why he believes in constant readiness to fight whatever retards human progress. The profound respect that Prof. Bose has for Einstein the man is not a whit less than his regard for the foremost teacher of the new physics. He wrote about his great Guide in Bengali :

"His personality as a man was beyond compare. He never lowered his head to violence and unreason. His faith in man was unlimited. He had to suffer much in life – and so he had an extra tenderness for the younger devotees of science... He did not bow to Hitler and Mussolini. In the last stage of his life when America following his researches found out the clue to nuclear power and used it to cause vast human death and destruction – he did not hesitate to openly record his protest against such in human behaviour". "We have to overcome heroically all obstacles and impediments to build up future civilisation, irrespective of all religious and national differences. The whole of humanity will be included in it. This is the message of hope we learn from science. A scientific attitude to life, cooperation and love in place of envy and jealousy, this is what we need, and the history of evolution shows the way to this end. Victory will come through science. By refusing the aid of science man can never attain the ultimate aim of life." These words of Pierre Teilhard, Prof. Bose says, reflect a deep affinity with his own ideas, and so he, writing in Bengali, has drawn the attention of his countrymen to the extraordinary self-sacrifice and love of humanity of Pierre Teilhard whose name so long was hardly known to us.

S N Bose : Biographical Resumé*

1894 1 January. S N Bose is born in the family residence, 22, Iswar Mill Lane, Goabagan, Calcutta.

Bose is the only male child of his parents (to be followed by six sisters), Surendranath (1868-1964), an accountant in the Executive Engineering Department of the East India Railway, who later founded the Indian Chemical and Pharmaceutical Works, a small unit dealing in chemicals; and Amodini (d. 1939).

1899 Bose is admitted to the Normal School in north Calcutta.

1900 7 October. Max Planck discovers what later comes to be known as Planck's Radiation Law.

14 December. Planck gives his original derivation of the law, and lays the foundation of the quantum theory.

1905 The discovery of special relativity by Albert Einstein, that 'brought clarity to old physics and created new physics, in particular Einstein's derivation of the relation $E = mc^2$.' In 1905, Einstein produces six papers, including one on the light-quantum and the photo-electric effect, completed 17 March, leading to his Nobel Prize in physics; his doctoral thesis on a new determination of molecular dimensions, completed 30 April; one on Brownian motion, received by the *Annalen der Physik* on 11 May; the first two papers on special relativity, received by the *Annalen* on 30 June and 27 September respectively; and a second paper on Brownian motion, received 19 December.

16 October. The Partition of Bengal. The day is declared a day of mourning throughout Bengal, with a day's fast, a closure of shops and institutions, people tying *rākhis* on each other's hands, demonstrations, and two huge rallies; giving a fillip to the Swadeshi movement.

* Reprinted from S N Bose : The Man and His Work. Vol. II, published by S N Bose National Centre for Basic Sciences, Calcutta.

1906 31 March. Sir Asutosh Mookerjee (1864-1924) becomes Vice-Chancellor, University of Calcutta, to continue till 30 March 1914 on his first term, running a second term, 4 April 1921–3 April 1923. Under the new Indian Universities Act which came into force on 1 September 1904, and under the leadership of Sir Asutosh, the University ceases to be a purely examining body, comes to exercise control over the schools and colleges, and 'provide for postgraduate teaching, study and research in the Faculties of Arts and Science'. The same year the National Council of Education, conceived as a parallel non-governmental University on the Swadeshi ideals, comes into being under the presidentship of Rashbehari Ghose (1845-1921).

1907 Bose changes school and joins the Hindu School, Calcutta, one of the city's oldest and best known schools.

1908 Down with an attack of chicken pox, Bose fails to appear for the school-leaving examination, then known as the Entrance Examination.

1909 Bose appears for the Entrance Examination of the Calcutta University, and stands fifth in order of merit. The same year he joins the intermediate classes in science at the Presidency College, where his classmates include Jnanchandra Ghosh (1894-1959), Jnanendranath Mukherjee (1893-1983), and Nikhilranjan Sen (1894-1963).

1910 'Perhaps the nearest derivation of Planck's radiation formula' is given by P Debye, in the *Annalen der Physik,* 33, 1427.

1911 L Natanson draws attention to the 'indistinguishability' of Planck's energy quanta implied by Planck's permutation measure. Planck adapts statistical mechanics to suit the requirements of the quantum theory by introducing elementary phase cells of volume h^3. Solvay Congress at Brussels on the Theory of Radiation and Quanta.

Bose stands first in the Intermediate science examination of the Calcutta University from Presidency College, and is awarded the Duff Scholarship for the best performance in Physics. He joins the B Sc classes at Presidency College the same year, and meets M N Saha (1893-1956) as classmate, beginning years of scientific collaboration and a lifelong friendship.

7 March. Rutherford presents his discovery of the atomic nucleus, at a meeting of the Manchester Literary and Philosophical Society. His definitive paper on the subject appears in *Phil. Mag.,* May 1911.

1912 Taraknath Palit (1831-1914), an eminent lawyer, executes two Trust Deeds in favour of the University of Calcutta, the effect of which is to vest in the University, lands and money of the aggregae value of 1 million 500 thousand rupees in aid of the foundation of a University College of Science and Technology and the maintenance of two Professorships, one in Chemistry and the other in Physics, and scholarships for advanced students in science to enable them to carry on research or investigation abroad, with the stipulation that the 'chairs shall always be filled by Indians.'

1913 Bose stands first in the B Sc Examination of the Calcutta University, with Honours in Mixed Mathematics, from Presidency College, and is awarded the Harishchandra Prize and the Herschel Gold Medal for being the Best in Mathematics and the Manmathanath Bhattacharya Gold Medal for standing first in the B Sc Examination. M N Saha stands second, and Nikhilranjan Sen third.

8 August. Rashbehari Ghose comes forward with an offer of one million rupees 'in furtherance of the University College of Science' and for the maintenance of four Professorships, one each in Applied Mathematics, Physics, Chemistry, and Botany with special reference to Agriculture; with the stipulation that the chairs 'must be always filled by Indians.'

Niels Bohr's paper on the quantum theory of the hydrogen atom, completed 5 April, and appearing in *Phil. Mag.,* 26, 1, in July, is the next major step in quantum theory after Planck's introduction of energy quanta and Einstein's hypothesis of light quanta. On 20 December, in a lecture before the Danish Physical Society, Bohr presents the germs of the correspondence principle, a powerful method of calculating the energies of the states of an atom.

1914 Bose marries Ushabati Ghosh, aged eleven. They would have nine children, of whom seven survive.

27 March. The foundation stone is laid for the building designed to house the University College of Science.

Ehrenfest and Kamerlingh Onnes distinguish between Planck's energy quanta ('indistinguishable') and Einstein's hypothetical light quanta ('distinguishable').

1 August. World War I breaks out.

1915 Bose stands first in the M Sc Examination, Calcutta University, in Mixed Mathematics, from Presidency College, and is awarded the Hemchandra Gossain Prize and Gold Medal. M N Saha stands second.

25 November. Einstein presents to the physics-mathematics section of the Prussian Academy of Science his paper, "The Field Equation of Gravitation', in which 'finally the general theory of relativity is closed as a logical structure.'

1916 Prafullachandra Ray joins the University College of Science as the first Palit Professor of Chemistry, a post which he holds till 1937. Teaching in the postgraduate departments in the sciences begins in July. Bose joins the University College of Science as a research scholar.

20 March. The *Annalen der Physik* receives 'Grundlage der Allgemein Relativitatstheorie', the first systematic expose of general relativity, to be published later in the year as Einstein's first book.

July. Einstein returns to the quantum theory, and in the next eitht months publishes three overlapping papers on the subject, containing the coefficients of spontaneous and induced emission and absorption, a new derivation of Planck's law, and the first statement in print by Einstein that a light-quantum with energy *hu* carries a momentum *hu/c*.

December. Einstein completes *Über die Spezielle und die Allgemeine Relativitätstheorie, Gemeinverständlich,* to be published early next year, to remain his most widely known book.

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Bose's first important contribution to theoretical physics, a paper (jointly with M N Saha) 'On the Influence of the Finite Volume of Molecules on the Equation of State', published in *Phil. Mag.,* Ser. 6, 36, 199-203. The equation of state proposed in the paper is generally known as the 'Saha-Bose equation of state'.

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Calcutta Univeristy publishes *The Principles of Relativity,* containing the original papers by Einstein and H Minkowski, translated from German by Saha and Bose, with an historical introduction by P C Mahalanobis.

6 November. At a joint meeting of the Royal Society and the Royal Astronomical Society in London, it is announced that the 29 May observations of the total solar eclipse, conducted under the supervision of Eddington on the island of Principle and under Crommelin in northern Brazil, confirm Einstein's predictions about the bending of light made in 1915, and wildly enthusiastic press announcements mark the beginning of the perception by the general public of Einstein as a world figure. Pais, Einstein's biographer, describes it as 'the day on which Einstein was canonized.'

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1921 15 July. The University of Dhaka (then spelt Dacca) starts functioning. Bose joins the new University as Reader in the Departments of Physics, with J C Ghosh as his colleague in the Department of Chemistry. He starts teaching quantum theory and acutely feels the lack of a logically satisfactory derivation of Planck's law. He attempts to provide one in his own way.

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1922 January. Einstein completes his first paper on unified field theory.

9 November. The Nobel Prize for physics for 1921 is awarded to Einstein while he is en route to Japan.

1923 The general acceptance of Einstein's light-quantum hypothesis comes through the theoretical work of Peter Debye and the experimental studies of A H Compton. Pauli shows that free electrons and radiation can be in thermal equilibrium (described by Planck's law), provided the probability of collisions between electrons and light-quanta satisfied a certain condition. Einstein and Ehrenfest generalize Pauli's work to elementary processes involving more than two light-quanta.

1924 M N Saha, then Professor of Physics, Allahabad University, meets Bose in Dhaka, and draws his attention to the papers of Pauli (1923) and Einstein and Ehrenfest (1923), published in *Zeitschrift für Physik.* Bose studies them and produces his celebrated paper, 'Plack's Law and the Light-Quantum Hypothesis'. He sends the paper to *Phil. Mag.,* but receives no response.

4 June. Bose sends his paper to Einstein, with an accompanying letter, asking him for his opinion and to 'arrange for its publication in *Zeitschrift für Physik.*'

15 June. Bose sends another paper, 'Thermal Equilibrium in the Radiation Field in the Presence of Matter', to Einstein.

2 July. In a postcard Einstein informs Bose that he has 'translated your work [the first paper] and communicated it to *Zeitchrift für Physik* for publication', and tells him that his work 'signified an important step forward and I liked it very much .... You are the first to derive the factor quantum theoretically, even though because of the polarization factor 2 not wholly rigorously. It is a beautiful step forward.' The journal receives the paper on the same day and publishes it in its August issue under the title, 'Plancks Gestez und Lichtquantenhypothese', with a note by Einstein at the end : 'Bose's derivation of Planck's law signifies, in my opinion, an important step forward. The method used here gives also the quantum theory of an ideal gas, as I shall show elsewhere'.

7 July. *Zeitchrift für Physik* receives Bose's second paper translated and communicated by Einstein, and publishes it in its September issue.

10 July. Einstein presents his first paper on Bose's counting method to the Prussian Academy, in which he extends Bose's method to ordinary material atoms.

September. Bose sails from Bombay on board a steamer of the Lloyd Triestine Line, for Paris.

18 October. Bose reaches Paris, where he stays at 17 Rue du Sommerard, Paris 5, with his Indian friends, Prabodh Bagchi (1898-1956) and others.

Bagchi introduces him to Sylvain Levi, the well-known French Indologist, who in his turn introduces Bose to Paul Langevin, Professor Titulaire at the College de France. On Langevin's recommendation, Bose has the opportunity of working on X-ray spectroscopy at the laboratory of Maurice de Broglie, and in a letter tells P J Hartog, Vice-Chancellor, Dhaka University, that 'Madame Curie also has given me hopes of allowing me facilities for work in the Radium Institute from the beginning of the new year.'

25 November. Louis de Broglie defends his thesis, which is a development of 'the idea, during the year 1923, that the decovery made by Einstein in 1905 should be generalized by extending it to all material particles and notably to electrons.' Einstein receives a copy of the thesis from Langevin, who was one of de Broglie's examiners, and considers it, in a letter to Lorentz (in December), 'a first feeble ray of light on this worst of our physics enigmas.'

1925 8 January. Einstein presents his second paper on Bose's counting method to the Prussian Academy, in which he discusses the differences between the counting methods of Boltzmann and Bose, and draws the inference that material particles obeying Bose's statistics should have a wave-like character. He draws attention to Louis de Broglie's doctoral thesis in which the latter had attached wave properties to ponderable matter.

27 January. Bose writes to Einstein, forwarding his 'third paper' to the latter 'under separate cover', with the informa-

tion that 'Langevin.... seems to think it interesting and worth publishing.' This paper remains unpublished and untraceable even in the Einstein archives.

29 January. Einstein presents his third paper to the Prussian Academy.

July. Heisenberg sends a paper to *Zeitschrift für Physik,* giving a preliminary account of matrix mechanics.

Pauli discovers the exclusion principle.

8 October. Bose, in Berlin, writes to Einstein seeking an appointment.

November. First Bose-Einstein meeting in Berlin, followed by several meetings and encounters with the leading German scientists : 'I was very friendly with Franck, Einstein, Born, Ewald, Szilard and Mark,' Bose would later recall.

1926 Bose, in Berlin, studies X-ray crystallography at Polanyi's laboratory, conducts a physical experimental investigation about the refractive index of Roentgen rays in the Kaiser Wilhelm Institute, and engages in theoretical studies with Gordon (of Klein-Gordon equation fame) and visits the radioactivity laboratories of Hahn and Meitner. He visits Göttingen where he meets Max Born and Erich Huckel.

Schrödinger writes four papers in which he develops wave mechanics and proves its equivalence with matrix mechanics. Fermi publishes his paper on the statistics of particles, obeying Pauli's principle. Dirac links the Bose and Fermi statistics of particles to the symmetry properties of their wave functions and names them 'bosons' and 'fermions'.

Bose applies for a Professor's post at Dhaka University, with recommendations from Einstein, Langevin, and Mark. Later in the year, he returns to Dhaka, and is appointed Professor and Head of the Department of Physics, when D M Bose, the original appointee, declines the offer. In his Dhaka years, he reorganizes the Physics Department, developing special facilities for research work in X-ray spectroscopy, X-ray diffraction, magnetic properties of matter, optical spectroscopy including Raman spectra, wireless etc.

1927 February. Dirac invents 'second quantization' of the electromagnetic field, and establishes a logical quantum theory of the interaction of light and matter in which the light field is represented by quantized harmonic oscillators.

Bose is appointed Dean, Faculty of Science, Dhaka University.

Bose and Sushilchandra Biswas publish a joint paper 'Measurements of the Decomposition Voltage in Non-Aqueous Solvents', in *Z. Phys. Chem,* 125, 442-51.

1928 February. Dirac announces his discovery of the relativistic wave equation for the electron, incorporating the spin; followed by several applications.

Ocober. Arnold Sommerfeld, visiting Calcutta to receive a doctoral degree, honoris causa, writes to the Vice-Chancellor, Dhaka University, expressing a desire to meet Bose : 'It would be a great pleasure for me indeed if Professor S N Bose could decide to see [me] at Calcutta.' Bose comes down to Calcutta to see Sommerfeld, and attends Raman's talk on the discovery of the new radiation.

1929 Bose presides over the Physics and Mathematics section of the Indian Science Congress held at Madras, and devotes his Presidential address to 'Tendencies in the Modern Theoretical Physics'.

March. General quantum field theory outlined by Heisenberg and Pauli.

Bose contributes (jointly with S K Mukherjee, Assistant Lecturer in Physics, Dhaka University) 'Beryllium Spectrum in the Region λ 3367-1964', to *Phil. Mag.,* Ser. 7, 7, 197-200.

K S Krishnan joins Dhaka University as Reader in Physics.

1931 Bose contributes his first article in Bengali, *Vijñāner Saṃkaṭ* (Crisis in Science) to the first issue of *Parichay,* a major Bengali periodical, beginning his lifelong campaign for the dissemination and teaching of scientific ideas through 'the mother tongue'.

May. Dirac declares the 'holes' to be new unknown particles, 'anti-electrons', which had the same mass as electrons, but with charge $+e$, and postulates the positron.

1932 February. Discovery of the neutron by Chadwick.

June. First nuclear process produced by an accelerator : Cockcroft and Walton become first men to accelerate protons and split lithium nuclei.

2 August. Experimental observation of the positron for the first time, by Carl D Anderson, in a cloud chamber exposed to cosmic radiation.

1933 October. 'The canonization of the new developments,' at the seventh Solvay Conference, Brussels, in which the evidence for both the positron and the neutron is discussed by Bohr, Curie, Dirac, Heisenberg, Pauli, and others.

Dirac is awarded the Nobel Prize.

30 January. The Nazis come to power is Germany.

20 March. While Einstein is on a visit to the USA, the Nazis raid his summer house in Caputh to look for weapons allegedly hidden there by the Communist Party.

28 March. Einstein returns to Europe, and settles temporarily in Belgium, never to set foot in Germany again; and sends his resignation to the Prussian Academy.

7 April. The *Beamtengesetz* (the civil service law) authorizes German Universities to fire staff on grounds of politics and/or race.

10 May. Burning of books in Germany.

1934 January. Iréne and Frèdéric Joliot-Curie first produce artificial radioactivity.

March. Fermi uses slow neutrons to bombard nuclei. 'In rapid succession, 40 of the 60 elements the [Fermi] group irradiated revealed the existence of at least one new isotope. A new one was found every few days' (G Holton, in *Minerva,* 12, 159, 1974, quoted by Pais, *Niels Bohr's Times,* Oxford 1991).

1935 7 January. Bose is nominated a Foundation Fellow of the National Institute of Sciences that has its inaugural meeting at the Senate Hall of the Calcutta University; and is also one of the five members representing the Indian Science Congress on the first general committee of the Institute.

Bose delivers the Adharchandra Memorial Lecture at Calcutta University on 'Recent Progress in Nuclear Physics'.

Chadwick receives the year's Nobel Prize in physics, and the Curies in chemistry.

1936 January. Bohr describes for the first time his theory of the compound atomic nucleus. 'The compound nucleus dominated the theory of nuclear reactions at least from 1936 to 1954 .... At Los Alamos .... the compound model could explain many phenomena'.

February. Bose lectures on 'Science in Education' at a conference held in connection with the Bengal Education Week.

June. Bose makes his first contribution to statistics - a paper 'On the Complete Moment-Coefficients of the D^2-Statistic', in *Saṃkhyā*, 2, 385-96.

1937 Rabindranath Tagore dedicates his first book on science - *Visva-Parichay* (Introduction to the Universe) - to Bose.

Bose contributes his second paper in statistics to *Saṁkhyā*, 3, 105-24 'On the Moment-Coefficients of the D^2-Statistic and Certain Integral and Differential Equations Connected with the Multivariate Normal Population'. 'Recent Progress in Nuclear Physics', the text of his Adharchandra Memorial lecture, appears in *Science and Culture*, 2, 473-79. *Science and Culture*, 3, 335-7, carries 'Anomalous Dielectric Constant of Aritificial Ionosphere'.

1938 28 January. Bose writes to Syamaprasad Mookerjee, Vice-Chancellor, Calcutta University, in response to a feeler sent by the latter, stating that 'it will not be wise for me to go in for change at this age.'

5 April. *Indian Journal of Physics* receives Bose's 'On the Total Reflection of Electromagnetic Waves in the Ionosphere', and carries it in issue no. 12, 121-44.

10 December. Fermi receives the Nobel Prize in physics 'for his demonstration of the existence of new radioactive elements produced by neutron irradiation, and for his related discovery of nuclear reactions brought out by slow neutrons.'

1939 January. Hahn and Strassmann in Germany, Meitner and Frisch in Denmark in cooperation with Bohr and Fermi es-

tablish the practicability of fission and chain reaction. Joliot, Halban and Kowarski in Paris prove that uranium and thorium could perhaps be burned to yield energy.

March. Fermi meets US Navy officials and points out the possibility of obtaining atomic power with fission by fast neutrons; but the Navy officials are unimpressed.

July. Szilard and Wigner take up the subject of the bomb with Einstein, and the three subsequently talk with Alexander Sachs, who had served as an advisor to President Roosevelt on several occasions.

2 August. Einstein sends a letter to Roosevelt drawing the latter's attention to the military implications of atomic energy.

1 September. Germany invades Poland, and sparks of World War II.

11 October. Sachs carries Einstein's letter to the White House in person.

21 October. The Advisory Committee on Uranium, headed by Lyman J Briggs, holds its first meeting – the three-man committee was appointed on the same day Roosevelt replied to Einstein's letter. Einstein would later regret having written the letter to Roosevelt, 'Had I known that the Germans would not succeed in producing an atomic bomb, I would not have lifted a finger.'

Bose publishes his paper in mathematical physics – 'Studies in Lorentz Group' – in the *Bulletin of the Calcutta Mathematical Society,* 31, 137-47.

16 November. Bose is appointed Provost of the Dhaka Hall at the University.

1940 June. With the Uranium Advisory Committee recommending funding for the procurement of uranium and graphite and the construction of a lattice, and the creation of the National Defence Research Committee, the US government enters the project that would lead to the making of the first atom bomb.

17 November. 'The complete solution of the Equation :

$$\nabla^2\varphi - \frac{\partial^2 \varphi}{c^2\, \partial t^2} - k^2 \varphi = -4\pi p\,(x\,y\,z\,t)',$$

joint paper by Bose and S C Kar, received by the *Proceedings of the National Institute of Sciences,* India, to be published in issue 7, 93-102.

1941 Compton, Chadwick, and Cockcroft, among others, prove the feasibility of the atomic bomb.

1942 July. Bose is nominated member of the Agricultural Research Sub-committee of the Indian Central Jute Committee.

2 December. Under Fermi's supervision, the first nuclear reactor comes into operation in Chicago, producing the first self-sustaining chain reaction, and thereby initiating the controlled release of nuclear energy.

1943 March. J R Oppenheimer arrives at the site of the Los Alamos Scientific Laboratory and takes charge as director, to be soon joined by Bethe, Fermi, Chadwick, Bohr, Wilson, Kennedy, Smith, Parson, Kistiakowsky, Bacher, and others, on a project of making the atomic bomb.

Bose is nominated Chairman, Weights and Measures Committee, Government of Bengal.

Bose contributes paper on 'Reaction of Sulphonazides with Pyridine : Salts and Derivatives of Phyridine-Imine', to *Science and Culture,* 9, 48-9; and 'A Note on Dirac Equations and the Zeeman Effect' (jointly with K Basu) to the *Indian Journal of Physics,* 17, 301-08.

1944 3 January. In his presidential address at the Thirty-first Indian Science Congress, Bose speaks on 'The Classical Determinism and the Quantum Theory'.

30 April. Hitler takes his own life under the ruins of his Chancellery in Berlin.

7-8 May. Germans surrender in Reims and Berlin.

19 July. Bose addresses the annual convocation of the College of Engineering and Technology, Jadavpur University.

2 September. The Japanese surrender, bringing World War II to an end.

11 December. As member of the Bengal Industrial Research Committee, Bose attends the first meeting of the Committee.

1945 15 May. *Bulletin of the Calcutta Mathematical Society* receives Bose's paper 'On an Integral Equation associated with the Equation for Hydrogen Atom', to be published in the *Bulletin*, 37, 51-61.

16 July. The first atomic explosion at the Alamogordo Air Base in the New Mexico desert takes place at 5.30 a.m.

6 August. The first atomic bomb is dropped on Hiroshima at 8.15 a.m. (Japanese time) from a B-29 aircraft, Enola Gay.

9 August. The second atomic bomb is dropped on Nagasaki at 11.02 a.m. (Japanese time) from a B-29 aircraft, the Great Artiste.

Bose returns to Calcutta as Khaira Professor of Physics at Calcutta University, and becomes President of the Indian Physical Society (in the latter position he would continue till 1948).

10 December. Einstein delivers an address in New York, 'The War is Won but Peace is Not'.

1946 Einstein agrees to serve as chairman of the Emergency Committee for Atomic Scientists.

October. Einstein writes an open letter to the general assembly of the United Nations, urging the formation of a world government.

1947 15 August. India gains independence.

1948 25 January. Bose launches the Bangiya Vijnan Parishad (Science Association of Bengal), and its monthly organ *Jñān O Vijñān* (Knowledge and Science), to popularize science in and through Bengali.

Bose becomes President of the National Institute of Sciences of India (to continue in this position till 1950).

1949 27 October. Bose sends a communication on 'Germanium in Sphalerite from Nepal' to the *Journal of Scientific and Industrial Research,* to be published in its issue no. 9B, 52-53, 1950.

1950 The *Journal of Scientific and Industrial Research,* New Delhi, carries 'Extraction of Germanium from Sphalerite Collected

from Nepal' by Bose and R K Dutta of the University College of Science, in two parts in 9B, 251-52, and in the following issue.

1951 As a Special Representative from India, Bose attends a meeting, sponsored by the UNESCO, at Paris, to consider the establishment of an international statistical centre. He visits Germany and meets Walter Bothe, Otto Haxel, J H D Jenson and H Meier Leibnitz in Heidelberg, and Otto Hahn, Werner Heisenberg and Houtermans in Göttingen.

1952 Bose addresses the All India Bengali Literature Conference at Cuttack, as President of the Science Section.

20 September. Bose writes to Einstein – what amounts to his first contribution to Einstein's 'new' unified field theory.

29 September. Bose's paper 'The Affine Connection in Einstein's New Unitary Field Theory', is received by the *Annals of Mathematics, USA,* which publishes it in issue 59, 171-76, 1954.

4 October. Einstein acknowledges Bose's communication, appreciating his 'interest' in the theory, and his 'so much work and penetration to the solution of the equations' of the unitary field, but does not find 'the solution of those equations ... of great help'.

1953 Bose attends the World Congress for General Disarmament and Peace at Budapest; and visits the USSR, Denmark, Czechoslovakia and Switzerland; meeting Wolfgang Pauli in Zurich and Niels Bohr in Conpenhagen.

Bose publishes a Note on 'The Identities of Divergence in the New Unitary Theory' in the *Comptes rendus de L'-Academie des Sciences,* Paris, 236, 1333-5, 'presented by Louis de Broglie'.

18 July. *Le Journal de Physiqueet le Radium,* Paris, receives Bose's papers 'A Unitary Field Theory with $\Gamma \mu \neq O$ and 'Certain Consequences of the Existence of the Tensor g in the Affine Relativistic Field' which it publishes in its issue no. 14, 641-47.

22 October. Einstein writes a long letter to Bose, commenting on the paper 'A Unified Field Theory....'

1954 26 January. The Republic Day Honours List shows Bose as Padmavibhushan, one of the highest national honours conferred by the President of India.

3 May. Bose is sworn in as a member of the Rajya Sabha, the upper house of the Indian Parliament, on a special nomination made by the President of India.

Bose attends the International Crystallography Conference at Paris, where he presents the constructional details of his Spectrophotometer, subsequently adopted in several well-known laboratories in Europe.

13 April. The trial of Oppenheimer begins.

Einstein sides with the overwhelming majority of atomic scientists who publicly condemn the United States government's actions in the security case against Oppenheimer.

30 November. Bose delivers the sixteenth Acharya Jagadishchandra Bose Memorial Lecture at the Bose Institute, on 'Search for New Sources of Power'.

1955 9 February. 'A Report on the Study of Thermoluminescence', a joint paper by Bose, J Sharma, and B C Dutta, is received for publication by the *Transactions of the Bose Research Institute,* which carries it in its issue 20, 177-80.

Bose's last scientific paper, 'Solution of a Tensor Equation Occurring in the Unitary Field Theory', appears in the *Bulletin de Société Mathématique de France,* 83, 81-85.

11 April. Einstein's last signed letter (to Bertrand Russell), in which he agrees to sign a manifesto urging all nations to renounce nuclear weapons. That same week, Einstein writes his final phrase in life, in an unfinished manuscript : 'Political passions, aroused everywhere, demand their victims'.

18 April. 1.15 a.m. Death of Einstein.

Bose visits Paris, on an invitation from the Council of National Scientific Research of Franch.

July. Bose attends the international conference commemorating Fifty Years of Relativity, at Berne.

1956 Bose retires from the post of Khaira Professor at Calcutta University.

July. Bose takes over as Vice-Chancellor of the Visva-Bharati University.

Bose attends as a special invitee the annual meeting of the British Association for the Cultivation of Science.

1957 15 January. Bose delivers the Vice-Chancellor's formal address at the Convocation of Visva-Bharati, also addressed by Jawaharlal Nehru, then Prime Minister of the country and Chancellor of the University. Calcutta University, on the occasion of its centenary, confers a D Sc, honoris causa, on Bose; followed by honorary doctoral degrees from the Allahabad and Jadavpur Universities.

1958 Bose is elected Fellow of the Royal Society, and visits London via Paris for the occasion.

Bose is nominated Professor Emeritus at Calcutta University.

Bose presides over the year's session of the All India Bengali Literature Conference, at Jabbalpur.

1959 Bose is appointed National Professor.

10 August. Bose's resignation from the Rajya Sabha is reported in the House.

1960 January. Bohr visits India to attend the Indian Science Congress session at Bombay, where he gives two lectures; and comes to Calcutta to deliver the M N Saha Memorial lecture at the M N Saha Institute of Nuclear Physics, Calcutta University College of Science; the session is chaired by Bose.

1961 Bose receives the title of Deshikottama – equivalent to a doctorate, honoris causa – from the Visva-Bharati University.

March. Bose speaks at the Indian Association for the Cultivation of Science at a meeting held to commemorate the death anniversary of Mahendralal Sircar.

1962 May. Bose participates in the deliberations of the Organizing Committee of the World Peace Council, held in Stockholm.

August. Bose attends and addresses a seminar on 'Science and Philosophy' held in Tokyo.

September. Bose attends the World Peace Conference in Moscow.

October. Bose inaugurates and addresses the *Angrezi Hatao* (Banish English) Conference, held at Hyderabad.

Bose receives an honorary D Sc degree from the Indian Statistical Institute.

Bose delivers the convocation address at the Calcutta University Convocation.

1963 11 May. Bose delivers the convocation address at Ranchi University.

July. Bose visits Cairo as a member of a delegation of Indian scientists.

1964 1 January. Bose is felicitated on his seventieth birthday, at the Mahajati Sadan auditorium, with Prafullachandra Sen, then Chief Minister of the State, as President of the Celebration Committee.

Bose receives an honorary D Sc from the Delhi University, and the title 'Vijnan-Bhaskaram' from Sanskrit College, Calcutta.

1965 1 January. Bose inaugurates the 51-52nd session of the Indian Science Congress.

Bose receives the Jagattarini Medal from Calcutta University in recognition of his contribution to the Bengali language.

7 April. Bose delivers the convocation address at the Indian Institute of Technology, Kharagpur.

1968 Bose elected President of the Asiatic Society.

1969 Bose inaugurates the building of the Vangiya Vijnan Parishad, at P 23, Raja Rajkrishna Street.

1 March. Bose delivers the convocation address at the Indian Agricultural Research Institute, New Delhi.

1970 Bose is awarded a D Litt, honoris causa, by Rabindra Bharati University.

1971 12 March. Bose delivers the Krishnan Memorial Lecture at the National Physical Laboratory.

10 May. Bose delivers the convocation address at Rabindra Bharati University.

1973 16 June. Bose delivers the convocation address at Calcutta University.

29 December. Bose speaks at the inaugural session of a Seminar on the Scientific Contributions of Professor S N Bose, held at the Calcutta Mathematical Society.

1974 1 January. Bose's eightieth birth anniversary is celebrated throughout the country.

The fiftieth year of Bose Statistics is commemorated at the Bose Institute, Calcutta.

4 February. Death of S N Bose.

Books by S N Bose (in Bengali) : in chronological sequence

Vijñāner Saṃkaṭ O Anyānya Prabandha (Crisis in Science and Other Essays), Lekhak Samabaya Samiti, Calcutta, 1371 [Bengali era, corresponding to 1964], 176 pages, and prelims, including a dedicatory note by Bose, dated 24 May 1964.

Satyendranāth Bose Racanā Saṅkalan (A Selection of Satyendranath Bose's Writings), Vangiya Vijnan Parishad, Calcutta, 1387 [Bengali era, corresponding to 1980], 422 pages, and prelims, including a prefatory note, a life sketch of Bose, and a memorial piece by Gaganbehari Banerjee. Enlarged second edition, published as centenary edition, 1993, 450 pages, with additional articles, letters and photographs.

ANNUAL ADDRESS 1968

Professor S N Bose, F.R.S., F.A.S.

LADIES AND GENTLEMEN,

I have very great pleasure in welcoming you all to this 185th Annual Meeting of the Asiatic Society.

Before we take up our regular business, it is my melancholy duty to report the passing away of five of our distinguished members :

(1) Dr J H Hutton, I. C. S., a fellow of the Society and an eminent Anthropologist. An author of a large number of works, he edited the Census Report of 1931.

(2) Dr Susil Kumar De, a renowned Sanskritic Scholar noted for his many original contributions in his own field. He was the Philological Secretary to our Society during 1956-57.

(3) Shri Sailendranath Sen Gupta, our Publication Secretary, till the day of his death on 23.5.68. He had also acted as a Treasurer of our Society some time.

(4) Shri Tapan Mohan Chatterjea, a lawyer and well-known Bengali writer.

(5) Shri Narendra Singh Singhi, scion of an illustrious family noted for their patronage and their valued collection of Indian arts.

The Society records here its profound sense of sorrow and of deep loss at their demise, and sends out its sincere sympathy to the members of the various bereaved families.

The Secretary has already given you a detailed account of our activities during the past year in his report, already circulated among you. I would like, however, to draw your special attention to the following points raised by him.

You will note that we have not been able to do as much as we would have liked for the preservation of our priceless collection of manuscripts and books. We have approached both the State and the Central Governments for making more generous grants, so that the long-standing problem of an adequate air-conditioning of our storage rooms are satisfactorily and permanently solved.

The authorities however have not as yet made a timely and generous response to our repeated requests.

This venerable Society possesses collection of books, and manuscripts indispensable for the advancement of knowledge and research, and unless steps be taken forthwith, there is danger of damage and loss to our treasures which may not be rectified, ever after.

There is at present a movement throughout the world to Microfilm valuable records and books for their parmanent preservation.

I have admired the steps that we take at present in our Library to repair damages, and preserve books and manuscripts. But I would earnestly put forward a strong plea for microfilming all our valuable documents. I am told that we are in possession of many of the essential apparatus for this purpose. What is wanted is a firm and resolute policy. After the first decisive step, I feel, its enormous utility will be apparent to our members, and our patrons.

This year as usual we have undertaken publication of a few manuscripts and republication of certain rare books. In this connection, I would like to thank our venerable scholar Dr R G Basak for his very valuable assistance in printing new edition of Ramacharitam.

The Society has been asked by the Central Government to be one of the principal collaborators in the Central Asian Studies recently inaugurated by the UNESCO.

We have gladly welcomed this step by our Central Government, and our Society will do whatever may be possible in this matter. The history of our ancient land is linked up vitally with that of Central Asia. where discoveries and excavations continue to throw valuable light on our venerable past.

I venture to suggest here that similar step may be taken for the inauguration of the studies of the history and the culture of South East Asia, sponsored by similar world-organisation.

Our land has been linked intimately for many centuries, with our neighbours, and had helped notably in the diffusion of culture, philosophy, and religion in this part of the world. A detailed study on a broad basis will bring into light, many important points of our past history as well as illuminate many dark problems of history of Civilisation of Mankind.

Our members will note that accessions to our library have continued to increase during the last year. We have secured more than 2000 volumes. Last year attention has been drawn to the necessity of construction of additional stories to our new building by our President. This has apparently not evoked any response from the Government so far.

I need hardly emphasise the necessity of taking immediate steps in this matter. Temporary and make-shift arrangements are no satisfactory solutions : Apathy, and carelessness may lead to loss and damage to the Society's collection. Members might have noticed that we possess also a number of valuable paintings by ancient Masters. Funds are also necessary for their preservation and renovation. Unless adequate steps are taken early there is bound to be lamentable and irretrievable damage to our paintings.

As in previous years the Society has marked its appreciation of work of eminent scholars in the usual way.

Dr William Normal Brown, the distinguished Indologist has been elected a Honorary Fellow.

The Rabindranath Plaque has been awarded to Dr Suniti Kumar Chatterji, our illustrious Indologist and Philologist.

C V Raman has been decorated with Sir William Jones medal, for his monumental contribution to Science.

The Society has also honoured Dr P C Mahalanobis, the father of statistical studies in India.

Dr Viswanath of the University of the Punjab and Dr N R Sircar of Calcutta by awarding medals of recognition and merit.

I offer my sincere thanks to Shri Dharma Vira, our Rajyapal for having taken interest in the affairs of our Society. I hope with his wise and helpful cooperation, the Society will be able to solve its many financial problems.

My predecessor in office, Dr R C Majumdar, has discussed at some length the importance of English continuing as the medium of expression of all the activities of this ancient Society. Though we have erected a modern multi-storied building by the side of the ancient site hallowed with many memories, our zeal for renovation should not affect our other practices which are now nearly two-century old. We may however foster under our care new institutions, where research and popularisation of the Sciences and the Humanistic studies may be pursued in a suitable manner in an Indian tongue. This Society has fostered the advent of many new societies in the past. I hope its vitality is not exhausted as yet, and it may yet give birth to many more institutions suited to our modern needs. I hope such daughter Institutions will grow and thrive under the paternal care of the Asiatic Society and help to building up a new Society, and a new India in this modern age.

Ladies and Gentlemen, I have come to the end, and thank you sincerely for your patience in sitting through this discourse.

These two letters of Satyendranath Bose from the Asiatic Society's archives clearly manifests his links with the Society since early twenties.

219, 220/1922 — The Chummery
Ramna
Dacca.
2.3.22.

To

The
Librarian
The Asiatic Society of Bengal.

Dear Sir,

I shall be highly obliged if you send me the following Journals at your earliest convenience.

1. Sitzungberichte, Wiener Akademie. (1118) (Containing M. 605) 1909.

2. Sitz. Ber. Münchener Akadamie 1915 (Containing P. 1)

3. Gottingen Nachrichten. Math. Phy. Klasse. 1916.

Yours faithfully
Satyendranath Bose.

The Chummery
Ramna
Dacca
15/3/22

Lib

To

The Librarian

The Asiatic Society of Bengal.

Dear Sir,

Many thanks for the journals sent. Unfortunately as regards Sitz Berichte 1909, you have sent me the 1st part of Natural Science containing papers on Zoology, Botany, etc; I really want the 2nd part (a). Please kindly see that at pp. 605, there is a paper by one Schillinger. If you kindly send this one I shall return both the parts together; at present I am keeping the first part—

Yours faithfully,
Satya Bose.

সত্যেন্দ্রনাথ বসু : সজনে ও নির্জনে

উজ্জ্বলকুমার মজুমদার*

সত্যেন্দ্রনাথ বসুর বাঙলা চিঠিপত্র, রচনা এবং তাঁর সম্পর্কে কিছু স্মৃতিচারণা আছে যার থেকে সত্যেন্দ্রনাথের একটা বিশেষ পরিচয় পাওয়া যায়। সেই পরিচয় সূত্রেই দু-চারটি কথা সূত্রাকারে বলতে পারি। কারণ তার বাইরে সত্যেন্দ্রনাথ সম্পর্কে কিছু বলার অধিকার আমার নেই।

সত্যেন্দ্রনাথের সাহিত্যপ্রীতি ছিল ছোটবেলা থেকেই। একটু বড় হয়ে তিনি শিবপুরে শরৎচন্দ্র চট্টোপাধ্যায়ের বাড়িতে যাতায়াত করতেন। শরৎচন্দ্রের মতো ভবঘুরের জীবন ও অভিজ্ঞতার রোমাঞ্চ নিশ্চয় তাঁকে টানতো। শরৎচন্দ্রের গল্প-উপন্যাসে যে বিচিত্র সাধারণ মানুষের স্বচ্ছন্দ আনাগোনা হয়েছে তাও তাঁকে শরৎচন্দ্রের প্রতি আকৃষ্ট করে থাকতে পারে।

তেমনি, প্রমথ চৌধুরীর 'সবুজপত্র' পত্রিকাকে ঘিরে যে আড্ডা বসতো সেখানেও সত্যেন্দ্রনাথ যেতেন। যেতেন 'পরিচয়' পত্রিকার আড্ডায়। প্রমথ চৌধুরী একটি চিঠিতে লিখেছিলেন, সত্যেন্দ্রনাথকে দিয়ে সবুজপত্রে একটি লেখাও লেখাতে পারেন নি। সাদা কাগজের ওপর কালো কালিতে লেখার চেয়ে কালো বোর্ডের ওপর সাদা খড়ি দিয়ে লিখতেই নাকি তার বেশি পছন্দ। পরিচয়ের আড্ডায় তিনি যে খুব মুখর ছিলেন তা নয়। তবে বিদেশে গিয়ে গবেষণা করে ফিরে আসার পর বিভিন্ন বৈজ্ঞানিক ও বিচিত্র মানুষের বিচিত্র স্বভাব নিয়ে রসিয়ে গল্প করতেন। কিন্তু তবু এই স্বল্পবাক্ মানুষটিকে হিরেণ সান্যাল বলেছেন, 'আড্ডার রাজা'। কারণ আড্ডার লোভে কলকাতার এক প্রান্ত থেকে আরেক প্রান্তে চলে যেতেন হাঁটা পথেই। পরে যখন সে-সব আড্ডা ভেঙে গেল, হাঁটাহাঁটিতেও অক্ষম হলেন, তখন নিজের বাড়িতেও বসতো আড্ডা। সাহিত্যিক বৈজ্ঞানিক দার্শনিক ঐতিহাসিক আড্ডা। বিজ্ঞান নিয়ে তর্কাতর্কি হতো কমই। কিন্তু তাঁর 'মন্তব্য শুনলে মনে হত উনি বিজ্ঞান ছাড়া আর সব কিছুই জানেন'।

ঢাকায় গিয়ে তাঁর জীবন সংক্রান্ত তথ্য যাঁরা সংগ্রহ করছেন তাঁদের একজনের মুখে শুনলাম, তিনি ঢাকায় মেলামেশা বেশি করতেন না, বাগান করতেই ভালো বাসতেন। কিন্তু ঢাকায় যেমন তিনি নির্জনে নীরবে গবেষণা করেছেন, তেমনি

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*বাঙলা সাহিত্যের একজন বিশিষ্ট অধ্যাপক। (জন্ম : ১৯৩৬)

বিখ্যাত এই মানুষটির ওখানেও একটি ঘনিষ্ঠ আড্ডা অবশ্যই ছিল। সত্যেন্দ্রনাথের একটি চিঠিতেই তার প্রমাণ পাচ্ছি। বাঙলা দেশ থেকে 'বিজ্ঞান সাময়িকী' নামে একটি পত্রিকার প্রাপ্তি স্বীকার ক'রে সত্যেন্দ্রনাথ একটি চিঠিতে লিখছেন, 'মনে পড়ছে আজ থেকে পঞ্চাশ বছর আগে যখন [ঢাকা] বিশ্ববিদ্যালয় প্রতিষ্ঠা হলো [তখন] আমরা কয়জন নবীন মিলে.....একটি সভায় মিলিত হতাম। তার মধ্যে পেয়েছিলাম সবে বিলেত-প্রত্যাগত হাকিম শ্রী অন্নদাশঙ্কর রায়কে ও পরলোকগত পূর্ণেন্দু মজুমদারকে, তখন ঢাকা কলেজের উদ্‌ভিদ্ বিজ্ঞানের অধ্যাপক। কাজী মোতাহার হোসেন তখন ছিলেন সভ্য, সকলের থেকে বয়সে ছোট। সেই আড্ডায় নানা বিষয়ের আলোচনা হতো। শেষ অবধি 'বিজ্ঞান পরিচয়' নামে বাংলা একটি মাসিক পত্র করা হয়। দেশভাগ হলো, আমি চলে এলাম, তারপরও কিছুদিন সে কাগজ চলেছিল বলে শুনেছি।' এর থেকে বোঝা যায়, ১৯৪৮ সালে কলকাতার বঙ্গীয় বিজ্ঞান পরিষদের প্রতিষ্ঠা ও 'জ্ঞান ও বিজ্ঞান' পত্রিকা প্রকাশের প্রায় পঁচিশ বছর আগেই সত্যেন্দ্রনাথ বাঙলা ভাষায় বিজ্ঞানচর্চার উদ্যোগ নিয়েছিলেন ঢাকায় একটি ঘনিষ্ঠ আড্ডার ভেতর থেকেই।

বাঙলা ভাষায় বিজ্ঞান চর্চা মানেই দেশীয় ভাষায় বিজ্ঞান চর্চা ক'রে সাধারণ মানুষের মনে বিজ্ঞান-চেতনা জাগিয়ে তোলা। দেশের মানুষকে জাগ্রত করবার এই প্রেরণা সত্যেন্দ্রনাথের মনে জাগে স্বদেশীযুগ থেকেই। সত্যেন্দ্রনাথের ছাত্রজীবন কেটেছিল স্বদেশিয়ানার জোয়ারের মধ্যে। 'বিজ্ঞানে আমরা যে সাহেবদের চেয়ে কম নই, তা দেখিয়ে দিতে হবে' —সত্যেন্দ্রনাথের স্মৃতিচারণা থেকেই এই আত্মবিশ্বাসের পরিচয় পাওয়া যায়, যা তাঁর সমকালীন অনেক বাঙালী ও ভারতীয় বিজ্ঞানীদের মধ্যেই ছিল। ছাত্রজীবন থেকেই অনুশীলন সমিতির সঙ্গে তাঁর ঘনিষ্ঠতা ছিল। ওয়ার্কিং মেন'স ইনস্টিট্যুটে (দিন মজুরদের জন্যে পরিচালিত নৈশ বিদ্যালয়ে) সত্যেন্দ্রনাথ নিজে তো পড়িয়েছিলেনই, বন্ধুবান্ধবদেরও উদ্যোগী করে তুলেছিলেন। বিদেশে—বিশেষত ফ্রান্সে যে সব পরীক্ষাগারে তিনি কাজ করেছিলেন সেই সব অভিজ্ঞতা তিনি দেশে ফিরে ঢাকা বিশ্ববিদ্যালয়ে ও কলকাতা বিশ্ববিদ্যালয়ের পরীক্ষাগারে কাজে লাগিয়েছিলেন। শুধু পরীক্ষাগার নয়, সাধারণভাবে বৈজ্ঞানিক মনোভাব ও বৈজ্ঞানিক প্রয়োগ পদ্ধতি দেশের মানুষের চাহিদা মেটাবে, তাদের কুসংস্কার দূর হবে, জাতি-বর্ণ-বৈষম্য লোপ পাবে, জ্ঞানের আলোয় সত্যের স্বরূপকে জানতে পারবে, যে সাধারণ মানুষকে নিয়ে দেশ সেই সাধারণ মানুষ শিক্ষিত হয়ে উঠবে, এটাই তাঁর বাসনা ছিল। কাজেই সত্যেন্দ্রনাথের বিজ্ঞানচেতনা

ও সমাজচেতনা মিশে গিয়ে আমাদের দেশের বিজ্ঞানচর্চার আন্দোলন যথার্থ পথটি খুঁজে পেয়েছিল তাঁরই মধ্যে।

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সত্যেন্দ্রনাথের প্রথম বাঙলা প্রবন্ধটি বেরোয় 'পরিচয়' পত্রিকায় (শ্রাবণ, ১৩৩৮)। প্রবন্ধটি হলো 'বিজ্ঞানের সংকট'। বিজ্ঞানের জগতে আলো ও বস্তুকণার দ্বৈত রূপের সন্ধান পাওয়াতে প্রচলিত পদার্থবিদ্যার জগতের ভিত যে নড়ে যায় তা-ই নিয়েই এই প্রবন্ধ। পরে বছর চারেক বাদে 'পরিচয়' পত্রিকাতেই 'আইনস্টাইন' নামে একটি প্রবন্ধ লেখেন তিনি। সে প্রবন্ধে আইনস্টাইনের সঙ্গে নিজের ব্যক্তিগত সম্পর্কের কথা যেমন বলেছেন, তেমনি ইহুদী আইনস্টাইন যে ইহুদী রাষ্ট্র ইসরাইলের স্বপ্ন দেখেছিলেন সে কথাও আছে। একথাও আছে যে ইংরেজরা আইনস্টাইনের চোখে ভালো মনে হলেও সত্যেন্দ্রনাথের বাসনা ইংরেজ হটে গিয়ে ভারত স্বাধীন হোক। আইনস্টাইন সে আবেগকে সমর্থন জানিয়েছেন। সে হলো ১৯২৫ সালের কথা। তারপরে তো অনেক জল গড়িয়েছিল। জার্মানীর ইহুদী বিদ্বেষে দেশছাড়া হয়ে আইনস্টাইন গেলেন ব্রিন্‌স্টনে। তারপর থেকে তিনি হন শান্তিকামী। বিশ্বশান্তি ছিল তাঁর কাম্য।

সত্যেন্দ্রনাথের সঙ্গে সাহিত্যিক, শিল্পী ও সংস্কৃতিমান মানুষদের সংস্পর্শ তো বহুকাল ধরেই চলে আসছিল। 'বিজ্ঞান পরিচয়' যখন প্রকাশিত হয়েছিল তখন রবীন্দ্রনাথ ও প্রফুল্লচন্দ্রের উৎসাহ ও প্রেরণা পেয়েছিলেন। তার আগে 'বিশ্বপরিচয়' বইটি রবীন্দ্রনাথ তো সত্যেন্দ্রনাথকে উৎসর্গ করেছিলেন। পরে দেশ স্বাধীন হবার কাছাকাছি সময়ে সত্যেন্দ্রনাথ যখন কলকাতায় চলে এলেন তখন নতুন করে বিজ্ঞানচর্চার সুফলকে সাধারণ মানুষের জীবনে পৌঁছে দিতে উদ্যোগী হলেন। দেশ স্বাধীন হবার সঙ্গে সঙ্গে মাতৃভাষায় বিজ্ঞানচর্চার নতুন উদ্যোগ নিলেন। 'বঙ্গীয় বিজ্ঞান পরিষদ' প্রতিষ্ঠিত হলো ১৯৪৮ সালের ২৫ জানুয়ারিতে। সেই থেকে আমৃত্যু সত্যেন্দ্রনাথ এই পরিষদের নেতৃত্ব দিয়েছিলেন। 'জ্ঞান ও বিজ্ঞান' পত্রিকা প্রকাশ সেই নেতৃত্বেরই ফল। পরে ১৯৬২ সালে সত্যেন্দ্রনাথ যখন জাপানে যান তখন জাপানী ভাষায় বিজ্ঞান চর্চার ব্যাপক চেষ্টা দেখে তিনি আরও অনুপ্রাণিত হন। 'জ্ঞান ও বিজ্ঞান' পত্রিকায় তাঁর অধিকাংশ রচনাই প্রকাশিত হয়েছিল। ফরাসী, জার্মান ও ইংরিজি ভাষা থেকে সত্যেন্দ্রনাথ কয়েকটি বিজ্ঞানবিষয়ক রচনা অনুবাদ করেছিলেন। তবে একথাও মনে করতে হবে, শুধু সাধারণ মানুষের কাছে বিজ্ঞানের সারতত্ত্ব পৌঁছে দেবার জন্যেই যে মাতৃভাষাকে

ব্যবহার করতে হবে তা নয়। সর্বস্তরেই তার ব্যবহার বিজ্ঞানকে ধাতস্থ করতে সুবিধা হবে বলেই তিনি মনে করতেন। তাই স্নাতকোত্তর স্তরে তিনি নিজেও মাতৃভাষায় বিজ্ঞান পড়িয়েছেন। 'মেঘনাদ সাহা স্মারক বক্তৃতা'-ও দিয়েছিলেন বাঙলায়। বিশ্ববিখ্যাত হবার সময় থেকেই অর্থাৎ বিশ-তিরিশের দশক থেকেই তাঁর এই ঝোঁক ছিল বলেই রবীন্দ্রনাথ তাঁর 'বিশ্বপরিচয়' তাঁকে উৎসর্গ করেছিলেন।

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দেশপ্রীতি তাঁর বিজ্ঞান সাধনার মূলে ছিল বলেই বহুভাষাবিদ সত্যেন্দ্রনাথ ফরাসী ভাষায় লেখা রোমাঁ রোলাঁর ডায়েরি থেকে রবীন্দ্রনাথ, গান্ধী ও সুভাষচন্দ্রের সঙ্গে তাঁর সাক্ষাৎকারের বিবরণগুলি অনুবাদ করেছিলেন। সে বিবরণগুলির মধ্যে স্বাধীনতাপূর্ব যুগের ভারতবর্ষ সম্পর্কে রোমাঁ রোলাঁর সঙ্গে ওই তিন বিখ্যাত ভারতীয়দের আলোচনা আছে। আইনস্টাইন এবং রবীন্দ্রনাথের সাক্ষাৎ-ও ইংরিজি থেকে অনুবাদ করেছিলেন দুই মনীষীর আদান-প্রদানের সঙ্গে সাধারণের পরিচয় করিয়ে দেবার জন্যেই। ফরাসী ভাষা থেকে টলস্টয়ের জীবনীর অংশ এবং মাও সে তুং সম্পর্কে আঁদ্রে মাল্‌রোর একটি রচনাও তিনি অনুবাদ করেন। তাছাড়া তিনটি গল্প ফরাসী ভাষা থেকে এবং একটি গল্প জার্মান থেকে তিনি অনুবাদ করেছিলেন। গল্পগুলির ভেতরকার সামাজিক বোধ ও তাঁর নিজের দেশের সঙ্গে সামাজিক ব্যবস্থাগত সাদৃশ্য আছে বলেই গল্পগুলি অনুবাদ করতে তাঁর ইচ্ছে হয়েছিল। এর মধ্যে দুটি গল্পের লেখক হলেন ১৯৬৬ সালের নোবেল পুরস্কার প্রাপ্ত ইহুদী লেখক সামুএল জোসেফ অ্যায়গনন। ফরাসী ভাষায় প্রকাশিত তাঁর 'জেরু-জালেমের গল্প' থেকে সত্যেন্দ্রনাথ দুটি গল্প অনুবাদ করেন। সত্যেন্দ্রনাথ নিজেই ছোট্ট ভূমিকায় বলেছেন, 'গল্পগুলি পড়লে বোঝা যায়, ভারতের বর্তমান সমস্যার সঙ্গে ইসরায়েলের নাড়ীর যোগ আছে।' এই মন্তব্য থেকেই তাঁর অনুবাদের উদ্দেশ্য ধরা পড়ে।

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গান-বাজনার ওপর ঝোঁক ছিল তাঁর সহজাত। অল্পবয়েস থেকেই ভালো এসরাজ বাজাতে পারতেন। সুরবোধও তাঁর গভীর। ভালো গান শুনেই তিনি সুর চিনে নিতে পারতেন। এ তো তাঁরই বন্ধু বিখ্যাত সুরসাধক ও গায়ক দিলীপকুমার রায়েরই সাক্ষ্য। ধূর্জটি প্রসাদ মুখোপাধ্যায় তাঁর সঙ্গীত বিষয়ক গ্রন্থ রচনার সময় সত্যেন্দ্রনাথের পরামর্শ নিয়েছিলেন। সাহিত্যপাঠেও তাঁর নেশা ছিল। কথাচ্ছলে

ট্রাজিডির বস্তু ও দর্শন আলোচনা করতে গিয়ে অ্যারিস্টট্‌ল থেকে শুরু করে শীলার, নীট্‌সে, গ্যয়টের বিশদ আলোচনায় চলে যেতেন। হঠাৎ কারো বাড়িতে দীনেশচন্দ্র সেনের 'বৃহৎবঙ্গ' দেখে উল্লসিত হয়ে কবিকঙ্কনের চণ্ডীমঙ্গলের খানিকটা মুখস্থ বলে গেছেন। আশুতোষ কলেজের হলে রবীন্দ্রনাথের মৃত্যুদিন উপলক্ষে সত্যেন্দ্রনাথের মুখে মৃত্যুবিষয়ক দীর্ঘ কবিতার নিখুঁত আবৃত্তি শোনা আমার ছাত্রজীবনের ব্যক্তিগত অভিজ্ঞতা। আবার শ্রীনিকেতনের হলকর্ষণ-উৎসবে আমন্ত্রিত হয়ে গাছ-পালা ও ফলমূলের বাড়-বৃদ্ধি কীভাবে হতে পারে, কোন মাটিকে কীভাবে কোন গাছ লাগাবার উপযুক্ত করে তুলতে হয়, সে সম্পর্কে তাঁর অজস্র তথ্য পরিবেশনের ঘরোয়া ভঙ্গিটি দেখাও আমার ব্যক্তিগত অভিজ্ঞতা।

সত্যেন্দ্রনাথ যতো বড়ো বিজ্ঞানীই হোন না কেন, যতখানি তিনি বিজ্ঞানসাধক, ততোখানিই তিনি জ্ঞানসাধক এবং ততোখানিই তিনি সাহিত্য-শিল্পসাধক। বন্ধু-সঙ্গে তিনি যেমন সপ্রাণ, নির্জনের সাধনায় তিনি তেমনি আত্মমগ্ন।

সজনে ও নির্জনে তিনি ছিলেন সমান দক্ষ। পূর্ণমাত্রায় তিনি ছিলেন সংস্কৃতিমান্।