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RAMAN, KRISHNAN AND THE IACS EPISODES OF THE 1930'S

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The Indian Association for the Cultivation of Science (abbreviated as IACS) was founded in 1876. The pioneering and scientific movement led by Sircar and Lafont achieved grand success when C.V. Raman of the said institution was awarded in 1930 the Nobel Prize in Physics. Some of the episodes during the following decade, which have remained un-researched and ignored, illustrate the complex relationship between scientists and institutions they serve. The interactions may result in dismal or enlightening results which merit critical analysis and not neglect.

Key words: CV Raman, Current Science, Fermi-Dirac Statistics, IACS, *Indian Journal of Physics*, KS Krishnan, LASER Light, Mahendralal Sircar, Max Born, *Nature*, *Proceedings of the Royal Society*, *Proceedings of IACS*, Raman Effect.

Dr. Mahendralal Sircar (1833-1904), Reverend Father Eugene Lafont (1837-1908) and many other patriots founded IACS, the first modern scientific institution in India during 1876. Its progress for one century has been recorded (Annon.1976) but lamentably with little emphasis on key personalities and scientists. The present author has attempted to fill up this lacunae (Biswas, 2000, 2001, 2003) and record the pre-independence history of the IACS in terms of some of the principal personalities such as Sircar, Lafont, Raman, Krishnan, Saha etc.[5] The publication of the recent most article has regrettably suffered from vital editorial deletions.[5] The deleted information and interpretation are crucially important; hence the necessity of this article.

Samarendra Nath Sen has admirably described the life of C.V. Raman (1888-1970) and his scientific work at Calcutta (Sen, 1988). K.S. Krishnan (1898-1961) was the lucky collaborator whose diaries dated 05-28 February 1928 are most revealing about the famous discovery. On 16 February 1928,

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Raman and Krishnan's joint paper, titled 'A New type of Secondary Radiation' was communicated to *Nature* where it was published on 31 March. The news of the discovery of 'Raman Effect' produced electrifying impact on the scientific community of the world.

In the words of Professor R.W. Wood, Raman Effect provided 'one of the most convincing proofs of the quantum theory of light'. In 1931 Lord Rutherford exclaimed: "The Raman Effect must rank among the best three or four discoveries in experimental physics of the last decade."

The whole world was euphoric. There was the volcanic eruption of publications centering the Raman Effect. Within six months of its announcement, more than 150 papers were published from different laboratories of the world. Bhagavantam reviewed that the number shot up to 350 by the end of June 1930!

Accolades were heaped on Raman: the Italian Matteuci Gold Medal (August 1928), Knighthood of the British Government (June 1929), President of the Indian Science Congress (1929), later honorary doctorate from the University of Freiberg, the Hughes Medal of the Royal Society, and of course the greatest reward, the Nobel prize in Physics from the Royal Academy of Sciences, Sweden conferred on 10 December, 1930 in Stockholm.

It may be recalled that in December 1875, when the leaders of the IACS movement advocated indigenous research in the area of basic sciences, one of the hostile critics wondered 'whether the IACS intended to produce Newtons, Galileos and Herschels', and then Father Lafont returned that retort by saying 'even that was not impossible'. Half a century later, the stand taken by Sircar and Lafont was vindicated; the IACS produced a Raman, a Nobel Laureate in Science, the first in Asia!

The Great Scientist

The universal interest in the applications of the Raman Effect is reflected in the publication of several works on Raman Spectroscopy over the decades. In 1939, the American Chemical Society (ACS) brought out the first publication, *The Raman Effect And the Chemical Applications*, in which we find brilliant theoretical discussions by J.H. Hibben and the great mathematical physicist, celebrated as the 'father of the hydrogen bomb', Edward Teller. The same ACS, in collaboration with the IACS, commemorated

on 15 December 1998, the designation of the Raman Effect as an 'International Historic Chemical Landmark'. The installed plaque hails the significance of this phenomenon as an analytical and research tool. It reads:

> "This method became even more valuable with the advent of modern computers and lasers. Its current uses range from the non-destructive identification of minerals to the early detection of life-threatening diseases".

In the wake of the discovery of the LASER light, characterized by pure frequency and high directionality, the Raman Effect has 'not only danced to the rhythms of molecular physics and analytical chemistry but also waltzed its way into the regions of biochemistry, biology, medicine, the environmental sciences and technology'. The Raman Effect has found a new home in the laser-producing laboratories of Harvard and Caltech.

Raman has also made distinguished contributions to theoretical physics. His work with N.S. Nagendra Nath (1935-36) related to ultrasonics and hypersonics yielded Raman-Nath theory. This theory, which states that when a plane wave of light passes through an ultrasonic wave field, it is speeded up in the regions of rarefaction, and slowed down in the regions of compression in order to emerge as a corrugated wave front, has been experimentally verified three decades later in February 1963, and utilized in various high-speed information processing systems and in experimental television systems. Even in the 1930's, Professor Max Born, Raman's colleague at the Indian Institute of Science, Bangalore, exulted: "Raman's quick mind leaps over mathematics"!

Raman possessed 'one of the truly seminal minds in the history of modern physics'. This is manifest in the very large categories of physical topics which his mind dabbled in.

Raman's Tribute to his Benefactors in Calcutta

The Indian Institute of Science, Bangalore founded in 1909, invited Professor Raman to succeed Sir M.O. Forster (1922-1933) and be the first Indian Director of the institute. Accepting the offer, Raman left the Calcutta University and the IACS in April 1933. Before his departure, Raman heaped words of eulogy on the city of Calcutta (Kolkata), the IACS and his benefactors.

In the historic gathering on 26 June 1931, the Corporation of Calcutta conferred civic honour to the Nobel Laureate, Professor Sir C.V. Raman.

The Mayor, Dr. Bidhan Chandra Roy read the Corporation Address, printed on 'Khaddar' with gold embroideries, and then presented the Address on an engraved silver tray. Professor Raman received the Address in the midst of thunderous applause from the assembly, and in a moving reply paid glowing tributes to Calcutta, IACS, Mahendralal, Sir Asutosh, Prafulla Chandra Ray etc:

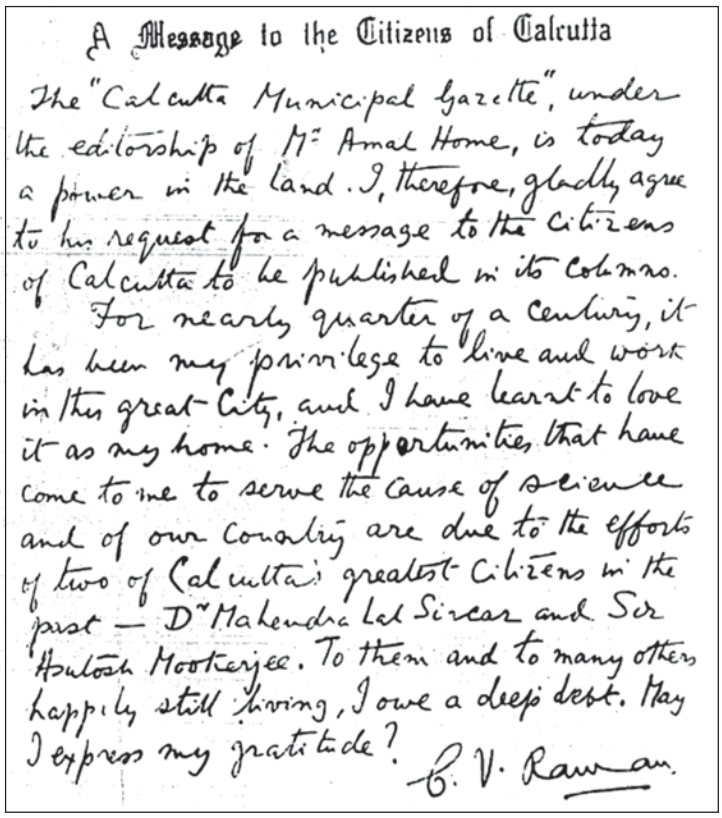
> "Permit me, Sir, to express my gratitude to you and to your Fellow-Councillors for what must be regarded as a supreme honour by every citizen of Calcutta…..
>
> …. .. " It has been my good fortune to have had during the past 15 years a long succession of highly gifted collaborators. To them, also, I am under a deep debt of obligation, for it is their assistance that has made possible much of the work that has emerged from my laboratory.
>
> "You, Sir, have said that you desire my association with Calcutta to be a permanent one. Let me say at once that this is also my earnest desire. I consider it my great good fortune to have been a citizen of Calcutta for nearly 25 years. Some have said that research work cannot be carried on successfully except in cool climates, such as those of Bangalore or Dehra Dun. A hot day in June is not an opportune moment to enter upon praise of the physical climate of Calcutta.
>
> "But from the point of view of research, there is something more important than physical climate, and that is the intellectual climate of the environment. For a hundred years, Calcutta has been the intellectual metropolis not only of Bengal, or of India, but of the whole of Asia. From Calcutta has gone forth a living stream of knowledge in many branches of study. It is inspiring to think of the long succession of scholars, both Indian and European, who have lived in this city, made it their own, and given it of their best. It must be a profound privilege to be able to work and live in such an environment.
>
> "Allow me to thank you once again for the great honour you have done me". The details of the speech have been reproduced elsewhere (Biswas, 2011, Sen, 1988).

Venkataraman's Journey into Darkness

The present author is indebted to S.N. Sen for his biographical work (1988) on C.V. Raman and his scientific work at Calcutta.[6] The records abundantly illustrate that the city of Kolkata and its inhabitants and institutions, in particular the IACS, on the one hand, and Sir C.V. Raman the

scientist on the other, were mutually indebted, and naturally thankful and respectful to each other in a profound sense. We may cite and reproduce a hand-written message of Professor Raman to the citizens of Calcutta in this context (Fig. 1). This mutually harmonious and affectionate relationship has been questioned by G. Venkataraman in his otherwise excellent biographical work on Raman: *Journey into Light* (Venkataraman, 1989).

Venkataraman wrote an acrimonious and stylishly sarcastic sub-chapter entitled 'Oh, Calcutta' in his book, alleging that the jealousy of adversaries (in Calcutta) was the root cause for Raman's departure from Calcutta to Bangalore. B.B. Baliga has made a similar charge, commenting wryly that 'in any society success breeds envy (Baliga, 1988).[8] Such insinuations have been leveled without an iota of truth or documentation.



A Message to the Citizens of Calcutta

The "Calcutta Municipal Gazette", under the editorship of Mr Amal Home, is today a power in the land. I, therefore, gladly agree to his request for a message to the Citizens of Calcutta to be published in its Columns.

For nearly quarter of a century, it has been my privilege to live and work in this great City, and I have learnt to love it as my home. The opportunities that have come to me to serve the cause of science and of our Country are due to the efforts of two of Calcutta's greatest Citizens in the past — Dr Mahendra Lal Sircar and Sir Asutosh Mookerjee. To them and to many others happily still living, I owe a deep debt. May I express my gratitude?

C. V. Raman.

Fig. 1. A message from Prof. Raman, in his own hand writing, to the citizens of Calcutta, printed in the *Calcutta Municipal Gazette*, dated July 4, 1931

For 25 years, Raman was surrounded by loving and competent Bengali scientists and Bengali students. He worked with 51 Research Associates according to the IACS record, of whom 22 were Bengalees. Who was 'jealous' or 'envious' of him? Dr. Meghnad Saha, towards whom a needle of suspicion has been pointed, was considered for Nobel Prize in 1930 itself (Rajinder Singh and Falk Riess, *Indian Journal of History of Science,* 34.1, 1999, pp.61-75). Saha wrote to the young S. Chandrasekhar, future Nobel Laureate, on 21 September 1929: "I hope you will continue to follow in the footsteps of your great uncle (Raman)". Saha and Raman disagreed with each other on several professional issues, but that has been a different matter.

Raman was never accused in Calcutta of any wrong-doing such as ignoring mathematical physics or bringing to his laboratory too many South Indian students; these were fictitious and imaginary charges brought out by Venkataraman for which he could not provide any evidence. On the other hand, Venkataraman documented the hostile treatment that Raman received at the Indian Institute of Science, Bangalore, where he was told at the end that 'he was unfit to continue any longer as Director'. Our complaint is that Venkataraman has been sacrilegious against the wonderful intellectual and liberal spirit of the inhabitants of Calcutta to which Raman himself has paid eloquent tributes quoted extensively by us. In his otherwise excellent biographical work *Journey into Light*, Venkataraman descended into darkness. His sub-chapter 'Oh Calcutta' is doubly objectionable since he did not use another caption such as 'Oh Bangalore'.

We may quote in this connection Raman's own student, the famous scientist Professor S. Bhagavantam, writing in the obituary printed by The Royal Society in November 1971: "Raman's association with the Indian Institute of Science was not a happy one ……whenever he referred to them (his experiences in Bangalore), he was very bitter". On the other hand, Bhagavantam has written under his own caption "The Golden Era of Calcutta (1917-1932)", which matches with S.N. Sen's detailed description quoted by us, and negates Venkataraman's dark insinuations (Bhagavantam and Raman, 1971).

What has led Venkataraman to hurl some unsubstantiated charges against the inhabitants of Calcutta? Robert S. Anderson has investigated the episodes of 1932-34 and written: "C.V.Raman slowly gained control over

the operation of the Calcutta institution (IACS), and his own attempt to limit membership, to only those of whom he approved, created an opposition group….. Following a dramatic showdown in an extra-ordinary meeting, Raman left the Association".[1]Venkataraman has himself conceded: "Raman had Himalayan ego and sharp tongue…… He certainly did not respect other people's feelings". Max Born the great scientist was quoted by Venkataraman: "Ego was part of Raman's problem". Despite his psychological problems Raman was adored as a hero in the city of Kolkata which has produced several other Nobel Laureates. This tradition is worthy of emulation by other Indian cities such as Bangalore.

Some More Developments in and around the IACS up to 1934

Dr. Mahendralal Sircar had himself looked for Ramans, but he failed to find one. His diary records that on 15 July 1898, Friday, he specially invited Babu Rajendranath Chatterjee, Professor in the City College and the IACS lecturer in Physics, and 'had some talk about conducting original research in the Science Association'. Before Mahendralal's death, Dr. Sarasilal Sircar made useful investigations in 1902 on the 'Crystallography of Copper Ferrocyanide'.

The tempo of research in the IACS picked up with the arrival of Raman in 1907. Two years later, the *Bulletin of the Association* regularly published original investigations of Raman and others, as well as the meteorological and astronomical observations. Gradually arrangements were made for the printing of the *Proceedings of the IACS*, the first volume of which appeared in 1917. By that time, Raman was the Professor in the Calcutta University and well-known in international circles. Many contributed articles were received even from outside the IACS, the Proceedings of which were in high demand from many international societies, which gleefully exchanged their publications with the IACS. In 1919 after the expiry of Amritalal, Raman took up the Secretaryship of the IACS.

The financial position of the Association was never satisfactory. It could not provide the salary of a full-time Professor before the 1930's. Dr. Durgadas Bose, Rai Bahadur Omkarmal Jatia, Mr. M.S.I Chari etc donated some money for the development of laboratory and workshop. During 1925-26, Government of India sanctioned a non-recurring grant of Rs. 10000

towards the renovation of the laboratories. In 1927, GOI increased the annual grant to Rs. 20000 for a period of five years. After a couple of years, a liberal donation of rupees one lakh by Rai Bahadur Veharilal Mitra helped the Association to create an endowment Mahendralal Sircar (MLS) Research Professorship.

In the very early stage (1913-14), S.K. Mitra and P.N. Ghosh had worked with Raman at the IACS. They, as well as M.N. Saha and S.N. Bose (who were never Raman's students), became Raman's colleagues at the Science College 1917, and became internationally reputed professors. M.N. Saha went abroad and then to Allahabad University, and S.N. Bose joined Dacca University to head the Physics Department in June 1921. Bose's world-famous research on quantum physics elicited the equally famous letter of appreciation dated 02 July, 1924 from Albert Einstein. To-day, the Bose-Einstein and the 'Boson' particles are text-book topics.

K.S. Krishnan collaborated with his guide since 1920, and in February 1928 discovered 'Raman Effect'. In his Krishnan Memorial Lecture delivered at the National Physical Laboratory, New Delhi on 12 March 1971, Professor Satyendra Nath Bose said: "Krishnan was much younger than us, and a very quiet sort of person. He had worked assiduously and without sparing himself…. Some people thought that it (the discovery) should be called the 'Raman – Krishnan Effect'; but Raman himself would have been angry if anybody had said it".

Within five months after the famous discovery at the IACS, Kolkata, the Dacca University advertised in the British journal *Nature* (July 1928) for the position of a Reader in the Physics Department under the Professorship of S. N. Bose. Krishnan applied for the post on 28 September with testimonials from his teachers: C.V. Raman, S.K. Mitra, D.M. Bose, P.N. Ghosh etc, and was duly selected. Krishnan joined the Dacca University on 15 December 1928. Many details about 'Krishnan at Dacca University' are available in A.K. Roy's lengthy paper from Bangladesh (K.S. Krishnan Birth Centenary Special Issue, *Indian Journal of Physics* 73S (1), December 1999, pp. 273-332).

Krishnan's work, while he was in the Dacca University, may be classified into two groups, namely Spectroscopic and Magnetic. His spectroscopic works include Raman Effect, conventional spectroscopy,

birefringence (having two different refractive indi--), and pleochroism (showing different colours when viewed in different direction) in ionic crystals, anisotropy of polarizing fields in liquids, effect of molecular shape in optical and electrical properties of liquids. In the area of magnetics, he made major and significant contribution in the magnetic anisotropy in relation to crystal structure both in inorganic and organic compounds.

Krishnan could not forget his old institution i.e IACS, and kept close contact with it. During his vacations he would spend his time in Kolkata, working at the IACS laboratory. C.V. Raman joined the Directorship at the Indian Institute of Science, Bangalore in April 1933 and was desirous to fill the vacuum at the IACS by recruiting Krishnan. In his letter dated 5th of April 1933, Krishnan at Dacca wrote to the Vice-chancellor, Dacca University: "Professor C.V. Raman has offered to propose my name for the Mahendralal Sircar Research Professorship at Calcutta, which is to be filled up shortly". At Dacca itself he applied for two years' leave from the university, and then proceeded to Calcutta for summer vacation. On 1st of June he informed the Registrar of the Dacca University that in the IACS Committee of Management meeting held in Calcutta on 23rd May 1933 he was offered the Professorship. He left Dacca to join IACS on leave from the Dacca University, sometime in December 1933, but never rejoined and finally resigned in August 1935.

Robert S. Anderson has quoted Max Born's letter to Lord Rutherford written in October 1936 (Rutherford papers at the University Library, Cambridge): "I know the following from Professor M. N. Saha himself. He had hoped to become the successor of Raman in (IACS) Calcutta, and Raman may not have helped him to get this post…… His pupil Krishnan got it. Since then Saha attacks Raman when he can. They have other objects of quarrel". [1,2]

The Momentous Events of 1933-34

The crucially important chain of events in 1933-34 which culminated in the showdown Annual General Meeting on 19 June 1934 has not been recorded meticulously by Sen (1988), Venkataraman (1989), Anderson[1] or even in the Official publication *A Century* (Annon.1976).The IACS Annual Reports of 1933 and 1934 are also silent on the crucial issues and contain merely Part I 'Report on Scientific Investigations' and Part II 'Administrative

Report' on routine matters minus the crucially important developments. Fortunately, the 1935 Annual Report submitted in 1936 recorded what had transpired earlier. No worthy historian should ignore or suppress such important documentary evidences!

During 1924-1927 C.V.Raman had received Government of India (GOI) grants for improving the equipment of the Association. Then came the munificent Veharilal Mitra Donation of one lac of rupees with which the MLS Professorship was created. Raman joined IISc. Bangalore in April 1933 and Krishnan joined the IACS (MLS) Professorship (offered to him in May 1933) by the end of 1933. Presumably, Raman was shuttling between Bangalore to Calcutta during 1933-34 to settle the affairs of the IACS and that is when the problems erupted. Now let us quote the relevant portions of the 1935 Annual Report:

> "Changes in the Administration: It was found that unauthorized transactions had been effected in a number of instances and liabilities thrown on the Association without proper sanction. The position of the MLS Professor, his duties and the sources of his salary required to be definitely laid down. In order to understand the following record of the steps taken by the Managing Committee, it is necessary to give a short account of the affairs of the Association. The Managing Committee takes this opportunity also of devoting a few lines to the history of the Association, as such an account is not available.
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> (The account goes on pp.1-4). Then in p.5:
>
> "Criticism of the Administration (presumably of 1933): Some actions of the (earlier) Managing Committee came in for criticism both from members of the Committee and from outside. Two very prominent members of the Committee, one of whom was a trustee of the Association, proposed the names of distinguished educationists for membership of the Association. A majority voted down the proposal.
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> "One of the oldest standing rules of the Association provided that a person contributing Rs 250/- to the MLS Memorial Fund would automatically become a member of the Association. An attempt was made to rescind the rule. The resolution of the Managing Committee (vide meeting dated 20th May, 1933, item 12) rescinding this rule (the effect of the deletion would have made the Association a closed body), however, required to be confirmed at a General Meeting of the Association.
>
> "About seventy prominent persons took advantage of the rule by contributing Rs 250/-each towards the MLS Memorial Fund and the deletion of this rule was prevented.

> "At the Annual General Meeting held on the 19th June 1934, presided over by Sir C.V. Raman, a new Managing Committee was formed unanimously with Sir Nilratan Sircar as its President".

The 1934 Annual Report did not contain the above details but mentioned Professor S.K. Mitra as the Secretary. Till 19 June 1934, K.S. Krishnan was functioning as the Secretary. In November 1935, Professor J.N. Mukherjee took over as the Secretary, and only then the Report which is being quoted by us was prepared.

On the 2nd of March 1935, GOI desired, as a condition of the grant provided, that one representative of the GOI should be included in Managing Committee. The IACS agreed that 'the association of a representative of the GOI in the Managing Committee would be a source of strength and in the best interests of the institution'. The conditions laid down by the GOI were 'therefore unanimously accepted'.

The earlier steps for arbitrary amalgamation of different funds were not approved, but a solution was found both to ensure the necessary income for meeting the salaries and Provident Fund contributions of the MLS Professor (Krishnan) and to restore the specific donations for the purposes for which they were intended. The duties and privileges of the MLS Professor were defined. He was put in charge of the laboratory, the workshop and the library, became ex-officio member of the Managing Committee and the Editorial Board of the *Indian Journal of Physics*. He would serve as a whole-timer officer of the Association under the Managing Committee.

The 1935 Annual Report ended with some concluding remarks:

> "There is a large field for work in other branches of science; the Association should undertake to fill up the gaps in scientific education and research not covered by other institutions. The Association can render invaluable service to the community in various ways. The ideal for which the institution was founded has only been fulfilled in part. There is still a large void for an institution like the IACS to cover. A well thought-out scheme should supplement and not compete with the activities of the other institutions.
>
> "What is best in the old culture, social, economic or philosophic, can be best preserved by a timely and proper adjustment in accordance with the living facts of the present situation. In all this work of adjustment, science must be encouraged to make its contribution…….There is no doubt

> something is being done, but what is more important is what should be done and is not being done".

Professor J.N. Mukherjee the Honorary Secretary of the IACS, concluded his 1935 Annual Report with a new vision of hope, and thanking the President, Dr. Nil Ratan Sircar, Dr. W.A. Jenkins, the GOI representative, and the MLS Professor K.S. Krishnan.

Krishnan must have been delighted in the new company of the great colloid and agricultural scientist, Professor Mukherjee, a renowned ex-student of Acharyya P.C. Ray. There was absolutely no trace of envy, jealousy or rancour in the Association or the city. We have quoted Anderson (p.21) earlier, writing that 'Raman left the Association following a dramatic showdown in an extra-ordinary meeting (June 1934)'. This is just not true. Raman had left IACS one year ago and joined I.I.Sc. Bangalore in April 1933!

The Era of Krishnan

Professor Kariamanikkam Srinavasa Krishnan (1898-1961) joined the IACS as Professor sometime in December 1933. He had been in constant touch with the Association ever since 1920, even during his stint at the Dacca University (1928-1933).

We have briefly mentioned his spectroscopic and magnetic work at the Dacca University which he continued at the IACS. With A. Mookherji, A. Bose, N.Ganguly etc. as co-workers, Krishnan continued vigorously the study of the magnetic properties of the salts of the rare earth and iron groups, and integrated the results of the measurements on the crystalline electric fields of crystals with the theoretical conclusions of Van Vleck, Penney and Schlapp.

Many of Krishnan's papers were published in the *Philosophical Transactions of the Royal Society*. Ganguly and Krishnan, in a classic paper in the *Proceedings of the Royal Society* (1941), established that the diamagnetism of graphite is very large indeed along the hexagonal axis, and that certain of the electrons in such a crystal, form a two-dimensional electron gas. Further, from the temperature-variation study, they concluded that the energy distribution of electrons in graphite obeyed Fermi-Dirac statistics.

Measurements were extended to anomalous 2d metals, bismuth, antimony, pyrite and marcasite. Commenting on this work, T.V. Ramakrishnan has written in *Current Science* (1998) that the theoretical explanation still remains intriguing, and that Krishnan remained a pioneer in the area of quantum approach to understanding phenomena in condensed matter. He was ahead of others in going into research on semi-conductors.

In 1937 Krishnan was invited to lecture in the Cavendish Laboratory, Cambridge and the Royal Institution, London and then Liege University Medal was awarded to him. In 1938 Krishnan set up the first cryogenic experimental facility down to 90^{o} K at the Association with his young student Akshayananda Bose, and became the pioneer in this field in India.

With the outbreak of Second World War, there was the immediate threat of Japanese attack on Kolkata, and it was decided to close the IACS temporarily. Krishnan moved to the University of Allababad (in 1942) where the position of Professorship in Physics had fallen vacant on account of Professor Meghnad Saha coming to the Calcutta University in 1938.

At Allahabad, Krishnan reviewed in a systematic way, various problems of the classical scattering of light, X-rays and electrons, of quantum theory, wave mechanics and statistical thermodynamics. In collaboration with A.B. Bhatia, Krishnan undertook a theoretical investigation on the electrical conductivities of metals and alloys and a special interest in the order-disorder phenomena related to metals and alloys.

After independence in India, Krishnan joined the National Physical Laboratory as the Director, and worked on thermionics in collaboration with S.C Jain. Towards the end of his career, he gave much thought to obtain an integrated picture of the problems of the solid state.

Krishnan was the recipient of many honours both in India and abroad, such as, Fellow of the Royal Society, London (1940), British Knighthood (1946), General President, Indian Science Congress (1949), Padma Bhusan (1954), the first recipient of the Bhatnagar Memorial Award (1961), the National Professorship etc. He passed away in 1961.

Resembling Professor Satyendranath Bose, Krishnan had great love for Indian languages and believed that sophisticated scientific papers can be and ought to be written in Bengali, Tamil etc.

From long association since 1920, Krishnan developed a very loving attachment to the IACS. One of his students A.K. Dutta provided some touching personal reminiscences (*Indian Journal of Physics*, 73 S (1), 1999, pp. 95-100):

> "There was a 'Tea Club' for all research workers of the Association which had its sitting on every week day at 4 p.m., and Professor Krishnan was regular in attending the tea club sitting. Besides research and contemporary scientific activities, all other items from politics to religion were discussed over a cup of tea and some snacks and cheap fruits like cucumber, tomato, banana etc. Though Professor Krishnan was always the most prominent speaker, we were also free to give our independent opinions there.
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> "The venue of the club was the well of the Lecture Hall. A long table with long wooden benches on both sides were laid in the middle of the vacant well surrounded by wooden gallery on three sides. On the galleries one could find the bed rolls of the scholars.

Most of the scholars were then staying within the precinct of the Association. If by chance the bed rolls were removed inside the two corner rooms of the lecture hall behind the galleries, it attracted the attention of Professor Krishnan and he used to enquire the whereabouts of the beds. We learnt then that Professor Krishnan used to live in a way similar to us during his early days as a scholar of the Association. One day Professor Birbal Sahni F.R.S. visited us and narrated how he also once stayed inside the Association like us, being invited by Prof. C.V. Raman.

> "Once during the national movement days, young Krishnan had witnessed a police lathi charge near the Bowbazar-College Street junction, then wounded persons being brought within the Association premises and a doctor giving injections to some of the wounded. He was told by a friend that the doctor was none other than Dr. Bidhan Chandra Roy and side by him stood another great leader, Tulsi Charan Goswami".
>
> "Even when at Allahabad (after 1942), Professor Krishnan used to visit Calcutta frequently on various official or personal business. He often came directly to the IACS from Howrah station, kept his luggage, took bath in the shabby universal bath room of the Science Association, used by all inmates (scholars, bearers and other staff residing inside the precinct of the IACS and their friends and relatives) of the IACS as well as some people from Bowbazar Market ! He used to leave shirt and trousers, and dress with dhuti, panjabi and chaddar and leave for houses of his friends and relatives. This I had seen several times. At the seminars, conferences or conventions outside Calcutta, Professor Krishnan never failed to identify

> people from IACS present there, and talk to them as if with relatives and friends he was meeting after a long time".

Immediately after C.V. Raman's departure from Calcutta in 1933, his Tamilian student K.S. Krishnan started his professorial life of bliss for a decade in Calcutta, guiding a total of 44 students from all over India of whom 17 were Bengalees. He did not face any regionalism or factionalism, as A.K. Dutta's reminiscences abundantly illustrate, while during the same period, namely the 1930's his teacher C.V. Raman faced in Bangalore 'endless wrangles even amongst students' in the words of Venkataraman (pages 277 and 280). Anderson has quoted (p.107) the 1936 Irvine Report (pages 10 & 11) on the Indian Institute of Science, Bangalore: "There must be in the institute a spirit of harmony and co-operation which we fear does not at present exist. There can be no doubt that an atmosphere of insecurity and misery has been created". The present author had written from I.I.T. Kanpur on the 8th of May 1989 complaining to the President of the Indian Academy of Science, which had published Venkataraman's controversial book and objectionable remarks captioned 'Oh Calcutta', but did not receive an acknowledgement let alone an apology !

In the later years C.V. Raman mellowed considerably and amazed everybody with his versatile interest in the diverse aspects of Science and Nature. His deep and abiding interest in optics, electron diffraction and crystal physics led him to the wonderful world of minerals and gems like diamond. During the last 12 years of his life till his death on 21 November 1970 he was interested in the colour of gems, colour of flowers (such as rose, *Current Science*, 38, 503, 1969) and also the physiology of vision. In 1968 his book *Physiology of Vision* was published. Throughout his entire life, he was obsessed with the beauty of light and sound, their propagation, properties and perception. Prof. Bhagavantam wrote:

> "Raman was richly endowed with a child-like sense of wonder at the unknown and not understood facets of nature, so that, throughout his life, he was pushed into exploring these aspects …… Subjects like colours, origin of minerals, birds and butterflies, the blue of the ocean, the sky and other natural phenomena were his primary concern".

The present author had the privilege of coming in contact with the great scientist twice in his career. He wrote to me on the 25th of July 1959 from Raman Research Institute describing his contact with Father Lafont.

Then a decade later, he visited us at the Indian Institute of Technology, Kanpur, addressed the students and even the Campus School children and described most enthusiastically, his child-like wonder at the mystery of vision and the colours of roses, begonia and red oleander!

For two decades after the departure of Raman, the IACS was benefited by the soft, quiet and unobtrusive leadership of K.S. Krishnan (1933-1942) and the bold and imaginative leadership of M.N. Saha (1944-1956). In our narrative (Biswas, 2011) we have partially adopted a prosopographical approach linking the IACS with four great personalities: Sircar, Raman, Krishnan and Saha, who moulded the Association during specific periods. Such an approach of prosopopoeia or 'personification of abstract thing' (dictionary meaning), adopted for the sake of convenience, is only partially valid and legitimate. One can certainly argue for the inadequacy of such an approach on several grounds: (a) there were other very important personalities such as the benefactors, and Lafont, Amritalal, Asutosh, Priyada Ranjan Ray etc, (b) the four heroes that we have chosen had, every one of them, vast segments in their careers not connected with the IACS ; and lastly, and most importantly, (c) an institution can never be fully represented by an individual howsoever great. Yet the complex interaction between personalities and an institution needs deeper scrutiny and analysis.

The ideal that the IACS formulated for itself in 1876 and pursued was too great, in the words of John Woodburn, one of the Lieutenant Governors in the British Raj, to be fulfilled during the lifetime of one person such as Dr. Mahendralal Sircar. Thus we find that not only Mahendralal, but also the other heroes, namely Raman, Krishnan, Saha, left the IACS scenario with a fair measure of unfulfilled desires in their hearts. At the end of this article we may pose a question and solicit an answer: whether the majestic ideal of the IACS should be allowed to be pruned down to a small 'realistic' size or we should take measures to pursue it comprehensively to the best of our abilities. In any case, the saga of the *IACS: A Nation's Dream* is much bigger than the individual glories of four (or even more in number) heroes of immortal fame put together.

Reference and Notes

1. Anderson, 1975, p.21, p.107, p.109 etc.

2. The present author heard from S.N. Sen that Saha, as a junior colleague of Raman in the Calcutta University during 1917-18 had difficulty in getting easy access to the X-ray Laboratory. Sir Asutosh Mookerjee had to intervene and help Saha in one instance.

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