

## B.B. RAY UNDER THE INFLUENCE OF C. V. RAMAN AND M. N. SAHA

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*Bidhubushan Ray or Bidhu Bhushan Ray or Bidhu Bhusan Ray (B.B. Ray) is one of the unsung heroes of Indian science. He belongs to a group of physicists like S.K. Mitra and K.S. Krishnan, who were guided by C.V. Raman. The Minutes of the Senates and the Minutes of the Science Faculty of the University of Calcutta are analysed to explore the complicated relation between Ray and Raman.*

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### Introduction

As a historian of science working for about two decades, my impression is that most of the biographies available are on J.C. Bose, C.V. Raman, M.N. Saha, H.J. Bhabha and S.N. Bose. S.K. Mitra, the pioneer of atmospheric science and D. M. Bose, a world renowned expert in cosmic rays<sup>1</sup> and cloud chamber technique, had been ignored in spite of the fact that their scientific achievements were appreciated by the Western scientific community.<sup>2,3</sup> B.B. Ray is another such unsung hero. In an article published in *Science and Culture* in 2000, his interaction with Western physicists was explored.<sup>4</sup> The present article intends to explore his relation with his mentor and the Nobel Laureate C.V. Raman.

### B.B. Ray – Some Less Known Facts

B.B. Ray is considered as one of the pioneers of X-ray spectroscopy in India. Nothing is known about his family background. He was a member of the Indian National Science Academy. The Academy publishes “Memoirs” of its Fellows. Unfortunately, Ray’s memoir was never published. What we find about Ray’s research achievements under the deceased fellows is: “Ray’s doctorate thesis on scattering of light brought him great

reputation. His findings had an important bearing on the colouring of glasses by suspended metal particles and the axial colours exhibited by clouds. His investigations at the laboratories of Manne Siegbahn (Uppsala, Sweden) and Niels Bohr (Copenhagen) contributed significantly to the revision of a theory on the origin of X-ray spectra. He was able to establish that the spectra are actually modified by chemical combination. He studied the emission and absorption spectra of elements in the soft X-ray region, which shed light on the distribution of electrons in the solid state. From the theory of the fine structure of X-ray absorption edges, he obtained interesting results on the nature of ions in a solution.”<sup>5</sup>

There nothing much is known about Ray’s private life. The British journal *Nature* produced a short “Obituary”, which does not contain information about Ray’s youth, childhood and family. It says that Ray died on July 4, 1944. He started career as scientist under C.V. Raman and later worked with M. Siegbahn and N. Bohr. He founded an active school of X-rays research at the University of Calcutta. He had a charming personality and was popular with his students.<sup>6</sup>

After the publication of article in *Science and Culture*, I came in contact with Mr. Subrata Roy, retired Director-in-Charge of Central Silk Technological Research Institute, Bangalore. He is son of Benoy Bhushan Ray (abbreviated as B.B. Ray), who did research work under S.K. Mitra.

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Bidhu Bhushan Ray advised his brother to change family name, to avoid confusion between the last names. After that Benoy Bhushan became B.B. Roy.

Mr. S. Roy wrote to me in a letter on May 19, 2009 that B.B. Ray was closely associated with the Ramakrishna Mission; and he was direct disciple of Swamy Saradananda. So far as family life of B.B. Ray is concerned – “he lost his father at the age of five and had to struggle hard to complete his education. He got a job in Bengal Civil Service based on his merit. It is Sir Ashutosh Mukherjee, then Vice-Chancellor of Calcutta University, who inspired him for persuading research, when he got the scholarship to go to Uppsala University. He declined to go initially as he was the only earning member in the family. Sir Ashutosh came to his rescue and arranged to send his salary to his mother every month during his absence.”

In one of the letters B.B. Ray wrote to N. Bohr about his bad health after his return. As we will see later, he asked the Senate to extend the time to send report about his third year stay in Europe, as he was not in a position to finish in time, due to illness. Mr. S. Roy explains the cause of the illness as follows: “In Uppsala at Siegbahn’s lab as well as at Niels Bohr’s lab he worked too hard ignoring his physical well-being. He became habitual smoker too. After coming from Europe he developed diabetes as well as chronic stomach problems which were never cured. I do not know that this ailments he suffered from was due to exposure to over doses of X-ray. But one thing is true that he had to endure considerable stress throughout his life due his initial poor family conditions, establishing X-ray lab to pursue his research in Calcutta University, enduring financial burden for supporting his distant relatives and poor students financially. Probably his diabetic problem and smoking habit coupled with over exhaustion for establishing X-ray lab at Calcutta University from scratch for persuading his own research activities neglecting totally his health conditions by avoiding doctor’s advice led to a situation where he could not escape a massive heart attack. He possessed good health at his college days and he was a good footballer and high jumper.”

In the following, I shall try to explain Ray-Raman relation; and show that it was not B.B. Ray’s fault. Most of us would have done, what B.B. Ray did, under similar conditions.

### ***B.B. Ray’s D.Sc. Thesis and Sir T.N. Palit Foreign Scholarship***

B.B. Ray began research under C.V. Raman, Palit

Professor, at the University of Calcutta. In 1918 Ray did first class M.Sc. in Physics. He won the Silver Medal. In 1921 he was appointed as Physics Lecturer at the University of Calcutta.

Ray’s initial scientific work was on the scattering of light. It was shown by him that as the size of particle increases first the shorter wavelengths are absorbed and with the increase of size all the visible spectrum is absorbed by the particles suspended in liquids. On this principle, Raman and Ray explained an important phenomenon, i.e., when a weak solution of sodium thiosulphate is added to dilute sulphuric acid, the colour of the solution changes from white to yellow, orange, red and deep crimson red and finally becomes completely opaque. The importance of this explanation lies in the fact that even Lord Rayleigh, the master of light scattering, had not been able to give a correct explanation.<sup>7</sup>

As we see from the following list, except in one case, all other articles were written by Ray alone:

1. The free and forced convection from heated cylinders in air, Proc. IACS 6, 87, 1920.
2. (co-author Raman CV), On the transmission colours of sulphur suspensions, Proc. RSL 100, 102, 1921.
3. On the colour and polarization of the light scattered by sulphur suspensions, Proc. IACS 7, 1, 1921.
4. The colour of the colloids in relation to the size of the dispersed particles, Proc. IACS 7, 221, 1922.
5. The formation of coloured bows and glories, Nature 111, 183, 1923.

Unfortunately Ray’s D.Sc. thesis is not available. Mr. S. Roy in a private communication reported that the thesis was based on some publications. This statement is true, if we see the record of the University of Calcutta. According to the rules of those days, the D.Sc. thesis was evaluated by British or other foreign examiners. The Board of Examiners of the University of Calcutta appointed G.C. Simpson, J.W. Nicholson and E.H. Barton. On 1<sup>st</sup> November, 1922, they submitted the following report: “We have examined the thesis submitted by Mr. Bidhubushan Ray, M.Sc., and consider that the work described in these is of sufficient merit to warrant the conferment upon Mr. Bidhubushan Ray of the Doctorate. The main thesis entitled “The scattering of light by liquid droplets and the theory of coronas, glories and iridescent clouds” deals with an

interesting branch of meteorological optics and the results obtained by Mr. Bidhubushan Ray are new and valuable.”<sup>8</sup>

In 1922 Ray was already working as Physics Lecturer. As is well known, in those days, to get higher position, it was necessary to study abroad. The University of Calcutta, which got donation from Bengali nationalists like Palit, Ghosh and Khaira families, encouraged its talented scientists to go abroad. D.M. Bose went to Berlin. M.N. Saha spent two years in England and Germany. B.B. Ray got a travelling scholarship for two years. To plan his stay in Europe, he wrote to Niels Bohr on March 23, 1923, stating: “I understand, Prof. Raman has already written to you about my working in your laboratory. You know also that I have got study leave for two years at present and it can be extended for another year if need be.” Then he presented a brief report about his scientific work on light scattering and promised to send reprints as soon as the work is published. With the letter, he sent reprint of his already published paper in “Nature” of Feb. 10, 1923. In the end he wrote: “I shall be grateful to you, if you kindly agree in allowing me to work under you in your laboratory and in that case I shall arrange for the journey as soon as I hear from you.”<sup>9</sup>

B.B. Ray had asked the University to grant him a Foreign Scholarship. In a meeting of the Syndicate of 27<sup>th</sup> April, 1923, his application was considered for Sir T.N. Palit Foreign Scholarship. It was resolved: “That a ‘Palit Foreign Scholarship’ of the value of Rs. 5,000 a year, tenable for two years, be awarded to Dr. Bidhubushan Ray to be held on the terms and conditions mentioned in the Second Trust Deed of the late Sir Taraknath Palit. ... That steps be taken to have the usual bond drawn up.”<sup>10</sup>

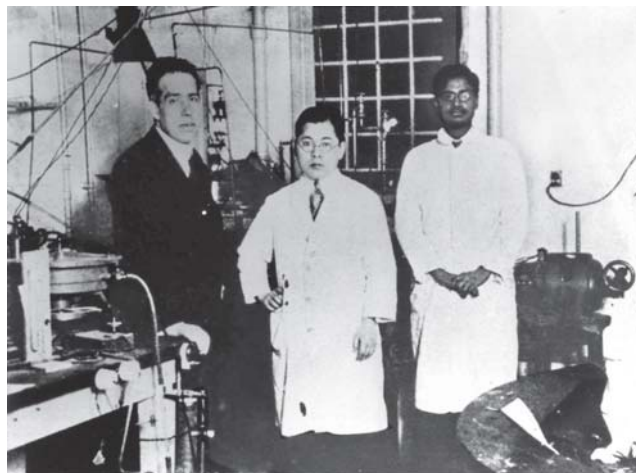
Ray’s next letter to N. Bohr suggests that Bohr did not receive Ray’s first letter. On May 30, 1923, Ray wrote that two months ago, Prof. Raman and he had written letters about the permission to work in Copenhagen Laboratory. In this letter he stated: “The date of my departure for Europe will be settled as soon as I get your reply. I am at present doing some work on the Scattering of X-Rays in this college.” In a letter dated Sept. 11, 1923, he was informed that Bohr has left Copenhagen for U.S.A. and will be back until about Christmas and will be able to see Ray’s letter after his return. He was suggested to contact M. Siegbahn. From another undated letter written by Ray to N. Bohr, we understand that Bohr wrote to C. V. Raman and suggested to postpone the visit till January 1924.

In August 1923, Ray’s letter was read in a meeting. According to it: B.B. Ray “has been awarded a Palit

Foreign Scholarship of Rs. 5,000 per year for two years, requesting that to enable him to go to Sweden by the middle of September, a sum of Rs. 2,000 may be paid to him out of his scholarship to meet his out-fit and passage expenses.”<sup>11</sup> It was noted: “The necessary bond has not been ensured for Rs. 10,000 (the full value of the scholarship) as required under the rules.”<sup>12</sup> The committee resolved that he should receive the required amount; however “That the following clause to be inserted in the bond to be drawn up. – ‘That if Dr. Ray on his return to India serves the University for five years, the bond will not be enforced.’”<sup>13</sup>

As we see from the above, Ray decided to go to Sweden and work under M. Siegbahn. After arriving in Uppsala, he started with the observation of  $K\alpha$  lines in pure metallic powders. The first paper published by Ray (with Siegbahn as co-author) was about the irregularity of the  $K\text{-}\alpha$  doublets in the elements of lower atomic number. The authors had shown that the irregularities observed by them actually appear in a region predicted by Bohr’s theory.<sup>14</sup> Bohr took notice of the Ray’s work.<sup>15-16</sup> His next publication confirmed the irregularities for higher elements as predicted by Bohr’s theory.<sup>17</sup> Ray’s work had significance for explaining Bohr’s idea regarding the position of elements in the periodic table<sup>18,19</sup>. He suggested to Ray to stay longer in Uppsala.<sup>20</sup> In September 1924 Ray left Uppsala. It is to be noted that in the short period of ca. 6 months, he published three papers.

From Copenhagen N. Bohr wrote a letter to the Registrar of the University of Calcutta and highly appreciated Ray’s achievements.<sup>21</sup> In his next letter, he requested the authorities to extend his stay for 6 months. There was no reply from Calcutta University. Bohr wrote third letter to the Registrar of the University and sent copies



**Figure 1:** Niels Bohr, Yoshio Nishina (Japan) and B.B. Ray (Credit: Niels Bohr Archive, Copenhagen).

of the previous letters<sup>22</sup>. Ray's application for the post of senior lecturer at the University of Calcutta was also recommended by Bohr.

According to the "Minutes of the Senate" of December 21<sup>st</sup>, 1925, Ray was on leave. The University authorities discussed about the salaries of five persons, who were appointed as whole time Lecturers. Ray was one of them. He was still in Europe. It was pointed out that his "salary is to take effect from the date of his resuming duties on return from leave." Apart from Rs. 300 as salary during leave, he was also given Rs. 100 per month as allowance.<sup>23</sup>

What to be noted is that – Ray had scholarship for two years, that is, from September 1923 to September 1925. In a letter of June 23, 1925, N. Bohr asked the University to extend the stay so that Ray can finish the scientific work, he had started. According to his letter of 16<sup>th</sup> April, 1926, which he wrote to Bohr from Italy, he was going to reach Calcutta on 5<sup>th</sup> May, 1926. Obviously, Ray's stay was extended for six months.

### **C. V. Raman Defends Ray's Interests**

The following suggests that Raman was seriously interested that "his" previous student gets research facilities. He forwarded an application from B.B. Ray; to the University of Calcutta stating: "who has recently returned from Europe, having specialized in X-Ray work and atomic Physics, and has joined his duty, requesting that a room in the Science College (92, Upper Circular Road) may be allowed to him to set up the apparatus recently purchased for his research work."<sup>24</sup> Raman argued that "there are some rooms in the north wing of the building which are at present not available for the work of the Physics Department and that, in view of the pressing necessity, it is a matter of consideration whether the arrangements under which some of the accommodation has been allotted to those unconnected with the College should not be terminated. If this is done, Dr. Ray's request could be complied with."<sup>25</sup> Was it self confidence or the F.R.S. title that Raman dared to "oppose" one of the most influential person at the University of Calcutta, who was "unconnected with the College"? (in Raman's words). The man was no other than "Rai Bahadur Upendranath Brahmachari."<sup>26</sup> The reading of the official records of the University of Calcutta, such as Minutes of Senate or Minutes of the Faculties of Sciences gives the impression that after Ashutosh Mukherjee, Nilratan Sircar and U.N. Brahmachari were the most influential persons, who determined the policies and administration of the University of Calcutta.

In another meeting Raman "proposed that the room on the ground floor in the northern wing of the Building which is now occupied by Rai Bahadur Dr. U.N. Brahmachari be allotted to Dr. Bidhubhushan Ray, ..., for carrying on his research work. The proposal was put to vote and declared carried, 12 members voting for and 3 against it."<sup>27</sup> B.B. Ray wrote a letter to the Secretary of the Governing Body of the University College of Science, requesting to place the room at his disposal by the 1<sup>st</sup> week of August 1927. U.N. Brahmachari be requested to indicate when it will be convenient for him to vacate the room.<sup>28</sup> Interestingly, it took more than a year, till Ray got the room..

After returning to India, B.B. Ray had to submit a report. In October 1926, he sent an application to the University authorities, telling that he is ill; and he requested for the permission to submit the report for the third year of his Premchand Roychand Studentship by the middle of December. The permission was granted. He was told to send the report until the end of December 1926.<sup>29</sup>

B.B. Ray though a pioneer in modern physics, did not think of establishing an independent field of research like S.K. Mitra and D.M. Bose. The X-ray spectroscopy was already being done by D.M. Bose at the University of Calcutta. For instance, according to the Minutes of Syndicate: "..., an application from Babu Sudhirchandra Datta, whose tenure of Sir Rashbehary Ghose Scholarship is to be expired on 30<sup>th</sup> June, 1923, praying for the a renewal of his scholarship for a period of another year was forwarded by Professor D.M. Bose. During the last year, he will be engaged in studying the focusing of X-Rays by means of reflection of X-Rays from crystal surfaces if the scholarship is granted to him."<sup>30</sup> The scholarship was extended for one year. Raman, who was working on the scattering of visible light; was interested to extend it for X-rays. He asked the authorities to buy books on X-ray and quantum mechanics, such as, "Intensity of emission of X-rays and their reflection from crystals", "Problems of X-ray emission", "Data relating to X-ray spectra", "The quantum theory of the atom", "The atom and the Bohr theory of its spectra", "The theory of spectra and atomic constitution" and "Problems of atomic dynamics."<sup>31</sup>

In 1927, the University of Calcutta was proud of its scientists and their achievements in different fields of specialization. It was reported that D.M. Bose as President of the Physics Section of the Science Congress delivered lecture on the magnetic properties of compounds; S.K. Mitra "is working on atmospheric in co-operation with the Radio Research Board of England" and "Dr.



Bidhubhushan Ray, after working under Professors Siegbahn and Bohr (both Nobel Prize winners), returned to our Science College last year, and has won the Elliot Prize for Science.”<sup>32</sup> Obviously, Ray was projected as a person, who is known more for working under “Nobel Laureates” than his research accomplishments. We will see later that the authorities of the University also did not pay appropriate attention to give him proper salary .

### ***B.B. Ray, Readership in Dacca and Salary Issues***

In a meeting Raman asked for a special increment of Rs. 50 per month for B.B. Ray, who was getting Rs. 350 per month at that time. His arguments were that Ray is a very distinguished alumnus, who in 1923 had won Premchand Roychand Scholarship. He was Palit Foreign Scholar from September, 1923, to April, 1925 [Raman’s statement varies from the Minutes of the Senate. There it was stated that Ray gets Palit Scholarship for two years], and worked under Nobel Laureates M. Siegbahn (Uppsala) and N. Bohr (Copenhagen). He has published 15 articles dealing with X-rays and atomic structure. He received the Elliot Prize of the Asiatic Society of Bengal and Mahendralal Sircar Research Gold Medal in 1926.<sup>33</sup> Raman further argued that “on 28<sup>th</sup> October, 1927, Dr. Bidhubhushan Ray received an offer of appointment on Rs. 600 per mensem, as Reader in Physics to the Dacca University for a period of two years in the first instance. He applied immediately to the Calcutta University for leave without pay for two years.”<sup>34</sup> The Executive Committee on 16<sup>th</sup> November, 1927, passed a resolution that the University needs his services. It recommended a special increment of Rs. 50 per month from 1<sup>st</sup> January, 1928. Raman was annoyed that the responsible bodies have not taken appropriate decision. Meanwhile, the Registrar from Dacca University sent a telegram to know about Ray’s decision. As it was a matter of urgency, Raman put the case before the Senate with the following note : “It would be a serious loss to the Physics Department ... if Dr. Ray were to leave us. On the other hand, it would be unfair to compel him under the terms of his agreement with the trustees of the Palit Endowment to refuse the offer of an increase of Rs. 250 per mensem in his salary, without, at least, some compensation.”<sup>35</sup>

The Vice-Chancellor refused to discuss the case as he was of the opinion that it is in the power of the Appointment Board, which has asked the Board of Accounts for advice. The information has not yet been given. Thus the Appointment Board is not in a position to give recommendation to the Senate.

The Appointment Board on 4<sup>th</sup> April, 1928, decided to give an increment to B.B. Ray with effect from 1<sup>st</sup> January, 1928.<sup>36</sup> Charuchandra Biswas from the Appointment Board said: B.B. Ray “was appointed in March 1921 on a salary of Rs. 200 rising to Rs. 300. ... On his return from abroad in May, 1926, he was appointed on a salary of Rs. 325, and since then he has been working on that salary. Under the terms of the Palit Scholarship he had to serve the University for 5 years on his return.”<sup>37</sup> However, the Board of Accounts pointed out: “that there was a saving owing to the fact that one Professor, Mr. Das, was taken into the Presidency College and it was suggested that this saving should be diverted to provide this increment for Dr. Bidhubhushan Ray.”<sup>38</sup> C. Biswas hoped the Senate would accept the increment as in the past more than once the Board of Higher Studies had recommended it.

The above decision led to a dispute with the Mathematics Department. R. Prasad, the Head of the Mathematics Department, who wanted to have the money for his Department, came with the argument that according to the contract B.B. Ray had to work for the University for five years. He wants to leave because he gets better salary in Dacca. After two years he might like to come back and would demand more than Rs. 600 , what he would get in Dacca. If he is allowed to do so, many would like to follow his example in future.

Raman stated that he knows from where Professor R. Prasad’s argument originated. He studied in Germany and according to German system, if a Professor gets better offer from other University, either he leaves his working place or his present University compensates the new salary and working conditions. Raman was of the opinion that there is nothing wrong if a highly qualified person asks for better salaries. Prasad opposed, because he wanted to appoint his own man.

### ***B. B. Ray Under the Influence of M. N. Saha***

Saha-Raman controversy due to “Mahendralal Sircar Professorship” or “Palit Chair” had been discussed by various authors. Bengal based historians like S. Chatterjee defended Saha;<sup>39</sup> whereas Bangalore based G. Venkataraman defended Raman.<sup>40</sup>

India is a multicultural land with a number of states with different cultures and languages. Outside India, its citizens are “Indians”; but within India, depending upon the state in which they belong; they are known as either Bengalis or Punjabis or Madrasis. However, within Punjab, they will identify themselves as Sikh or Hindu or Christian.

Both religion and language play an important role in India. India was divided on the basis of religion, we witnessed formation of new states on the basis of language. Under such conditions, people can be easily exploited on the basis of communities or languages. Even today, we have such problems in India. Those who left their own state and worked in other states, will better understand the meaning of my statement. M. N. Saha appealed to the Bengali Sentiments to win Ray's sympathy to work against Raman.

Raman-Saha conflict began in the 1920s. For instance, in a letter in 1927 Saha wrote to Partap Kishan Kichlu the following: "When you submit your thesis for D.Sc. ... The examiners ought to be Professor Fowler, Lord Rayleigh and myself. Do not allow Raman or Nicholson to be put in. It is time that the Committee of Courses in Physics should insist on an internal man."<sup>41</sup>

When Raman decided to leave Calcutta, some started opposing his way of controlling the affairs of the Indian Association for the Cultivation of Science. The newspapers show that by the end of 1932, some anonymous letters started appearing against Raman. In "The Advance" of December 15, 1932, one of Raman's co-workers, C.M. Sogani, Professor at the Benares Hindu University, responded to a letter dated December 4, 1932, and opposed the sentiment that during Raman's time the Bengali students have derived little from the I.A.C.S. He published a list of 20 persons, who had earlier worked under Raman, now holding good positions.<sup>42</sup>

Before permanently accepting the Directorship of the Indian Institute of Science, Bangalore, Raman sent a letter to the Calcutta University and asked for a leave for one year and 3 months (from April 1, 1933 onwards), while acting as director in Bangalore. He also suggested that in his absence the Head of Physics Department should be Professor Debendra Mohan Bose.<sup>43</sup>

The parallel part of the story is - M.N. Saha wrote to P.C. Ray that Dr. B.S. Guha wanted to talk to him (P.C. Ray). Under P.S., Saha wrote: "I am sending a cutting sent to me by Dr. Guha. I understand that the writer is known to you." Presumably, the writer was B. B. Ray.

Saha wrote to P.C. Ray on Dec. 21, 1932, telling that Raman is able to get funds from Rai Bahadur Bihari Lal Mitra to create Mahendralal Sircar Chair of Physics and "appoint a Madrasi to the job. Bidhu knows this man. Can you not exert some influence on this man?" (Figure 2).

In the same letter Saha said: "Raman tells me that he wants to get Dr. B.B. Ray appointed the chair, but one cannot trust him. Any how if Bidhu is appointed to this

I hope you returned to Calcutta safely and is now in receipt of the letter which I addressed to you from Bombay. I am enclosing in this a letter for Dr. Bidhu Bhusan Ray, ~~and~~ <sup>and</sup> a letter from Sir C.V. Raman. You will grasp the complete situation when you read ~~the~~ <sup>Raman's</sup> letter in company with Bidhu.

Figure 2: A part of M.N. Saha's letter to P.C. Ray.

chair, I will welcome it. We two can work in the Science Association in perfect amity, and with mutual benefit to each." Saha also wrote: "I have detailed out a plan of campaigning for Bidhu, he should go on with it relentlessly. Please show him this letter. This will grace him up." In the same letter he stated: "I hope you won't rest until the association comes back to Bengal." (Figure 3).

Raman ~~then~~ is now proposing a new theory of Palit Professorship, a theory which he has most flagrantly disobeyed for the last 15 years. He must be going round and tutoring the members of the Palit Governing Body in order to get them round to his views, and as they are neither aware of the context, and do not suspect the motive, most of them may easily swallow the bait. The whole object is perpetual Dravidisation of the ~~Indian~~ <sup>Association</sup> ~~Indian~~ ~~Institute~~ ~~of~~ ~~Science~~. He knows that if the Palit Body accepts his theory, nobody can stop his plans. Dr. P.C. Mitra is already a convert to the view for his <sup>own</sup> personal reasons.

Figure 3: M.N. Saha's letter to Sir P. C. Ray.

What is evident from the above that B.B. Ray became a part of the game, played by Raman, Saha and P.C. Ray. To get an answer, how Ray became a victim of the game played by the trio, one has to look at the historical, psychological and social position of B.B. Ray at that time. In my opinion, reasons are :

- Raman pointed out again and again that Ray is a brilliant scientist, but he was being paid poorly. Evidently, from financial point of view, the authorities of the University of Calcutta, in those days, did not give him proper credit. He came from a poor family. He was ill. For his own treatment, as well as for the needs of other family members, like his widowed mother, he needed money. All this have must had been frustrating for him.

- He returned from Europe highly motivated to set up his own laboratory to pursue further research on X-rays. The university authorities let him hang over for more than a year, just to get a room; forget about the other research facilities.
- He got a chance to get better position in Dacca, with double of the salary he was receiving at the University of Calcutta. He was not allowed to take the position. Just a compensation of Rs. 50 was a matter of dispute in the meetings of the Senate.
- More importantly, Ray's mentor, Sir Asutosh Mukherjee died in 1924. Except Raman, none supported him at the official level.

The following list of publications of BB Ray from 1927 to 1930 (which by all means is not complete) shows that he had established himself as an independent researcher.

1. Ray BB, Saha MN, Über das Mainsmith-Stonersche Schema des Aufbaus der Atome. *Phys. Z.* **28**, 221, 1927.
2. Ray BB, Majumder RC, Critical potentials of light elements for simultaneous transitions, *Nature* **123**, 49, 1928.
3. Ray BB, Secondary absorption edges in x-rays, *Nature* **122**, 771, 1928.
4. X-ray absorption limits and the distribution of electrons round the atom, *Proc. IACS* **3**, 477, 1928.
5. Ray BB, Mehrfachabsorption und sekundäre K-Absorptionsgrenze im Röntgengebiet, *Zeitschrift für Physik* **55**, 119, 1929.
6. Ray BB, Mazumdar RC, Critical potential of light, *Nature*, **123**, 49, 1929.
7. Ray BB, On the origin of the spark lines in X-ray spectra, *Philosophical Magazine Series 7*, 772, 1929.
8. Ray BB, Mahanti PC, Fine structure absorption edges in metals, *Nature* **123**, 528-529, 1929.
9. Mukherjee BC, Ray BB, Kritische Bestimmungen des K-, L<sub>1</sub>- und M<sub>1</sub>-Niveaus für leichtere Elemente, *Zeitschrift für Physik* **57**, 345, 1929.
10. Ray BB, Chaudhuri DPR, Ionisation potentials and conductivities of metals, *Nature* **124**, 512-513, 1929.
11. Ray BB, Mazumdar RC, Ursprung der weichen Röntgenstrahlen bei den leichteren Elementen, *Zeitschrift für Physik* **53**, 646-657, 1929.
12. Ray BB, Teilabsorption von Röntgenstrahlung, *Zeitschrift für Physik* **66**, 261-268, 1930.
13. Ray BB, Scattering of x-rays by bound electrons, *Nature* **126**, 746, 1930.
14. Ray BB, Scattering of x-rays by bound electrons, *Nature* **125**, 856, 1930.
15. Ray BB, Scattering of x-rays by bound electrons, *Nature* **126**, 399, 1930.

B.B. Ray, a scientist of high caliber had not given proper credit both in terms of salary and position, was frustrating and which had a psychological pressure on him. Apart from that, in the beginning of the 1930s Ray faced a kind of humiliation as his scientific work was put under suspicion. According to Mr. S. Roy: Ray was doing work on partial absorption of X-ray quanta (photographically) and once it seems he found Raman line, but while repeating the experiment he could not reproduce it for that he had to face some kind of humiliation in Calcutta University". Though Sommerfeld supported Ray's results, the fact remains that for any scientists, it is a kind of shock and a blow on his confidence. This could have been the case for B.B. Ray.

The only person, who gave him hope for better prospect at that time was M.N. Saha. He promised better prospects, which were "coated with Bengali sentiments." Thus, it is not surprising to me that Ray joined Saha to oppose Raman. How much role Saha played for B.B. Ray to get better position at the University of Calcutta, needs further research. The fact is - after Raman left the University of Calcutta, D.M. Bose took Palit Professorship; the Ghosh Professorship occupied by him was given to S.K. Mitra. B.B. Ray became Khaira Professor for a limited period of time. According to the Proceedings of the Board of Management of the Khaira Fund of 16<sup>th</sup> Feb., 1940, the Registrar was informed that B.B. Ray's term would expire on the 5<sup>th</sup> April, 1940. In a meeting on April 27, 1940, B.B. Ray was re-appointed as Khaira Professor of Physics, "on the expiry of his ... term of appointment, till he completes his sixtieth year, on a salary of Rs. 800 per month, ..." <sup>1</sup> At last, he got the position he deserved. What a pity, he died at the age of 49.

### Conclusion

In conclusion, B.B. Ray was a victim of poverty, ill health, improper treatment of the authorities and scientific controversy. He envisaged his chance of prosperity in Saha's plan and joined Saha to follow him blindly.

Probably, most of us would have done the same under the condition Ray faced.

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