STM JOURNALS

OmniScience: A Multi-disciplinary Journal
ISSN: 2231-0398 (Online), ISSN: 2347-9949 (Print)
Volume 7, Issue 1
www.stmjournals.com

Homi J. Bhabha: Physics Nobel Prize Nominee and Nominator

Rajinder Singh[1], Hardev Singh Virk[2,*]
[1]Institute of Physics, Research Group Physics Education and History of Science, University of Oldenburg, Oldenburg, Germany
[2]Professor of Eminence, Punjabi University, Patiala, Punjab, India

Abstract

Homi J. Bhabha (30 October 1909–24 January 1966) is known as "Father of the Indian Nuclear Programme". He was the founding director of the Tata Institute of Fundamental Research (TIFR), Bombay in 1945 and then became Director of Atomic Energy Establishment (now called BARC) at Trombay and Secretary, Department of Atomic Energy, Govt. of India in 1954. Homi J. Bhabha was one of the most accomplished scientists who excelled in both theoretical and experimental physics, as well as in science administration. According to the record of the Nobel Foundation, until 1964 only five Indians were nominated for the Physics Nobel Prize, and 10 were asked to nominate candidate/s. H.J. Bhabha, well-known for his work on nuclear physics and cosmic rays, belongs to the list of nominators and nominees from India. The documents, such as nomination letters and report of the Nobel Committee (N.C.) were obtained from the Archive of the Royal Swedish Academy of Science, Stockholm. The result of their analysis is given in this article.

Keywords: *Homi J. Bhabha, physics nobel prize, cosmic rays, meson, FRS*

****Author for Correspondence*** E-mail: hardevsingh.virk@gmail.com

INTRODUCTION

Seen in the Nobel Prize context, India's first nominator for the Nobel Peace Prize was Lady Tata, National Council of Women in India. In her letter of Dec. 23rd, 1930, she nominated Lady Aberdeen, The Marchioness of Aberdeen and Temair, President of the International Council of Women. From the Tata family, Homi J. Bhabha, a physicist, was the next person, who was nominator and nominee for the Physics Nobel Prize. H.J. Bhabha is a well-known figure in India. Not surprisingly various aspects of his life and scientific work are given by different authors [1]. To start with, it may be mentioned that the present article is based on our different articles, which deal with Bhabha's life and his nomination for the Nobel Prize.

Homi J. Bhabha: A Short Biography

Homi Jehangir Bhabha was one of the most accomplished scientists who excelled in both theoretical and experimental physics, as well as in science administration. Lord Redcliffe-Maud pays his tribute to Bhabha in the following words: "He stood out as a world citizen qualified in all three subjects - education, science and culture [2]."

Bhabha was born on 30th Oct. 1909. In 1927, he joined Caius College, Cambridge. He went to Cambridge at the young age of 18 to study Mechanical Engineering but his love for Physics was ignited in Cambridge University which is revealed by his letter written in 1928 to his father: "I am burning with a desire to do Physics. I will and must do it some time. It is my only ambition. I have no ambition to be a 'successful' man or head of a big firm."

Bhabha was impressed by P.A.M. Dirac who was at Cambridge during the same period. In 1930, he did Tripos in Mechanical Engineering. He joined the Cavendish Laboratory in Cambridge from where he obtained his Ph.D. in theoretical physics in 1935. As a young scholar, he visited and worked with renowned physicists like Wolfgang Pauli in Zürich, Enrico Fermi in Rome and Hendrik A. Kramers in Utrecht, Niels Bohr in Copenhagen [3]. In 1933, during his stay in Zürich he wrote his first scientific

© STM Journals 2017. All Rights Reserved

paper for a German journal *Zeitschrift für Physik* [4]. After about a 12 years stay in Europe he returned to India in 1939 and joined as Reader at Indian Institute of Science or IISc Bangalore (popularly known as Tata Institute). In 1942, he was made professor at the IISc.

In 1945, he founded the Tata Institute of Fundamental Research (T.I.F.R) in Bombay. He invited well-known physicists to deliver lectures and established theoretical physics. Bhabha's close contact with India's Prime Minister J.L. Nehru lead to his appointment as the Chairman of the Atomic Energy Commission, and later as the Secretary of the Department of Atomic Energy, Govt. of India. This gave him dictatorial powers over and above the other Ministers of government establishment. H.J. Bhabha occupied higher positions on international level, such as President, United Nations Conference on the Peaceful Uses of Atomic Energy, Geneva, and President, International Union of Pure and Applied Physics. Due to plane crash on Mount Blanc in Switzerland, Bhabha died on Jan. 24, 1966.

BHABHA'S THEORETICAL WORK ON COSMIC RAYS

H.J. Bhabha, N. Bohr and Coining the Term "Meson"

Bhabha's first paper on: "Zur Absorption der Höhenstrahlung" (The absorption of high altitude rays) was based on the work done under the guidance of Wolfgang Pauli at Zürich in Switzerland. In this article, he gave the explanation for electron shower production in cosmic rays [5]. In 1935, Bhabha wrote a paper, which was aimed to discuss the creation of electron pairs caused by the collision of the particles, which move at nearly the speed of light. He found out: "The effective cross-section for the pair creation by fast protons in the lead is more than a thousand times larger than the cross-section for pair creation by slow protons calculated by [W.] Heitler and [L.] Nordheim" [6].

So far as the scientific publications and their standard are concerned, the most creative period of Bhabha's life was in Europe. Between 1933 and 1938 he published 15 articles [7]. The most important of them were: "The scattering of positrons and electrons with exchange on Dirac's theory of the positrons [8]", "The passage of fast electrons and the theory of comic shower [9]", and "On the theory of heavy electrons and nuclear forces [10]." In a short letter to "Nature" [11], he pointed out that the lifetimes of fast, unstable cosmic rays particles would be increased because of the time-dilatation effect that follows as a consequence of Einstein's special theory of relativity. The verification of this effect by means of cosmic rays experiments gave the most straightforward experimental evidence supporting special relativity [12]. H.J. Bhabha and Walter Heitler gave a theory to explain the production of particles, which come into play due to the interaction of cosmic rays with the upper atmosphere of the earth [13].

Mesotron or Meson: It was known that nucleus of an atom consists of protons and neutrons. In order to explain the interaction between these particles, Werner Heisenberg, Germany, and Enrico Fermi, Italy, proposed theories. However, the energy calculated by their methods was too small to account for the binding energy of the nucleus. To solve the problem, in 1935, the Japanese theoretical physicist, Hideki Yukawa, proposed a field of force, accompanied by 'a new sort of quanta' with mass 200 times that of an electron's. He suggested: "The massive quanta may also have some bearing on the shower produced by the cosmic rays [14]." In the U.S.A, S.T. Neddermeyer and C.D. Anderson reported to have had observed particles with electron mass 240. They named them as mesotrons [15].

Bohr in his address at the British Association for the Advancement of Science called it as "yucon". Americans were not happy with it as they thought "mesotron" (intermediate) is the most appropriate name. Robert A. Millikan wrote a letter to Bohr about his views. Bohr's reply was published in the "*Physical Review"* as follows: "I take pleasure in telling you that everyone at the small conference on cosmic-ray problems, including [P.] Auger, [P.M.S.] Blackett, [E.] Fermi, [W.] Heisenberg, and [B.B.] Rossi, which we have just held in Copenhagen, was in complete agreement with Anderson's proposal of the name 'mesotron' for the penetrating cosmic-ray particles [16]."

Bhabha wrote to Bohr that in his paper to "*Nature"*, he had called the new particle meson. Dirac and other physicists in Cambridge find 'meson' better than 'mesotron'. But if he (Bohr) does not agree with the name meson, Bhabha was willing to change the name in mesotron. The change can be made in proof (Bhabha H.J. to Bohr N., Dec. 17, 1938). Bhabha's paper was published in February 1939 under the title "The fundamental length introduced by the theory of the mesotron (meson)". In the footnote Bhabha wrote: "The name 'mesotron' has been suggested by Anderson and Neddermeyer (…) for the new particle found in cosmic radiation with a mass intermediate between that of electron and proton. It is felt that 'tr' in this word is redundant, since it does not belong to the Greek root 'meso' for middle, the 'tr' in neutron and electron belong, of course, to the roots, "neutr" and "electra". In these circumstances, it seems better to follow the suggestion of Bohr and to use electron to denote particles of electronic mass independently of their charge. It would therefore be more logical and also shorter to call the new particle a meson instead of mesotron [17]."

In the letter of December 17, 1938 Bhabha had informed Bohr about the footnote. Due to support from influential European physicists, Bhabha's baptism of the new particle was accepted. H.J. Bhabha's article using the term meson was sent on December 17, 1938, and published on Feb. 18, 1939 [18]. This leaves no doubt that Bhabha was the first to coin the term meson (Figure 1).

Fig. 1: *Homi J. Bhabha and Niels Bohr – 1960 (Courtesy: Tata Institute of Fundamental Research, Bombay).*

In 1946, it came out that the particle observed by the Americans "was not the particle predicted by Yukawa as the mediator of nuclear forces, but was instead almost completely unreactive in a nuclear sense [19]." Today we call the "mesotron" a "muon [20]."

BHABHA AND FELLOWSHIP OF THE ROYAL SOCIETY OF LONDON

Regarding Bhabha's nomination for the Fellowship of the Royal Society of London, C.V. Raman communicated with the renowned theoretical physicist Paul A.M. Dirac and sent the scientific record of Bhabha for his opinion to know whether he (Dirac) would agree to support this candidature (Raman C.V. to Dirac P.A.M., July 20, 1940). After getting Dirac's consent, Raman sent Bhabha's certificate to the former and requested him to sign it as a "Seconder" as well as to get support from the other two Fellows (Raman C.V. to Dirac P.A.M., Oct. 25, 1940). In the same letter he informed P.A.M. Dirac that Max Born and Marcus L.E. Oliphant had agreed to support Bhabha's election.

On Raman's request, K.S. Krishnan and B. Sahni signed Bhabha's certificate (Krishnan K.S. to Sahni B., Oct. 20, 1940). Bhabha's nomination certificate in part reads: "… has contributed notably to our understanding of cosmic ray bursts by the penetrating component, and the radioactive decay of mesons. He has made important contributions to the theory of mesons and nuclear forces and has recently extended Dirac's classical theory of radiating electrons to spinning particles and meson fields. Has indicated the theoretical grounds for the probable existence of protons with multiple charges" (Document - Ref. No. EC/1941/02, Archive: Royal Soc. London). Bhabha was elected as F.R.S. in 1941.

BHABHA'S NOMINATION FOR THE NOBEL PRIZE BY JACQUES HADAMARD

Between 1933 and 1966, Bhabha published 81 articles; out of them 21 with co-authors. After 1950 most of his publications were in the form of popular lectures and science policies [21]. Bhabha was nominated for the Physics Nobel Prize for the years 1951 and 1953–1956. Surprisingly none of his contact persons ever

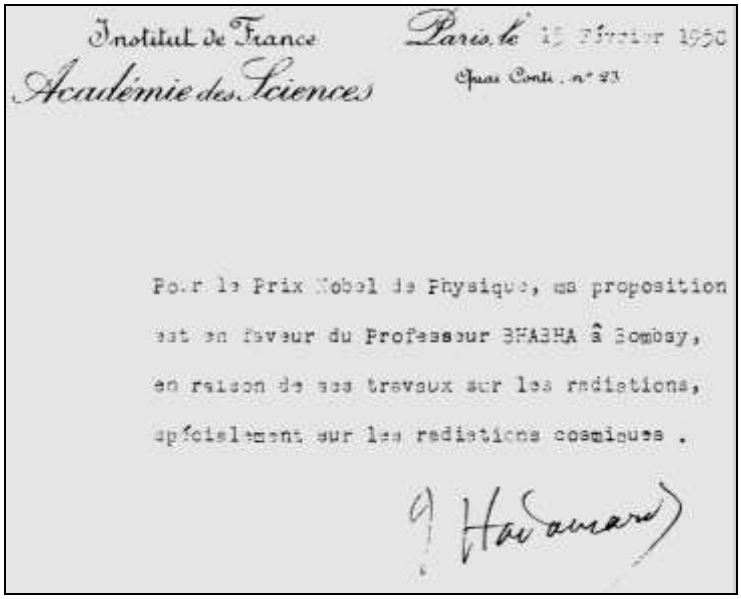
nominated him, except Jacques Hadamard - a Mathematician from the "Institut de France." In a short letter dated Feb. 15, 1951, he proposed Bhabha for his work on radiation, in particular the cosmic rays (Hadamard J. to N.C., Feb. 15, 1950). Unfortunately, the letter was sent after the deadline. Next time, Hadamard sent a nomination letter in favour of Bhabha (Physics Nobel prize) and L. Pauling (Chemistry Nobel prize) (Hadamard J. to N.C., Sept. 29, 1950).

The third proposal followed on October 8, 1952. He repeated the proposal from 1951 (Hadamard J. to N.C., Oct. 8, 1952). In the fourth, undated letter in January 1954, he stressed Bhabha's contribution to cosmic rays research and its relevance to nuclear physics. The next two nominations were similar as in the previous years (Hadamard J. to N.C. in Oct. 10, 1954) [22].

Hadamard's four proposals reached in time. However, they did not fulfil one of the important conditions, namely, proposals with evidences. These evidences can be long letters arguing the case of the candidate. It may include the importance of work for the development of a scientific field. Nominator can support his case by sending the list of publications. For instance for the Nobel prize for the year 1930, C.V. Raman's nominators E. Rutherford and C.T.R. Wilson who on January 25, 1930 wrote a joint letter to the Nobel Committee sent a list containing 160 papers on Raman effect [23]. In contrast, Hadamard's letters were rather too short and rudimentary (Figure 2). The letter written in French reads: "For the Nobel Prize in Physics, I propose the name of Professor Bhabha of Bombay for the reason of his work on radiations, especially cosmic radiation". It speaks nothing about quality of Bhabha's work and his publications.

J. Hadamard did not take trouble to argue Bhabha's case effectively. Was he not well-informed about the process of nomination? Yes, he was. In the first half of the twentieth century, he had sent 14 nominations for physics and 10 for chemistry Nobel prizes [24]. Then why Hadamard proposed Bhabha "half-heartedly"? The only plausible reason seems to be Hadamard's age. The first time he nominated Bhabha, he was 85 years old.

Presumably, it was not easy for him to write long proposals and get information about Bhabha's publications. It seems Bhabha himself did not become active like his countryman C.V. Raman, who managed to publish a list of papers on the Raman effect and sent the reprints to the well-known scientists. Rutherford and Wilson sent the same list to the Nobel Committee. Apart from that he asked N. Bohr to nominate him for the Prize [25].



Institut de France
Académie des Sciences

Paris le 15 Février 1950
Quai Conti, n° 23

Pour le Prix Nobel de Physique, ma proposition
est en faveur du Professeur BHABHA à Bombay,
en raison de ses travaux sur les radiations,
spécialement sur les radiations cosmiques.

J. Hadamard

Fig. 2: *A Facsimile of Jacques Hadamard's Nomination Letter for the Award of Nobel Prize to Bhabha (Credit: Archive, Royal Swedish Academy of Sciences, Stockholm).*

Decision of the Nobel Committee

After getting the proposals, the Nobel Committee sorts them. The self-nominations and the proposals reached after the deadline are rejected. A list of valid candidates is made. Two types of reports are prepared: (a) Experts' reports on the work of candidates, whom the Committee takes in the "short-list" and thinks as the "potential" candidates. If the "promising" candidate was already nominated, his report is complimented. (b) The report of the Nobel Committee. It contains short review on all proposed candidates; however, detailed review on those, who "deserve" the Prize, according to the Committee's opinion.

According to the Nobel Committee's report for the year 1955, 44 persons were nominated by 58 applicants. Out of 44, 10 candidates were proposed for the first time (Report of the Nobel Committee, 1955). So far as H.J Bhabha was concerned, the N.C. stated that as in several previous years, J. Hadamard, Paris, proposed H.J. Bhabha, Bombay, for his work on cosmic radiation. Other proposal for the work in the same area is for Marietta Blau, earlier in Vienna, now in the U.S.A. Walter Thirring, Vienna, proposed her for pioneering work, for the development of the photographic method for observing nuclear processes. The work was done during 1930 and 1937. The Committee said that it might be recalled that for such work, in 1950, the Prize was awarded to C.F. Powell "for his development of the photographic method of studying nuclear processes and his discoveries regarding mesons made with this method" (Report of the Nobel Committee, 1955).

In 1956, the Nobel Committee reported that Hadamard, Paris, repeats his earlier proposal for H.J. Bhabha, about a reward for his work on cosmic radiation. Other proposal for work on the cosmic radiation and meson research was by E. Schrödinger, Dublin, who nominated Marietta Blau (Report of the Nobel Committee, 1956).

Bhabha was never short-listed. The N.C. did not ask its experts to write a report on his achievements. Obviously, Bhabha was never seen as a candidate who deserves the Nobel Prize.

HOMI J. BHABHA AS A NOMINATOR

According to the rules and regulations of the Nobel Foundation, mainly Scandinavian scientists and Nobel Laureates had the permanent right to nominate candidates for Nobel Prizes in Physics. Apart from that holders of corresponding chairs in at least six universities or university colleges, or the persons, to whom the Academy may see fit to invite proposals. They have only ad-hoc status. The Nobel Committee sends invitations during the month of September to the competent persons to put forward proposals. They had to be submitted before the first of February of the following year. A nominator can propose one or more candidates.

Probably, H.J. Bhabha was not aware of the deadline. His first nomination was sent on Feb. 16, 1951. He nominated J.D. Cockcroft, U.K., a distinguished experimental nuclear physicist (Bhabha H.J. to N.C., Feb. 16, 1951). Bhabha's next candidate was Felix Bloch, University of Stanford, California, U.S.A. In favour of his candidate, Bhabha argued as follows: "Professor Bloch has made fundamental contributions to the electron theory of metals and the present theory of the conductivity of metals is based largely on his work. More recently he has developed methods for making very accurate measurements of the magnetic moments of the proton and the neutron and has measured these quantities with the highest accuracy achieved so far. Knowledge of these quantities is of fundamental importance for the development of physics".

"For both of the above contributions he deserves in my opinion, the Nobel Prize for Physics" (Bhabha H.J. to N.C., Dec. 14, 1951). In the same year, that is, 1952, he was awarded the Physics Nobel Prize. The third proposal sent by Bhabha was for Willis E. Lamb, Jr., U.S.A., "for his discovery of the Lamb Shift, an effect of fundamental importance in deepening our understanding of the properties of nature, and in particular of the electron and its interaction with the electromagnetic field" (Bhabha H.J. to N.C., Jan. 28, 1952). W.E. Lamb received the Nobel Prize in 1955.

DISCUSSION

Bhabha was a successful nominator as all the three persons proposed by him received the Nobel Prize. He nominated both American and British scientists. He did not nominate Indians. Obviously, he did not appreciate the scientific work of his own countrymen. It is a matter of general knowledge that nomination for Memberships or awards is often a matter of contacts with colleagues than only that of scientific achievements. This would suggest that Indian scientists of high caliber, who got invitation to send proposals, did not have good contact with him. However, it did not explain, why British and American physicists ignored Bhabha? It will be wrong to think that Bhabha did not have contact with them.

The author N. Jacobson published a list of 45 and 39 lectures in Mathematics and Physics, respectively, which were delivered by known mathematicians and physicists in TIFR until 1969 [26]. Particularly from theoretical physics we find the well-known names as Paul A.M. Dirac, Gregor Wentzel, J.J. Sakurai and Walter H. Heitler who came to TIFR. The only plausible reason for ignoring Bhabha by them suggests that at the later stage his scientific work done in India was seen as of "lower" level than in Europe? The fact is, even if, Bhabha had international support, he had little chance to receive the Nobel Prize, because the N.C. did not take interest in work for which the Prize had already been awarded. As we have seen before, the Committee was of the opinion that for such a work, in 1950, the Prize was awarded to C.F. Powell.

ACKNOWLEDGEMENTS

We are thankful to Archivist Maria Asp – Royal Swedish Academy of Sciences, Stockholm, for sending the referred to material as well as information regarding expert's reports. We shall like to thank Deutsches Museum (München) for Bhabha-Bohr correspondence; Archivist Facility Pors and Dr. Finn Aaserud - Director, Niels Bohr Archive (Copenhagen) for sending Bohr-Indian scientists correspondence; Royal Society (London) for Bhabha's nomination letter; Dr. Oindrila Raychaudhuri, Tata Institute of Fundamental Research, Bombay for Bhabha-Bohr photograph. Thanks are due to Prof. D.C.V. Mallik, Bangalore, for sending us K.S. Krishnan – B. Sahni correspondence, referred to in this paper. One of us (R. Singh) thanks his Boss, Prof. Dr. Michael Komorek, Head of Research Group – Physics Didactic and History of Science, University of Oldenburg, Germany, for providing research facilities.

REFERENCES

1. Swarna T, Kalyane V.L, Prakasan E.R, *et al.* Eponymous citations to Homi Jehangir Bhabha, *http://eprints.rclis.org/1048/1/H.J.Bhabha 1.pdf*, May 30, 2009; Dasannacharya B.A., Homi Jahangir Bhabha, *Curr. Sci*. 96, 1536–1538, 2009; Mukunda N., Homi Bhabha – An appreciation and a hope, *Curr. Sci.* 100, 1437–1441, 2011; Penny L., Homi Jehangir Bhabha 1909–1966, *Biogr. Mem. Fellows R. Soc. Lond*. 13, 35–55, 1967; Anderson R.S., Building scientific institutions in India: Saha and Bhabha, McGill University, Montreal 1975; Sreekantan B.V., Singh V., Udgaonkar B.M., (Eds.), Homi Jehangir Bhabha - Collected scientific papers, Tata Institute of Fundamental Research, Bombay 1985; Swarup G., Homi Bhabha - Personal reminiscences, *Curr. Sci.*, 60, 75–78, 1991; Venkataraman G., Bhabha and his magnificent obsessions, University Press (India) Limited, Hyderabad, 1994; Deshmukh C., Homi Jehangir Bhabha, National Book Trust, New Delhi 2005; Wadia S.R., Homi Jehangir Bhabha and the Tata Institute of Fundamental Research, *Curr. Sci*. 96, 725–733, 2009; Singh V., Bhabha's contribution to elementary particle physics and cosmic rays research, Tata Institute of Fundamental Research, *http://www.tifr.res.in/~hbbccc/download/v singh.pdf*, May 8, 2016; Swarna T., Kalyane V.L., Prakasan E.R., *et al.*, Eponymous citations to Homi Jehangir Bhabha, Paper dedicated to Bhabha during Golden Jubilee of the Department of Atomic Energy (India), *http://eprints.rclis.org/archive/00002081J uly 7, 2006*; I.N.S.A., Fellows of the Indian National Science Academy 1935–1993, vol. 1, Indian National Science Academy, New Delhi 1994, 72–73p.

2. Remembering Dr Homi Bhabha, The Physicist. Homi Bhabha Birth Centenary Volume (2008–09). Published by Bhabha Atomic Research Centre, Mumbai, 2009; 68p.
3. Penny L., Homi Jehangir Bhabha 1909–1966, *Biographical Memoirs - Fellows R. Soc. Lond.*, 1967; 13: 35–55p.
4. Bhabha HJ, Zur absorption der Höhenstrahlun, *Zeitschrift für Physik*, 1933; 86: 120–130p.
5. Bhabha HJ, Zur Absorption der Höhenstrahlung, *Z. Phys*. 1933; 86: 120–130p.
6. Bhabha HJ, The creation of electron pairs by the fast charged particles, *Proc. R. Soc. Lond*. 1935; 154: 559–586p.
7. Penny L. Homi Jehangir Bhabha 1909-1966, *Biogr. Mem. Fellows R. Soc. Lond*. 1967; 13: 35–55p.
8. Bhabha HJ. The scattering of positrons and electrons with exchange on Dirac's theory of the positrons, *Proc. R. Soc. Lond*. 1936; 154: 195–206p.
9. Bhabha HJ. Heitler W. The passage of fast electrons and the theory of comic shower, *Proc. R. Soc. Lond*. 1937; 159: 432–458p.
10. Bhabha HJ. On the theory of heavy electrons and nuclear forces, *Proc. R. Soc. Lond*. 1938; 166: 501–528p.
11. Bhabha HJ. Nuclear forces, heavy electrons and the β-decay, *Nature*. 1938; 141: 117–118p.
12. Gillispie CC. (Ed. in Chief), Dictionary of scientific biography, vol. XV, Charles Scribner's Sons, New York 1978; 25–28; Penny L., Homi Jehangir Bhabha 1909–1966, *Biogr. Mem. Fellows R. Soc. Lond*. 13, 35–55, 1967; I.N.S.A., Fellows of the Indian National Science Academy 1935–1993, 1: Indian National Science Academy, New Delhi 1994; 72–73p.
13. Bhabha HJ. Heitler W., The passage of fast electrons and the theory of cosmic showers, *Proc. R. Soc. Lond*. 1937; 159: 432–458p.
14. Yukawa H., On the interaction of elementary particles - I, *Proc. Phys. - Math. Soc. Japan* 1935; 17: 48–57p.
15. Neddermeyer S.T., Anderson C.D., Cosmic-ray particles of intermediate mass, *Phys. Rev*. 1938; 51: 884–885p.
16. Millikan R.A., Mesotron as the name of the new particle. *Physical Review*. 1939; 55: 105p.
17. Bhabha, H.J., The fundamental length introduced by the theory of the mesotron (meson). *Nature*. 1939; 143: 276–277p.
18. Bhabha HJ. The fundamental length introduced by the theory of the mesotron (meson), *Nature*. 1939; 143: 276–277p.
19. Alvarez L.W., Recent development in particle physics, *Science.* 1969; 165: 1071–1091p.
20. Lee TD., A brief history of the muon, Hyperfine Interactions 86, 439–453, 1994. For detail of Yukawa's prediction and influence of his ideas on physics, see, Brown L.M., Yukawa's prediction of the meson, *Centaurus*. 1981; 25: 71–132p.
21. Penny L., Homi Jehangir Bhabha 1909-1966, *Biogr. Mem. Fellows R. Soc. Lond*. 1967; 13: 35–55p.
22. *http://www.nobelprize.org/nomination/archive/show_people.php?id=983*, May 23, 2016.
23. Singh R., Riess F. The 1930 Nobel Prize for Physics: A close decision? *Notes and Records of the Royal Society of London.* 2001; 55: 267–283p.
24. Crawford E. The nobel population 1901–1950 – A census of the nominators and nominee for the prizes in physics and chemistry, Universal Academy Press, Inc., Tokyo, 2002; 372p.
25. Singh R., Riess F., Sir C.V. Raman and the story of the Nobel prize, *Curr. Sci.* 1998; 75: 965–971p.
26. Jacobsen N. *Lectures on quadratic Jordan algebras*, Tata Institute of Fundamental Research Bombay, 1969.

Cite this Article
Rajinder Singh, Hardev Singh Virk. Homi J. Bhabha as Physics Nobel Prize Nominee and Nominator. *Omniscience: A Multi-disciplinary Journal.* 2017; 7(1): 4–10p.