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Indian connections to Nobel Prizes

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Abstract: This research is an attempt to find out the possible reasons why some great Indian scientists missed the Nobel Prize. There are many great scientists worldwide who have made significant contributions pertaining to science but not received any recognition yet. Human being are always scientifically curious which should never fade away. We should pay due homage to their efforts and success which have helped us to lead a meaningful life.

Keywords: Nobel prize; Science and society; Indian scientists

1. Introduction

The prizes for outstanding accomplishments in physics, chemistry, physiology or medicine, literature and peace which were instituted by Alfred Nobel in 1895 and later on for economics are regarded as a recognition of the highest order achievement [1]. Nobel prize winners have a special status as it include great minds like Albert Einstein, Max Planck, Neils Bohr, Paul Adrien Maurice Dirac, Werner Karl Heisenberg, Erwin Schrödinger, C. V. Raman and Richard Feynman. We attempt at understanding the secret of getting a Nobel by way of knowledge from journalistic pieces and book form (even from former Nobel Laureates).

We should first give up the colonial mindset that everything trend-setting in science comes only from the West. Governments should set up an autonomous Research Excellence Council to exclusively cater to promoting research excellence, with a size-able fund to put this into practice.

A brief outline of the originator of the Nobel and his Will would be appropriate before I come to the topic proper. It will afford a glimpse into his personality, what his Will stresses and what the Nobel stands for and, therefore, what motivates the Nobel Committee to select the one from many potentially worthy recipients.

Fig. 1 Alfred Nobel (1883-1896)

Alfred Nobel [2], in whose name this prize has been instituted, was an interesting and complex personality. He was a bachelor with literary interests, had great energy, ascetic habits, proneness to depressive bouts; he was a pacifist with a pessimistic outlook towards mankind (Frängsmyr, 1966) [3]. Nobel's complex personality puzzled his contemporaries. He had a deep interest in literature and wrote plays, novels, and poems, almost all of which remained unpublished. Among his contemporaries, he had the reputation of a liberal or even a socialist, but he actually distrusted democracy. Though Nobel was essentially a pacifist and hoped that the destructive powers of his inventions would help bring an end to war, his view of mankind and nations was pessimistic. He was, further, a benevolent misanthrope but at the same time a super idealist.

He once wrote: 'I am a misanthrope and yet utterly benevolent, have more than one screw loose yet I am a super-idealist who digests philosophy more efficiently than food'. It was the idealist in him that drove Nobel to bequeath his fortune to those who had benefited humanity through science, literature and efforts to promote peace (Frängsmyr, 1966). It is worthwhile noting here the contents of his will connected with the Nobel Prize: The whole of my remaining realizable estate shall be dealt with in the following way: The whole of my capital, invested in safe securities by my executors, shall constitute a fund, the interest on which shall be annually distributed in the form of prizes to those who, during the preceding year, shall have conferred the greatest benefit to mankind. The said interest shall be divided into five equal parts, which shall be apportioned as follows: one part to the person who shall have made the most important discovery or invention within the field of physics; one part to the person who shall have made the most important chemical discovery or improvement; one part to the person who shall have made the most important discovery within the domain of physiology or medicine; one part to the person who shall have produced in the field of literature the most outstanding work in an ideal direction; and one part to the person who shall have done the most or the best work for fraternity between nations, for the abolition or reduction of standing armies and for the holding and promotion of peace congresses. The prizes for physics and chemistry shall be awarded by the Swedish Academy of Sciences; that for physiological or medical work by the Caroline Institute in Stockholm; that for literature by the Academy in Stockholm, and that for champions of peace by a committee of five persons to be elected by the Norwegian Storting. It is my express wish that in awarding the prizes no consideration whatever shall be given to the nationality of the candidates, but that the most worthy shall receive the prize, whether he be a Scandinavian or not".

2. Great Indian scientists

Out of 10 Nobel prizes connected with India, only 6 have gone to Indian citizens: Rabindranath Tagore in 1913 for literature, C.V Raman in 1930 for physics, Mother Teresa in 1979 for peace, Amartya Sen in 1998 for economic sciences and Kailash Satyarthi in 2014 for Peace [4]. Sixty-year-old Kailash Satyarthi [5] today became the fifth Indian citizen to win the Nobel Prize joining the likes of Rabindranath Tagore, C. V. Raman, Mother Teresa and Amartya Sen in the elite club. The child rights crusader, shared the Nobel Peace prize for 2014 with Pakistani teenager Malala Yousafzai for "their struggle against the suppression of children and young people and for the right of all children to education". He is

Fig. 2 Sir Ronald Ross (1857-1932)

Fig. 3 Sir Jagadish Chandra Bose (1858-1937)

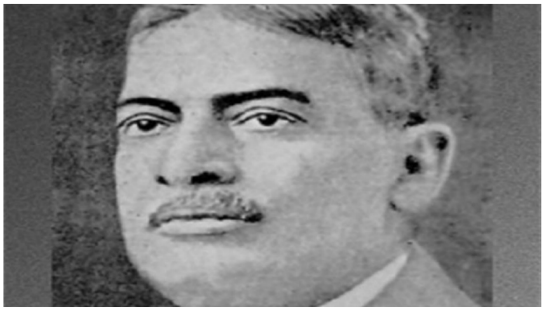

Fig. 4 Sir Upendranath Brahmachari (1873-1946)

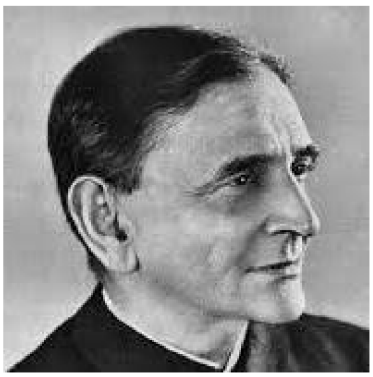

Fig. 5 Debendra Mohan Bose (1885-1975)

Fig. 6 C. V. Raman (1888-1970)

Fig. 7 Meghnad Saha (1893-1956)

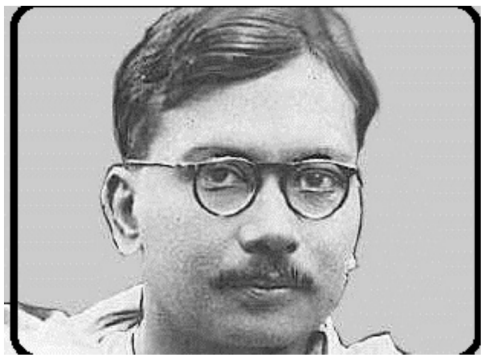

Fig. 8 Jnan Chandra Ghosh (1894-1959)

Fig. 9 Satyendra Nath Bose (1894-1974)

Fig. 10 Subrahmanyan Chandrasekhar (1910-1995)

Fig. 11 Har Gobind Khorana (1922-2011)

the first India-born activist to win the Peace Nobel. Sir Ronald Ross, born in Almora, India, North West of Nepal, was a British medical doctor who received the Nobel Prize for Physiology or Medicine in 1902 for his work on the transmission of malaria. He is the first Indian Nobel lauteate in medical science. One can debatably add R. K. Pachauri, who was Chair of the Intergovernmental Panel on Climate Change, which got the Peace prize in 2007. If one think of Nobel Laureates of Indian origin or settlement, one could add Subrahmanyan Chandrasekhar for Physics in 1983, Har Gobind Khorana (an American of Indian origin) for Physiology or Medicine in 1968 and Abhijit Vinayak Banerjee in economic sciences in 2019. One could debatably also add V. S. Naipaul's Nobel for Literature in 2001, since his forefathers came from India.

Ten Nobel prizes, having a near or distant connection with India and eight Nobel prizes, having a near or distant connection with psychiatry. It is heartening that the number has gone up by 1 for India and 3 for psychiatry-allied branches in 2014. Is it not intriguing, however, that the number of Nobel that India has produced as an area and psychiatry and allied branches have produced as a discipline is much the same? And if we were to see how many mainstream psychiatrists have got the Nobel, it is just two: Wagner-Jauregg way back in 1927, and Kandel in 2000, and if we were to see how many Indian citizens working from India have got the Nobel in Medicine, it is none.

C. V. Raman won the Nobel Prize in Physics in 1930 for the discovery of the Raman effect. He once said that although scientists are claimed as nationals by one or another of many different countries, yet in the truest sense, they belong to the whole world". Raman studied physics in India and got his degrees from the University of Madras. He did not follow the usual route of Indian scholars and go to Britain to get a PhD degree. He worked in a government office and in 1917 accepted a physics professorship at the University of Calcutta. He and his associate, K. S. Krishnan, observed a phenomenon of light scattering, first with their naked eyes, later with some optical instruments. They communicated the discovery in 1928. Legend has it that as soon as Raman had submitted the manuscript on the new effect for publication, he booked his passage to Stockholm from Calcutta for the following December. This is believable to the extent that

Raman was known to be self-confident and that his Nobel recognition followed his discovery with unusual speed. Raman was Indian and India could rightly claim him. Many of the Nobel laureates, however, migrated from their native lands, often changing countries more than once. This migration comes naturally to scientists, even under the most peaceful and ordinary conditions. Since the Second World War, too, The Nobel Prize and national politics there has been a steady migration of scientists responding to the pull of better research and economic opportunities afforded primarily in the United States and Western Europe.

It sometimes happens that nationalism, however benevolent, creeps into a nomination. In an unsuccessful nomination for the Nobel Prize in Chemistry for 1939, N. R. Dhar of Allahabad, then in India, sent a letter to the Nobel Committee proposing the Frenchman Georges Urbain for his excellent researches on rare earth chemistry. Following a description of Urbain's achievements in chemistry, Dhar notes that Urbain is the doyen of French chemistry and a real gentleman. In Dhar's time his expressions raised fewer eyebrows than they would today. Frederick Sanger is the only person to have received two Nobel Prizes in chemistry, in 1958 and 1980. A few years before, the American Chemical Society's Chemical C Engineering News conducted a poll for its 75th anniversary to establish an international list of 75 people who, during the past 75 years, had contributed most to chemical enterprise. Curiously, the British Sanger did not make that list of 75, even though the poll targeted chemists only.

It is a delicate question whether the authorities in any country are willing to actively help their scientists receive a Nobel Prize. Lobbying may be done with taste and honest means, though nobody is eager to go on record about what activities may be carried out in this respect. Recently, a noted science historian in Budapest was invited to prepare a report on whether it was feasible to facilitate creating another Nobel laureate in Hungary.

A large number of great Indians who did not receive the Nobel Prize include the names of Jagdish Chandra Bose, Sir Upendranath Brahmachari, Debendra Mohan Bose, Sir Jnan Chandra Ghosh, Satyendra Nath Bose, Meghnad Saha, G. N. Ramachandran and E. C. G. Sudarshan. Apart from them in medical science [11], Mahendralal Sarkar, Gopal Ray, Nilratan Sarkar, Gopal Chandra Chattopadhyay are some notable names.

Jagdish Chandra Bose was born on 30.11.1858 at Mymensinghin (now in Bangladesh) located in the Bengal Province of British India and was fortunate enough to have education at Cambridge (B.A.) and London(B. Sc.) and received the exposure to science which was fast altering the face of western civilization even though British colonial power had no interest in nurturing science in India. Bose having the heritage of ancient Indian civilization with its multi faceted accomplishments could easily absorb the spirit of science and pursued it at Presidency college, Calcutta after returning to India. Initially he faced some discrimination but his exceptional talent as a teacher and scientist was too overwhelming and was eventually given due recognition.

Bose's research works are mainly in two areas: (i) electromagnetic waves, their transmission and reception and (ii) nature of life process present in plants. His pioneering breakthroughs in both these are outstanding. However, in this article will confine ourselves to the former. Over the years, fortunately, the scientific community seems to have got the historical records right. In 1998 IEEE (institution of Electrical and Electronics Engineers) accepted that it was J. C. Bose who invented

the mercury drop coherer which was used by Marconi. Maxwell's equations had predicted electromagnetic waves and their generation in different frequencies and application was a hot priority area of work. As far as Bose's work is concerned, the following facts are known: In 1895 at Presidency college Bose ignited gun powder and rang a bell kept at a reasonably large distance using the electromagnetic wave signaling and thus demonstrated for the first time that communication could be sent through electro-magnetic waves. He was vehemently against making money out of his researches and had no hesitation in generously sharing the path breaking works that he did. He introduced the best research attitude to his generation of Indians. For them, he represented the spirit of old selfless rishis of India whose teachings and insights are open to all willing to accept it. Unlike Marconi who sought commercialize his work on radio waves, Bose was interested in all his researches purely as a scientific endeavor in quest of nature. In 1899 he announced his invention of iron-mercury-iron coherer (transmitter) in a paper submitted to Royal Society. Bose's demonstration of wireless signaling has priority over that of Marconi. The period 1894-1900 was very productive years for Bose. He performed pioneering research in radio transmission and mm range microwaves. He designed equipment for radio wave transmission and reception and also studied the wave properties of reflection, refraction and polarization. Based on his experiments with galena he developed a type of semi conductor diode useful for detection of cm range electromagnetic waves. In spite of these, it was Guglielmo Marconi and Carl Ferdinand Braun who were awarded 1909 Nobel prize in physics for their contributions for the development of wireless telegraphy. It may be noted that in 1896 both Bose and Marconi were in London and had interactions. Over the years, fortunately, the scientific community seems to have got the historical records right. In 1998 IEEE (Institution of Electrical and Electronics Engineers) accepted that it was J. C. Bose who invented the mercury drop coherer which was used by Marconi. Bose also holds the first patent for the solid state detector based on galena crystal and was the first to use a semiconducting junction to detect mm length microwaves. His pioneering work on microwaves was acknowledged by great physicists like Lord Kelvin and Lord Rayleigh. In a book by O. E Dunlop Jr. titled "Marconi-the Man and His Wireless" and edited by Marconi himself, full one and a half page was devoted in tribute to Sir Jagdish Chandra Bose for providing crucial support to Marconi at the critical juncture when Marconi needed it most [6]. Many of the instruments designed by Bose are still on display at Bose Institute, Kolkata and largely in usable condition. They include antennas, polarizers and wave guides. Neville Francis Mott, who received Nobel Prize in 1977 for his work on solid state electronics remarked that "J C Bose was at least 60 years ahead of his time ... In fact he had anticipated the existence of P-type and N-type semiconductors".

J. C. Bose [7] was an example of the best in Indias spiritual tradition. He was vehemently against making money out of his researches and had no hesitation in generously sharing the path breaking works that he did. Reflecting on his works on life in plants he felt that he experimentally substantiated the Hindu belief that whole universe was an aspect of the Eternal One. He introduced the best research attitude to his generation of Indians. For them, he represented the spirit of old selfless rishis of India whose teachings and insights are open to all willing to accept it. Unlike Marconi who sought commercialize his work on radio waves, Bose was interested in all his researches purely as a scientific endeavor in quest of nature. Satyendra Nath Bose (1894-1974) was a Kolkata born physicist and he and the

other great Bengali physicist M. N. Saha studied together at Calcutta university and respectively ranked first and second in their M.Sc. examination. Both were students of Jagdish Chandra Bose and it is like one lighted a candle triggering the lighting of other candles. Both Bose and Saha were highly motivated young men who were excited by the revolution taking place in physics triggered by In sharp contrast to the attitude of Drona, Einstein immediately realized that Boses paper was an important step forward in understanding the general quantum behavior of particles . He himself translated it into German and got it published in the famous German research journal Zeitschrift für Physik (Vol 26, 178-181, 1924) and elaborated the ideas further to formulate what is now known as Bose Einstein statistics relativity and quantum hypothesis. In fact the first English translation of Einstein's relativity papers were by Bose and Saha. After serving some years at Calcutta university, in 1921 Bose joined Dacca university (now in Bangladesh) as a lecturer. At that time Planck's quantum hypothesis was well accepted but quantum mechanics was yet to emerge. It was the era of old quantum theory. While studying the black body radiation as photon gas, Bose used a counting procedure (statistics) for the gas constituents (photons) different from the then well known Maxwell-Bolizmann statistics which to his surprise and excitement gave the correct radiation intensity distribution discovered by Planck. He had difficulty in getting this new derivation published and hence decided to request the great Einstein for help in its publication. Like Ekalavya of Mahabharata who considered Drona as his guru, Bose was considering himself as a humble disciple of the 'revered master' that Einstein was. But the irony of it all is that in spite of this revolutionary work, Bose is not a Nobel Laureate even though he was nominated for it! Einstein immediately realized that Bose's paper was an important step forward in understanding the general quantum behavior of particles. He himself translated it into German and got it published in Abraham Pais who has written an authoritative biography of Einstein considers Bose's paper as the fourth and last revolutionary papers of old quantum theory. The other three are by Planck, Einstein and Bohr. Thus Bose belongs to the exalted group of Bose, Einstein, Fermi and Dirac on one hand and equally formidable company of Planck, Einstein and Bohr. But the irony of it all is that in spite of this revolutionary work, Bose is not a Nobel Laureate even though he was nominated for it! [German research journal Zeitschrift für Physik (Vol. 26, 178-181, 1924)]. His ideas formulated now what is now known as Bose-Einstein statistics. In fact this work is the origin of quantum statistics dealing with Bose-Einstein statistics for bosons integer spin, i.e., 0, 1 ,..spin particles) and Fermi-Dirac statistics for fermions (half integer spin , i.e., 1/2.3/2,.. spin particles). Astrophysicist J. V. Narlikar considers this as an achievement in the Nobel Prize class. Abraham Pais who has written an authoritative biography of Einstein considers Bose's paper as per of old quantum theory. The other three are by Planck, Einstein and Bohr. Thus Bose belongs to the exalted group of Bose, Einstein, Fermi and Dirac on one hand and equally formidable company of Planck, Einstein and Bohr. But the irony of it all is that in spite of this revolutionary work, Bose is not a Nobel Laureate even though he was nominated for it! Bose Einstein statistics has a crucial role in the governing principle of lasers, superfluid quantum systems, superonductivity and Bose-Einstein condensates. In fact more than one Nobel prizes were awarded for research related to the concept of Boson and the latest one was in 2001 for the discovery of Bose-Einstein condensates. Boses work stands out as one of the corner stones of the way we understand the micro world

and quantum phenomena. Every student of physics learns about bosons which is the most lasting honor for his memory and achievements.

Rai Bahadur Sir Upendranath Brahmachari [8] was an Indian scientist and a leading medical practitioner of his time. In 1909 he developed a scientific method to estimate the amount of haemoglobin in the resistant corpuscles. He discovered pentavalent antimonials, Urea Stibamine (carbostibamide) in 1922 and determined that it was an effective substitute for the other antimony-containing compounds in the treatment of Kala-azar (Visceral leishmaniasis) which is caused by a protozoon, Leishmania donovani. The drug effectively countered the epidemic of kala-azar which was prevalent during the late twentieth century in the vast track of the Gangetic plain and the Brahmaputra valley. He was rightly nominated for the Fellowship of the Royal Society of London, as well as Nobel Prize. He never received international support and even within India, his nominators were only from Calcutta, as a result he could not receive the Nobel prize in medicine.

D. M. Bose [9] was an undoubtedly an exceptional physicist and contemporary scientists who shared comparable international and national reputation in his lifetime. His life and works are less discussed and known to people today. He has made well-known contributions in the field of cosmic rays, artificial radioactivity and neutron physics. During his work in England and Germany, he came in contact with many reputed physicists of that time like Max Planck, Albert Einstein, Peter Debye, Walther Nernst, Heinrich Hertz and Max Born. Much less is known about the work of D. M. Bose and his colleague Bibha Choudhuri, who missed the Nobel Prize for discovering the mu-meson, due to lack of access to modern scientific tools. Nobel prize in 1950 went to C. F. Powell for his development of the photographic method of studying nuclear processes and his discoveries regarding mesons made with modern technology. In his book "The Study of Elementary Particles by the Photographic Method", Powell has rightly acknowledged that the method developed by Bose and Choudhuri in 1941 on distinguishing between tracks of proton and meson in an emulsion was inevitably the first attempt and commented that "the physical basis of their method was correct and their work represent the first approach to the scattering method of determining momenta of charged particles by observation of their tracks in emulsion".

Sir Jnan Chandra Ghosh [10] can be rightly considered as one who tried to make the country a better place to live in through his dedicated services in science and technology. He is remembered for his research on the theory on strong electrolytes which was proposed in 1918. He also made significant contributions in kinetics, fluorescence, catalysis, auto-oxidation and other allied branches. He also made pioneering investigations in areas like the Fischer-Tropsch synthesis for obtaining liquid fuel from carbon monoxide and hydrogen and step-wise mechanism of ammonia synthesis from its elements, nitrogen and hydrogen. Ghosh played a very important role in shaping science and engineering education in the country and should have deserved the Nobel prize in chemistry.

Satyendra Nath Bose citef4 pointed out that Planck's formula for the distribution of energy in the radiation from a black body was the starting point of the quantum theory, which has been prevalent during the last 20 years and has fruitful in every domain of physics. Bose's early scientific interest had been aroused by reading Einstein's papers on relativity. When he arrived in Berlin, Einstein had already published his research on a unified field theory. Einstein later extended Bose's method to establish the quantum theory of a monoatomic ideal gas. He

developed the theory in three communications to the Prussian Academy in Berlin on 10 July 1924, 8 January 1925 and 29 January 1925, respectively. Einstein also extended Bose's method of treating light-quanta to material particles. At Dacca University Bose kept up an interest in experimental physics, especially the studies of thermoluminescence and crystal structure.

Meghnad Saha [12] was born on the 6th October 1893 in a village named near Dhaka. He belonged to very poor backward community and had to struggle before he could come to eminence. Fortunate circumstances helped him to get good education and he was a class fellow of S. N. Bose at Presidency college. Before shifting to Allahabad university in 1923 he was working in Calcutta. There in 1920 he formulated the famous theory of ionization and equation bearing his name which is a major achievement crucial in understanding stellar structure and evolution. That both S. N. Bose and M. N. Saha could incorporate correct quantum mechanical concepts in their theories even before the formal advent of quantum mechanics speaks highly of their physical insight. Saha's theory deals with high temperature ionization of elements and its application to stellar atmosphere. His theory and subsequent developments led to detailed study of stellar spectra and knowledge of pressure and temperature distribution in stellar atmosphere. In his book Theoretical Astrophysics (Oxford University Press 1939) Professor S. Rosseland writes: "The impetus given to astrophysics by Saha's work can scarcely be overestimated, as nearly all later progress in this field has been influenced by it and much of the subsequent work has the character of refinement of Saha's idea". Narlikar considers that Saha's work belongs to Nobel class. Saha is equally well known for his sustained efforts in nurturing research in physics. During his leadership the physics department at Allahabad became well known for its academic excellence. He was the leading light in organizing scientific societies like National Academy of Sciences, Allahabad, Indian Physical Society, and Indian Association for Cultivation of Science. He continued to diversify his areas of interest and has trained or inspired a large number of physicists. His greatest contribution to the cause of Indian Science is the establishment of Institute of Nuclear Physics at Kolkota in 1943 presently known as Saha Institute of Nuclear Physics run by the Department of Atomic Energy and has evolved as a prominent center of physics research in India. He was an architect of river planning and played a critical role in reforming the traditional Indian calender. He was a social activist and was a member of Indian Parliament. He died when he was 63 but fully active in his multifarious academic and social activities till the end Saha's theory deals with high temperature ionization of elements and its application to stellar atmosphere. His theory and subsequent developments led to detailed study of stellar spectra and knowledge of pressure and temperature distribution in stellar atmosphere.

Gopalasamudram Narayanan Ramachandran [13] was born on 8.10.1922 at Ernakulam, Kerala and studied for his B.Sc. at St Joseph's college, Tiruchi. In 1942 he moved to Indian Institute of Science, Bangalore to study electrical engineering. Sir C. V. Raman spotted the research. It is said that he told the chairman of the department of electrical engineering that I am admitting Ramachandran into my department as he is a bit too bright to be in yours". Ramachandran is perhaps the most distinguished of Raman's students. He obtained his D.Sc. from IISc also later a Ph.D. from Cambridge. Soon the then famous Vice-Chancellor of Madras university spotted Ramachandran's potential and appointed him as professor and head of physics department when he was just 30. World renowned works of Ra-

Fig. 12 Gopalasamudram Narayanan Ramachandran (1922-2001)

machandran were accomplished at Madras. At IISc Ramachandran had become an expert in X-ray diffraction techniques and this was being applied at that time to a wide variety of bio-molecules. Ramachandran's works bring together the fields of molecular biophysics, X-ray crystallography, peptide synthesis, NMR and other optical studies. He (along with his students) is most widely known for discovering triple helix structure of collagen-most abundant protein of connective tissues in 1955 and his analysis of allowed conformations of proteins through the use of what are known as 'Ramachandran plots' was published in the Journal of Molecular Biology in 1963. These rank among the most outstanding works on structural biology along with the other two famous works namely alpha helix structure folded polypeptides discovered by Linus Pauling and double helix structure of DNA discovered by Watson and Crick. It is remarkable that Ramachandran's works were carried out in India facing all the problems associated with Indian science. In this sense, he is a true successor to C. V. Raman's legacy. Ramachandran was clearly a Nobel class' scientist who did not get entry into this class. His works are text book material in the area of structural biology and molecular biophysics. However, in 1999 the international scientific community made some amends to this omission. The Edwald Prize (1999) of the International Union of Crystallography was awarded to G. N. Ramachandran for his outstanding contribution in the field of crystallography, in the area of anomalous scattering and its use in the solution of the phase problem, in the analysis of fibres, collagen in particular and foremost for his fundamental work on the macromolecular conformation and the validation of macromolecular structures by means of Ramachandran Plot" which even today remains the most useful validation tool'. Ramachandran returned from Madras (Chennai) to IISc in 1971 and led a new department which has evolved as a important center for research in structural biology. During his last years he suffered from Parkinsonisim and died on 7.4.2001 at the age of 78.

Ennakkal Chandy George Sudarshan [14] was born on 16.9.1931 at Pollam, Kottayam district of Kerala. He did his M.Sc. from Madras university (1952) and Ph.D. from University of Rochester, New York in 1958. His academic career is mostly in USA and he is at the University of Texas at Austin since 1969. Sudarshan is undoubtedly the most accomplished and renowned living theoretical physicists of Indian origin and has prodigious creative output. His research interests span the fields of particle physics, quantum optics, quantum field theory,

Fig. 13 Ennakkal Chandy George Sudarshan (1931-2018)

quantum information theory, gauge theories, and classical mechanics. He has deep interest in Vedanta philosophy and spirituality worked as Director of Institute of Mathematical Sciences at Chennai for over five years during 1980's. No doubt, he is the most accomplished and renowned living theoretical physicists of Indian origin and has prodigious creative output. His research interests span the fields of particle physics, quantum optics, quantum field theory, quantum information theory, gauge theories, and classical mechanics. He has deep interest in Vedanta philosophy and spirituality. He was nominated to Nobel prize several times but the coveted honor has eluded him so far. He together with Robert Marshaks, invented in 1957 of what is known as the V-A theory of weak interaction. Around the same time Gell-Mann and Feynman also published similar work. In fact, Sudarshan and Marshak narrowly missed the full credit for this important work which clearly belongs to Nobel class because of some delay in the publication of their work in a regular research journal. This theory eventually evolved as electro weak theory of weak interactions developed by Sheldon Glashow, Abdus Salam and Steven Weinberg. They were honored with Nobel prize in 1979.

In 1960's Sudarshan put forward the theory of tachyons-conjectured particles which have speeds larger than the speed of light in vacuum. Most of the journals were initially reluctant to publish novel idea but eventually it got the attention of a number of physicists and much work was done. However tachyons have remained elusive experimentally. If and when they get discovered it will completely change our conception and understanding of the universe and can also have several potential applications. The idea of tachyon was a revolutionary concept within the framework of special theory of relativity. He developed the quantum representation of coherent light which is being referred to in literature as Sudarshan-Glauber representation. It is said that original idea of coherent representation of light beams is due to Glauber However, the diagonal representation' discovered by Sudarshan is a far reaching result which showed the general equivalence of classical and quantal descriptions of all states of light field and is of wider validity. The mathematical equivalence is now referred as the Optical Equivalence Theorem' and is a very fundamental result in modern optics. In fact Sudarshan's diagonal representation forms the starting point of later developments in quantum optics.

Sudarshan developed formalism called dynamical maps which is a fundamental work in the theory of open quantum systems. In collaboration with B. Mishra

he has proposed in 1977 what is known as quantum zeno effect. It predicts an interesting result that an unstable particle, if subjected to continuous observation, will never decay. Quantum zeno effect corresponds to the limiting behavior of an unstable quantum system when subjected to infinitely strong coupling to environment. In 1989 there was a report of the experimental confirmation of quantum zeno effect by W. Itano and collaborators. The 2005 Nobel Prize given to Glauber for the contribution to the quantum theory of optical coherence ignoring the seminal contributions of Sudarshan has caused much anguish among physicists who are admirers of Sudarshan's contributions to physics in general and quantum optics in particular. A number of physicists from India and abroad have expressed their concern and dismay to the Nobel committee regarding this. Sudarshan himself has put forward his forthright opinion to the Nobel committee in a letter. A section of the letter (taken from Frontline Vol 22, Issue 24 Nov 19-Dec 02, 2005) reads: "It is my belief that the Royal Swedish Academy was impartial and that to assure the proper priorities it has a Committee in Physics, with members competent to examine and understand the published work. It was also my belief that the members of the Committee did their work diligently and with care. I am therefore genuinely surprised and disappointed by this year's choice. It would distress many others and me if extra scientific considerations were responsible for this decision. It is my hope that these glaring injustices would be noted by the Academy and modify the citations. Give unto Glauber only what is his. Sincerely yours E. C. G. Sudarshan".

5. Concluding remarks

Undoubtedly the eight cases discussed above concern Indian scientists who carried out outstanding work deserving Nobel Prize. The researches of all of them except Sudarshan were carried out in India. The works of Jagdish Chandra Bose, Sir Upendranath Brahmachari, Debendra Mohan Bose, Sir Jnan Chandra Ghosh, Satyendra Nath Bose and Meghnad Saha were done during colonial period and lack of resources and modern facilities during that time.

One may suspect that Nobel prizes which epitomize the achievement of excellence as per the vision and norms of western civilization are hard to win by scientists from other nations, particularly from third world countries, in spite of the fact according to "Nobel's will" in awarding the prizes no consideration be given to the nationality of the candidate. There would have been numerous deserving Nobel Laureates if the entire history of India is taken into consideration. It is generally believed that to be worthy of the prize, scientists from India have to stand out distinctly much above his western counterpart. But such a view is perhaps too simplistic. Even in the western world there have been a number of cases where Nobel prizes were not awarded to very deserving cases. Confining only to physics, some of the glaring omissions (not in any particular order) are: Thomas Alva Edison (Inventor of many gadgets including telegraph, movies,electric bulb etc), Thomas Tesla (Electromagnetism), Lise Meitner (nuclear fission), Chien-Shiung Wu (Parity non-conservation), Yuval Ne'eman (Particle physics), George Zweig (quark composition of particles), Fred Hoyle (Astrophysics), Jocelyn Bell Burnell (Radio pulsars), George Gamow (Theory of Cosmic Microwave Background radiation), Freeman Dyson (quantum field theory), Robert Oppenheimer (Theoretical physics), Sidney R. Coleman (Particle physics).

The debate as to why most Indian Scientists missed the Nobel is left open to all audiences and Indians at large. Let's hope for a better world where scientist's shall be properly judged as they spent most of their times for the welfare of people and always try for a better improvement and quality of life.

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