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MEGHNAD SAHA – THE SCIENTIST AND THE INSTITUTION BUILDER

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Meghnad Saha happened to appear on the scientific scene in India when studies in advanced physics were just beginning in a colonial set up which did not encourage such attempts by the native Indians. Saha was further handicapped by the fact that he came from a remote village and from a family with no academic background. However he soon overcame the hurdles and joined the Calcutta University to teach physics and to carry out research on his own. During this period he developed his theory of thermal ionisation and applied it to solve the problems of astrophysics. This made him famous overnight. In 1920 he went to Europe, interacted with the leading physicists in England and Germany, and also had his first taste of scientific discrimination the details of which have been recounted in the article. After a stint as Khaira Professor of Physics at Calcutta he moved to Allahabad where he spent seventeen fruitful years developing a school, initiating research and expanding his field of interest. During this time he became F.R.S. and began to make his presence felt in the all India scene. In 1930 he founded the UP Academy of Sciences, in 1934 he became the general President of the Indian Science Congress, and took a leading part in founding the National Institute of Sciences (now INSA). Saha was also the main force in founding the journal Science & Culture in 1935, through which he propagated his ideas for national reconstruction till his death in 1956.

Saha's visit to Europe in 1936 on his way to Harvard Summer School in Astrophysics was a turning point in his interests. He realised the importance of the newly emerging science of nuclear physics. As soon as he came back to Calcutta, he introduced teaching and research in nuclear physics and finally founded the Institute of Nuclear Physics. He also expanded the activities of Mahendra Lal Sircar's Indian Association for the Cultivation of Science to make this an Institution of national importance. Mention has also been made of his other involvements, his participation in the National Planning Committee of the Indian National Congress, his contribution in the thinking of national planning, his debates on the floor of the Parliament and his unique work on the reform of the Indian Calendar.

Meghnad Saha was one of the pioneers of modern physics in India, which is all the more remarkable because of the many hurdles he had to cross. First of all he had to cross the social hurdle coming as he did from a remote village and having to compete with the city-bred students. The second hurdle was the lack of facilities in the newly started University Science College Laboratory and the lack of guidance. Being a pioneer in the field, he only had his friends to talk to. The third hurdle was finance. He could not publish a very important paper because the foreign journal wanted him to pay for it. Another hurdle was racial discrimination, even in the highest academic sphere in the west, the details of which are given later.

Saha became internationally known with the publication of his paper "Ionisation in the Solar Chromosphere"[1]. Saha's theory of thermal ionisation and its application in the solar and stellar spectra opened a new direction in astrophysics. According to Sir Arther Eddington, this can be counted as a major event in the history of astronomy[2].

For those not acquainted with this branch of science, particularly with spectroscopy a little background may be necessary.

During the last half of the nineteenth century and the first two decades of this century, a lot of data had been collected on the spectra of different stars and specially the spectrum of the sun. As better and improved telescopes of higher magnification and light gathering power were developed and put in use, larger amount of spectral data accumulated. This voluminous data began to look unmeaningful because they could not be identified with the spectra of elements known in the earth. Also, many elements commonly found on earth could not be identified in the sun and in other stars. This led some scientists to speculate about the existence of new elements in the stars. The spectrum of the sun's chromosphere was very well studied, particularly during the total solar eclipses and certain puzzling facts were revealed. The H- and K-lines of calcium were found much higher in the sun's atmosphere than the corresponding lines of the lighter elements like hydrogen, helium or sodium. This fact was puzzling everybody in those days and was a specific example of the confusion that prevailed.

Saha was interested in astronomy from his very childhood and was aware of these problems since the beginning of his career as a research worker. He had quickly mastered the quantum theory of radiation and applied the same to deduce the existence of the pressure of light. He also showed how it would work in a selective manner on different atoms. It was generally accepted that high temperature prevailed in the inside of the stars. Eddington amongst others had suggested that at that high temperature atoms would be deprived of most of their electrons. But nobody attempted to work out the mechanism of the ionisation. John Eggert, a young physicist working with the celebrated Professor Nernst of Berlin, tried to justify this ionisation on the basis of reaction isochore, but used hypothetical values for ionisation of elements. Saha came across this paper and immediately could see the correct way. He obtained the exact values of the ionisation energies from the spectral data or from the experiments on ionisation potential that were available, applied his knowledge of thermodynamics and chemical constants and formulated his theory of thermal ionisation. His previous acquaintance with the problems of astrophysics helped him to apply the equation immediately to explain the peculiarities of the solar atmosphere. he could explain the disppearance of arc lines from the higher layer, and intensification of the spark lines in the solar atmosphere as an effect of reduction of pressure.

Meghnad Saha was born on 6 October, 1893 in the small village of Seoratali, 45 km away from Dacca, now the capital of Bangladesh. He was the fifth child of his parents, Jagannath Saha and Bhubaneswari Debi. The family had a very meagre income and Saha's early education was beset with many hardships. He was a brilliant student and could continue his studies by winning merit scholarships. He came to Calcutta in 1911 to join the honours course in Mathematics in the B.Sc. class. He passed his B.Sc. in 1913 and M.Sc. in 1915 in mixed mathematics. The Calcutta University started post-graduate classes in physics in 1916 and Saha joined as a lecturer. Saha's early lectures to the post-graduate classes covered diverse subjects such as hydrostatics, spectroscopy, thermodynamics, etc. Saha worked very hard not only to teach the post-graduate students, but also to get acquainted with the latest concepts in physics. He had mastered the German language at an early age and could read most research papers in the original. His first paper on 'Maxwell's Stresses' was published in the *Philosophical Magazine* in 1917. In 1918, the Calcutta University awarded him a D.Sc. for his work in the field of electromagnetic theory and radiation pressure. In 1919, he was awarded the Premachand Roychand Scholarship for his thesis on the 'Harvard Classification of Stellar Spectra'. Early in 1920, he communicated from Calcutta the now famous paper 'On the Ionisation of the Solar Chromosphere', and three other papers – 'Elements in the Sun' (Paper B), 'On the Problems of Temperature Radiation of Gases' (Paper C) and 'The Harvard Classification of the Stellar Spectra'. (Paper D).

Saha had gone to England in 1920 hoping to verify his theory. Fortunately his paper on thermal ionisation had just been published. This helped him to get an entry to Prof. Fowler's laboratory at the Imperial College of Science and Technology. There he came across a storehouse of data, published and unpublished, of Sir Norman Lockyear and his colleagues, including those of Fowler. He revised his paper "Harvard classification of Stars' and at the advice of Fowler renamed it 'on a physical theory of stellar spectra'. This was published in the *Proceeding of the Royal Society*[4] and earned Saha the fame as father of modern astrophysics. But his intention to experimentally verify his theory could not be achieved as such facilities were not available in the English laboratories. He was advised to go to Germany to Nernst's Laboratory. Before leaving England, Prof. H.H. Turner of Oxford suggested to Saha that Mount Wilson Observatory will be the best place for this kind of work and advised him to write to the Director G.H. Hale. On 9 July 1921, Saha wrote to Hale: "I shall be very glad if some one at the Mount Wilson Solar Observatory undertakes the work suggested overleaf. My means are too limited and my University is poorly provided for astrophysical work, I see no prospects of ever being able to carry out the ideas contained in my papers. It will be a source of great pleasure for me to find that my exertions have resulted in throwing some light on some dark problems of astrophysics"[5]. In the enclosure Saha added his predictions made in four of his papers that could be verified in Mount Wilson.

Hale did not reply to Saha. The reply came from H.N. Russell who enclosed carbon copies of papers communicated for publication and wrote "you will see that your predictions about the lines of the alkali metals in the sun-spot spectrum has been completely verified. Rubidium is present ..."[7]. Recently, DeVorkin and Kent have shown the importance of Saha's work in their historical survey of "Quantum Physics and the Stars"[8]. In another article[9], DeVorkin comments: "Many others based their work on Saha, but it was at Mount Wilson, under the coordination of Russell and Hale's staff that the general attack on spectra took place. As a favour to Hale, Russell answered Saha's letter, outlining the planned agenda for Mount Wilson. He assured Saha that they were going to follow his lead. Saha, however, was not invited to the party". Saha, on his own, did not have the resources to join.

Saha had been corresponding with Russell for more than 25 years. In a letter dated 18 September 1924 Saha wrote:

..... My object of writing to you is to ascertain if you could help in getting a research grant from some charitable American Institute – the Rockefeller Trust or the Carnegie Trust. About £ 2000/- will suffice for my work. I want to buy a good quartz spectegraph, a diffraction grating, a low tension transformer and certain other accessories. If we have the apparatus, we can install them in the laboratory and we would not require much afterwards, for labour is very cheap and our post-graduate students and research scholars would be only to glad to join in the work...[10].

This did not bring any positive response. Even earlier, at the beginning of his research career, financial stringency deprived Saha of an early glory. In his own words[11]: "By the end of 1917 I had written a long essay on 'Selective Radiation Pressure' elaborating a theory on the role of radiation pressure acting on the atoms selectively and compensating the action of gravity on solar atoms. This paper was sent to the *Astrophysical Journal* for publication, but the editors replied that as the paper was rather long, it could be published only if I were willing to bear a part of the printing costs which ran to three figures in dollars. Much as I would have liked to do so, it was not possible for me to find so much money as my salary was small (about £ 150 per annum) and I had to maintain my old parents and a younger brother who was studying within this salary. So I wrote to the Editors of the *Astrophysical Journal* expressing my inability to pay the cost of printing, but never heard anything more about the publication of the paper nor was it returned to me. Years afterwards in 1936, when I visited the York's observatory, Dr. Morgan showed the manuscript which was still being kept there. I got a short note published in the *Astrophysical Journal*, Vol. 50, 220 (1919) and submitted a duplicate of the original article for publication in our own university journal (which has no circulation worth mentioning) on Selective Radiation Pressure and Problems of Solar Atmosphere: *Journal of the Department of Science, Calcutta University*, 1919, sometime afterwards. I am mentioning this because I might claim to be the originator of the theory of Selective Radiation Pressure, though on account of the above discouraging circumstances, I did not pursue the idea and develop it. E.A. Milne apparently read a note of mine in *Nature* **107**, 488 (1921) because in his first paper in the *Month. Not. R. Astr. Soc.* Vol. 84 – "Astrophysical Determination of Average of an Excited Calcium Atom", he mentioned my contribution in a footnote, though nobody appears to have noticed it. His exact words were: "These paragraphs develop the ideas originally put forward by Saha".

On a later occasion[12], Saha said, "myself and a brilliant student of mine Dr. D.S. Kothari were discussing in 1932 Chadwick's discovery of the neutron and had come to the conclusion that neutrons could be smuggled more easily into the nucleus of the atom than the proton or the alpha particle and thus it will be possible to induce nuclear reactions in all atoms. We needed small quantity of radium for the work we planned. While we were still trying to find out some prospective donor for a gift of 1 g of radium, Fermi's work on neutron induced reactions, which were carried out with the aid of about a gram of radium lent to him by the Italian government, came out. I think many of my brother scientists in India had the same experience, at one or other epoch of their life".

The financial strains were relieved to a great extent after independence.

As mentioned earlier, Saha wanted to verify his theory by laboratory experiment. He could not get support either in U.K.. or in Germany. Later, after he left Calcutta and went to the Allahabad University, he finally set up an apparatus and was able to obtain experimental test of thermal ionisation of elements[13]. At Allahabad, Saha started from scratch, built up a school of physics and initiated a generation of physicists into working in spectroscopy, statistical mechanics, propagation of radiowaves in the upper atmosphere, etc. He was himself very productive. It was at Allahabad that his interest in Nuclear Physics started growing.

The particular work published during Saha's Allahabad days which is frequently referred to in current literature is his masterly rederivation of Dirac's quantisation condition for magnetic monopole now called Dirac-Saha equation[14]. In the same paper, Saha estimated from classical consideration the mass of monopole to be 2.54 times that of a neutron (i.e. approx 2.5 Gev). This is yet to be verified when magnetic monopoles are detected.

In 1936, Saha obtained a Carnegi Trust Fellowship to Harvard for attending primarily the famous Summer School in Astrophysics. On his way, Saha attended Bohr's conference on nuclear physics at Copenhagen and had with him a transcript of the conference. Shapeey asked Saha to give a colloquium on the proceedings of the conference[15]. The farsighted astrophysicist realised even then that nuclear physics will play a great part in astrophysics in the coming days. On the same occasion, Saha published a Bulletin on 'A Stratospheric Observatory[16]. He predicted what could be observed above the ozone layer. How Saha's dream came true and predictions verified have been described in an obituary Note by Harold Shapley in the *Journal of the Asiatic Society*, 1957[17].

From 1930 onwards, Saha was slowly turning his attention to other social and national problems. Expressed in his own words he was "coming out of the ivory tower". The first step in this direction was to collect the scientists in one forum and found the U.P. Academy of Sciences, Allahabad (later named National Academy of Sciences, Allahabad). He had invited Jawaharlal Nehru and Subhas Chandra Bose to address the conferences organised by the Academy to discuss national problems. But Saha was not happy, because activities of this academy remained confined more or less to northern India.

As General President of the Indian Science Congress in 1934, he pleaded for an All India Academy of Sciences. The General Body of the Science Congress Association agreed and formed a large committee representing scientists from all branches in the universities, institutes and government survey departments, the Asiatic Society of Bengal, etc. There had been some initial dissents. But as a result of his determined effort and help from his scientific colleagues, the National Institute of Science was formed[18] (This was later renamed as Indian National Science Academy and the headquarters shifted from Calcutta to New Delhi).

But Saha was very keen to ventilate his own views and the views of other scientists on matters of national importance like education, scientific research and above all the role of science in national planning. In 1935, he started the journal '*Science & Culture*'. Professor Bidhu Bhusan Roy from Calcutta became its co-editor. Later, when Indian Science News Association was formed in Calcutta, *Science & Culture* became its organ[18].

The starting of *Science and Culture* became the most important event to guide Saha's future activities. P.C. Ray[20] once wrote to Saha: "Your articles in *Science & culture* are like electric shocks to wake up the sleeping scientific community". Saha was successful in involving in this effort all his former colleagues (specially J.C. Ghosh, S.K. Mitra) and discovered new talents in the process. In presenting the contributions of Saha and his colleagues in *Science and Culture* I have used data and material freely from the book *Organising for Science* by the well known science historian Shiv Visvanathan[21].

For 20 years, *Science and Culture* devoted itself to its two fundamental objectives: the interpretation of science and its popularisation, and an advocacy of the full scale application of science to bring about a technological revolution. The 2110 articles and 4600 notes published till Saha's death in 1956 were devoted to an attack on Gandhian regressiveness (in one of his early articles Saha wrote "we do not for a moment believe that better and happier conditions of life can be created discarding modern scientific techniques reverting back to the spinning wheel, the loin cloth and the bullock cart) and to elaborate it the intricacies of an alternative vision of a scientific, industrial society. To the *Science and Culture* group, industrialisation in the 20th century presupposed two imperatives: first, the necessity of total planning, and secondly the necessity of scienticised technology.

Meghnad Saha found his model of a high energy society in Soviet Russia. But electricity was costlier in Calcutta. He had shown that despite the improvements in the technology which enabled a ton of coal to produce four times as much energy as it did two decades ago, there was no corresponding reduction in the rates charged. The CESC produced electricity at a cost of 0.35 annas per unit for domestic purposes. The charges where nearly six times higher than the cost of production. An analysis of British supply companies showed that nowhere was the ratio more than 2 or 3. What impressed Saha and the *Science & Culture* group was that Russia before the First World War was as backward as India – a poverty striken agricultural country where industries were primitive and power a luxury. It was then that Lenin inaugurated his schemes for planned industrialisation and by 1935 Russia was producing 300 units per capita. In a series of articles on the Soviet experiment, Saha emphasized that Lenin realised clearly that unless Russia was placed at a different technical level, the growth of the national economy and the establishment of communism was impossible – "Communism is Soviet Power plan electrification, for without electrification progress of industry is impossible".

Saha believed that when Russia was confronted with this choice, her leaders 'Chose the cold logic of technology over the vague utopias of Tolstoy'. The other conclusion that Saha arrived at was that re-thinking was needed about agriculture. His survey showed "an acre of Indian soil produced four times less crop than in any other country. An increase in agricultural production of even 20% would require an estimated 6 million tons of ammonia. Fertilizers require electrification and we can consume 10 thousand to 20 thousand million units on fertilizer alone". What Saha was arguing in effect was that higher productivity in agriculture required a planned industrial infrastructure to provide basic inputs like electricity and fertiliser. these editorials had a deep impression on progressive political leaders, among them Sri Subhas Chandra Bose.

Subhas Chandra Bose addressed the Indian Science News Association in 1938: "Swaraj is no longer a dream. On the contrary, we are in sight of power. Seven of the provinces of British India are now under Congress ministries. Limited though there powers are, they have yet to handle the problem of reconstruction of their respective domains. How are we to solve the problems? We want first and foremost the aid of science in this task....... We who are practical politicians need help from you who are scientists, in the shape of ideas. We can in turn help propagate these ideas and, when the citadel of power is finally captured help translate these ideas into reality. What is wanted is a far-reaching co-operation between science and politics".

It was at this time that Saha was able to convince Subhas Chandra Bose, then President of the Indian National Congress, to establish the National Planning Committee – the first major achievement for Saha and his colleagues in *Science and Culture.*

Saha then set about concentrating on the other elements of his industrial society. With this end in view, he and his colleagues contributed profusely in the journal *Science and Culture.* These can be divided into 5 analytical categories. (i) an analysis of industrial research as it developed within the context of capitalism; (ii) a follow-up of the first by a superb set of studies on the implications of industrial research for a colonised society devoted to a culture of primary products; (iii) criticism of the view that science-based technology was not possible within a colonized society; (iv) an attempt to reform the existing organisation of industrial research; and (v) a working out of the relations between pure and applied science, development and production.

Between 1935 and 1950, *Science & Culture* behaved like a monitoring group examining every single development in the synthetic industry and its implication for primary products. The contributions to the journal included systematic studies on indigo, lac, jute, cotton, rubber, petrol and mica.

Saha participated whole-heartedly in the National Planning Committee as a member of the Core Committee and as Chairman of two sub-committees – Fuel & Power and Education. The report on Fuel & Power[22] is still considered as a source material. When the National Government started functioning, the recommendations of the National Planning Committee were forgotten and preference was given to the Bombay Plan[23].

Saha's involvement in planning and later in the post-independence period his criticism of not implementing the recommendations of the National Planning Committee is the history not of Saha's life alone but that of *Science and Culture*. Saha's ideas on various national problems on river management, power, fuel and electricity, resources and industrialisation are contained in 51 articles in 637 pages of the *Collected Works of Meghnad Saha*, Vol. 2[24].

Just after he joined the Calcutta University, uranium fission was discovered. Saha understood the growing importance of nuclear research. He introduced nuclear physics as a course of study in the M.Sc. Physics syllabus of the Calcutta University. He initiated research work in nuclear physics and cosmic rays at the Palit Laboratory of Physics. His ambition was to get a nuclear machine – a cyclotron – as a facility around which nuclear research would build up. But cyclotron was too costly a machine to be financed by any university. Through Pandit Nehru he convinced the Tatas to give a grant of Rs. 60,000 for purchasing the components of the cyclotron. At his persistent request the Calcutta University granted him money to build a two storied house for the cyclotron. The money collected was too little. But it could not hamper Saha's interest in the work. Other private doners, including the Birlas, also came forward to help.

In the newly built two storied building for the cyclotron and in the old Palit Laboratory of Physics, work in nuclear physics and cosmic rays continued under the direct supervision of the Professor. Some of the results of these early experiments were very encouraging. By measuring the intensity of cosmic rays at Calcutta and at Darjeeling (where Saha went for a summer vacation along with his students P.C. Bhattacharyya and N.N. Dasgupta in 1940) measured the μ – meson life time for the first time. S. Biswas's modification of the Geiger Nultel law (1948) has found a place in the college textbooks. Fission cross-section of U^{235} measured by S. Biswas and A.P. Patro (1949) was later corroborated when nuclear data was declassified after the Geneva Conference in 1955.

After independence, Saha could look forward to help from the National Government. Saha now planned a separate institute for conducting research and training in Nuclear Physics and allied sciences, with the cyclotrom laboratory as its nucleus. He had to convince the university on one hand and the Central Government on the other – both the Atomic Energy Committee and the Education Department. With the help of Vice-Chancellor, P.N. Banerjee, Chief Minister of West Bengal, B.C. Roy, and Prime Minister of India, Jawaharlal Nehru, Saha's dream was at last realised. The foundationstone of the institute was laid by Dr. Shyamaprasad Mukherjee on 21 March, 1948. The institute was formally opened on 11 January, 1950 by Irene Joliot Curie. Frederick Joliot, Robert Robinson, Mrs. Robinson, J.D. Bernal were also present on this historic occasion.

The administrative machinery of the university was very slow and Saha could do nothing about it. He also realised that individual donations and meagre resources of the university would not be enough to meet the growing demands of nuclear research. His immediate efforts, therefore, were to put the institute on an all-India footing run by an independent and autonomous governing body with members from the Calcutta University faculty, scientists from the Government of India and the Inter-University Board, Accountant General, West Bengal, etc. This was finally achieved on 12 May, 1951, when the Calcutta University Senate passed a resolution to the same effect. The autonomous Governing Body thus formed had the Vice-Chancellor as the ex-officio Chairman and Professor Saha as honorary life-Director.

Professor Saha next tried to place the institute on a sound financial footing through the Second Five Year Plan of the Government of India. In the five year plan (1954-1959) for the institute Saha envisaged the following:

(a) Particle Accelerator: In addition to the cyclotron he wished to instal an electron synchrotron.
(b) Nuclear Physics: dealing with alpha-, beta- and gamma-spectroscopy, nuclear induction technique and microwaye spectroscopy.
(c) Electronics and Radio (Instrumentation)
(d) Nuclear Chemistry
(e) Theoretical Nuclear Science
(f) Neutron Physics.
(g) Post-M.Sc. Teaching Section.

The five year plan was finally approved, although in a pruned form. But Professor Saha's wish to instal an electron synchrotron was not fulfilled. The persuit in that direction finally ended in the establishment of the VEC. His ideas on developing the Neutron Physics Section around a university type research reactor also did not find support from the DAE. Professor Saha's another dream – an institute of Medical Physics with the then Biophysics Laboratory of the institute as its nucleus – also did not come true. Biophysics and molecular biology are at present two important divisions of the institute.

After his return to Calcutta, Saha himself worked on different kinds of problems, viz. systematics of atomic neclei-particularly beta-activity, propagation of electromagnetic waves through the ionosphere, the geological age of Indian rocks and minerals and the problems of the solar corona. His theory of thermal ionisation was able to explain many unsolved phenomena in the solar chromosphere, but the solar corona presented many more mysterious data yet to be solved. The outstanding problem was how could ion atoms in the solar corona lose 9 to 13 electrons, or how could nickel be present in the inner corona. D.N. Kundu, working under Saha, established highly ionised cobalt lines in the bright coronal spectra. All these findings suggested that the solar corona is at a very high temperature comparable to the temperature of the stellar interior. Saha found it difficult to accept the existence of such high temperature at that height from the solar surface. He wrote a number of papers 'on a physical theory of solar corona". He advanced the hypothesis that the highly charged ions necessary for the emission are produced as a result of nuclear fission occurring in the sun's atmosphere. he also worked on the emission of radiowaves from the sun and other stellar bodies. In a letter to *Nature*, he discussed the likely role of magnetic field and hyperfine structure level splitting of the ground state of the H-atom.

These papers are included in the *Collected Scientific Papers*[25]. Saha took deep interest in diverse fields. His interest in the ancient Indian history led him to establish the "Origin of the Saka Era"[26]. His interest in ancient Indian astronomy led to the reform of the Indian Calendar[27]. His views on 'Modern Science and Hindu Religion' were expressed in a dialogue with Shri Anil Baran Roy[28].

From 1944 onwards, Professor Saha also took very active interest in the affairs of the Indian Association for the Cultivation of Science, the pioneer research institution founded in 1876. As President of the Council, he drafted a complete plan for reorganising the Association. A new campus at Jadavpur was selected. The building at 210, Bowbazar Street (Now Bipin Bihari Ganguly Street) was sold and the Indian Association was moved to the newly built spacious laboratory building opposite the Jadavpur University. Saha was appointed the permanent Director of the Association in 1953. He retired from the Palit Professorship and joined the Indian Association. He, however, continued to remain an Honorary Director of the Insitutte of Nuclear Physics. He continued in this position till his death in 1956.

To quote from Prof. S.K. Mitra's obituary note[29]:

The founding of the Indian Physical Society in 1934 is another of his achievements. And, last but not the least, the establishment of the Institute of Nuclear Physics and the striking expansion of the Indian Association for the Cultivation of Science by securing funds from the government, are lasting monuments of his organising ability.

Dr. Saha's love for his motherland – his patriotism – was rational, with a scientific outlook. He wanted his country to be free not only from the foreign yoke, but also from the grip of the trie – poverty, ignorance and disease. This advanced views on the former, brought him inclash, when he was still a student, with the then governmental authorities. He was refused permission to sit for the competitive examination of the Indian Finance Department. This was, of course, a blessing in disguise. The country perhaps lost an able finance officer, but surely gained a scientist of eminence.

Saha's burning desire to see his country freed from poverty and its attendant evils led him to plead for planned economy, for forced march to bridge the gap of 15 years by which we are behind the advanced countries of the West. Saha drew pointed attention of the country to the root cause of mass poverty. He argued that this was due to our not making full use of the natural powers for productive purposes, being reliant mainly on man and animal power. He maintained that the only way of driving away poverty is to industrialize the country and that quickly and extensively. It was at Dr. Saha's insistance, in fact, that in 1938, the late Subhas Chandra Bose, the then President of the Indian National Congress, founded the National Planning Committee with Nehru as its Chairman. The same rational, patriotic outlook of his made Saha agitate for the establishment of the so-called River-Valley Projects by which a River of Sorrow like the Damodar could be turned to a River of Bounty. It was largely through his efforts that the D.V.C. came into existence on the model of the Tennessee Valley Authority of the U.S.A. About the multiplicity of the benefits of the T.V.A. – flood control, irrigation, electrical power generation and recreational facilities – it was Saha who draw the attention of the public to it through his articles in *Science and Culture* and in the newspapers.

Saha's patriotism led him, in later years, to enter into the public life of the country as a Parliamentarian. He got himself elected because – he confided to me in the one of the electioneering campaigns – he could then plead more forcefully and more effectively for the cause of science and for its utilization for the economic uplift of the country''.

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28. *MEGHNAD RACHANA SANKALAN*, ed. Santimay Chatterjee 2nd edn. Orient Longman Limited, 109-190, 1986. An English translation is in press with THEMA publishers.
29. S.K. Mitra: Dr. Meghnad Saha, *JASB*, **23** i-iii, 1957.

Note:

See David H DeVorkin: Saha's influence in the West, *Meghnad Saha Birth Centenary Commemoration Volume*, Ed: S.B. Karmohapatro, Saha Institute of Nuclear Physics Pp 154-202, 1994. Amongst other details DeVorkin writes that Saha's election to the Fellowship of the Royal Society was delayed by two years due to opposition by eminent physicists like Sir James Jeans who wrote that Saha was a rabid revolutionary and had been mixed up with various sorts of anti-British propaganda.