PRIYADARANJAN RÂY

(1888–1982)

Foundation Fellow

"THE life that is well spent is a long life", wrote Leonardo da Vinci. This beautifully summarizes the life of PRIYADARANJAN RÂY who lived upto ninety four years, combining in himself the erudition of a scholar, creativity of a scientist, wisdom of a philosopher and saintliness of an ascetic. His death has left a void, hard to fill.

Professor Rây symbolized the best of Indian tradition and philosophy, buttressed with scientific reasoning, analytical approach and a missionary zeal in the pursuit of knowledge. He was an example of modesty, which is expressively recommended to the scientific worker in the 'Essay on Man' by Alexander Pope : Modesty thy Guide.

His researches cover various aspects of coordination chemistry, magnetochemistry and microchemistry and he is aptly considered a doyen of inorganic chemists in India. Neither glamour nor publicity had any attraction to him, even though they followed at his heels.

Successive generation of chemists were trained by him, many of whom have earned distinction in their lives. Neither age nor his virtual blindness during the last fifteen years deterred him from creative activities. As 'Paradise Lost' flowed through the blindness of Milton, Rây's moving finger moved on during these years through science, philosophy, religion, culture and socio-economic problems. His writings are 'Paradise Regained' for us.

To him, science and spirituality were not contradictory, but complementary and he believed in their harmonious orchestration. Priyadaranjan was neither a dogmatist nor an agnostic, but like Sri Aurobindo, realised the limitations of physical science. Science, to him, is not the ultimate, but a means to pursue what is beyond. It never corrupts the concept of God, but only confirms the divine superiority and man's limitations. He believed that there was nothing in science that could in any way disturb religion which has its foundation not on irrational doctrines and unscientific creeds but on the deepest experiences of the soul. Knowledge for its own sake and service to mankind were his motto and truthfulness and righteousness were his principal code of conduct. He was a great believer in the rationalizing influence of science on the human mind and thinking. Few men have been so catholic as Rây. He always used to extend his sympathies and charities to all who approached him to help the needy to the best of his power.

Early Life and Education

Priyadaranjan was born on Monday, January 16, 1888 in a well-known zamindar (landlord) family in the village Noapara in the district of Chittagong (now Bangla Desh). This village, situated on the bank of the river Karnafuli, was the home of the ancestors of the Ray family for over 200 years. Anand Rây, an ancestor of this Ray family, migrated during the Maharashtrian uprising (1663-1680) from the village Tribeni in the district of Hooghly (of the present West Bengal) to the state of Tripura. His eldest son Vishnuprasad was an intelligent and accomplished person who secured a high rank in the court of Nawab Murshidkuli Khan of Bengal. In recognition of his meritorious services, he obtained from the Nawab several villages of Chittagong district to establish the zamindari for the Rây family. His eldest son settled at Noapara village, which thus became the ancestral home of Priyadaranjan.

This zamindar family of Noapara was well-known for their benevolence, righteousness and service for the promotion of education and learning. The famous poet of Bengal, Nabin Chandra Sen, belonged to this family. There were quite a few other illustrious personalities of Bengal who had their origin in this Rây family. They were Akhil Chandra Ray, the renowned advocate of Calcutta High Court, Rajani Ranjan Sen, well-known literateur and Birendra Binode Ray and Bibhuti Bhushan Sen, the reputed educationists. Priyadaranjan's father Kali Kumar Rây, was a Sub-Deputy Collector of Rangamati in Chittagong, and his mother Shymasundari Devi was an accomplished lady of enlightened views, to whom Priyadaranjan was deeply attached. He was the third of the four sons and three daughters of his parents.

Priyadaranjan had his early education in the village *pathsala,* where he came under the tutelage of Rashmohan Sen, a teacher of repute and profound integrity. Having finished his primary education, he joined the Chittagong Collegiate school in 1899. In the year 1902, when he was a student of class IX, his father expired. In spite of this mishap, Priyadaranjan passed the entrance examination from Chittagong Collegiate School in 1904 in the first division securing the 'Rai Bahadur Golakchandra Scholarship'. He then joined the Chittagong Government College and passed the FA (First Arts) examination in 1906, securing a merit scholarship and a certificate for originality in Bengali composition, a talent which found prolific expession in his later scientific and phllosophical writings.

At the Presidency College, Calcutta

In July 1906, Priyadaranjan came to Calcutta for higher education and joined the first year BA class in Presidency College. He became a boarder of the Eden Hindu Hostel, where Dr Rajendra Prasad the first President of India, was a fellow boarder and monitor. At the Presidency college, he came in contact with renowned teachers like Principal H M Percival, Acharya Jagadish Chandra Bose and Acharya Prafulla Chandra Rây. In 1908, he passed the BA Examination from Presidency

College with Honours in both Chemistry and Physics. In addition to the science subjects, he studied English, Bengali and Sanskrit languages in his BA course. Later he attained proficiency in German language also. Acharya Prafulla Chandra Ray's inspiration persuaded him to take chemistry for his MA examination, which he passed in 1911 securing the first class first in the order of merit, and thus, secured the University Gold Medal and the Motilal Mullick Gold Medal. In his MA class he had Hemendra Kumar Sen, Biman Bihari De and Ramesh Chandra Ray as his fellow students. All of them subsequently attained distinction as renowned chemists and teachers.

Early Career and Accident

In 1911, Priyadaranjan started research work in inorganic chemistry under Sir P C Rây at the Presidency College. In collaboration with his colleague H K Sen, he published his first paper entitled "The action of hydrazine and hydroxylamine on ferricyanides and a new method for the estimation of hydrazines and ferricyanides" [Die Einwirkung von Hydrazin and Hydroxylamins auf Ferricyanide und neuer Methoden zur Bestimmung von Hydrazin and Ferricyaniden]. which was published in Germany in *Z. anorg. Chem. 76, 380, (1912)*. On August 12, 1912, he met with a severe accident which culminated in total loss of his left eye and serious damage to his right eye and other parts of his body. Professor N R Dhar gives the following description of the accident : "We contemplated a joint research project in 1912 on complex formation between cuprous thiocyanate and potassium thiocyanate. I tackled the problem from electric conductivity measurement and he took up the thermal method by fusing potassium thiocyanate to which copper thiocyanate was added. Unfortunately the beaker containing potassium thiocyanate which was being heated on a bath of strong sulphuric acid, broke down and there was a terrible explosion, which ruined one of the eyes of Priyadaranjan Rây". At the instance of Sir P C Rây, he was immediately removed to the Calcutta Medical College Hospital, where he remained a cabin patient for about a couple of months. He was practically incapacitated thereafter and had to stay away from Calcutta for about two years to recuperate his lost strength.

Teaching Career at the University College of Science, Calcutta

He returned to Calcutta in 1914 and joined the City College as a Professor of Chemistry. At this time, Sir Asutosh Mookerjee, the Vice-Chancellor of the Calcutta University, was looking for competent young teachers and research workers to join the newly established University College of Science, to help and assist Acharya Prafulla Chandra Rây, then Sir Tarak Nath Palit Professor and Head of the Department of Chemistry, who would be able to develop the university to an advance centre of scientific research and teaching in the country. Priyadaranjan was one of those who was picked up by Sir Asutosh for this purpose and in the year 1919 he joined the University College of Science as Assistant Palit Professor of Chemistry.

Here he devoted himself to teaching and research and was given the charge of organizing and developing the inorganic chemistry section of the Department of Chemistry. It was by his devotion and perseverence that he ultimately succeeded, inspite of many odds, in establishing a renowned school of modern inorganic chemistry in the University College of Science. Here he devoted the best part of his research career for nearly four decades till his retirement, in 1952.

In the words of his *guru,* Sir P C Rây : "Priyadaranjan Rây is regarded as an acknowledged authority on complexes and valency and also on microchemistry and it is my practice to submit my own papers to his criticism and judgement before they are contributed to the chemical societies. My presidential addresses at the annual meetings of the Indian Chemical Society of 1926 and 1929 are based mainly upon his ideas and suggestions. A more silent and unobtrusive worker is seldom to be met with." Priyadaranjan had always been a silent worker throughout his life, who never had any lust for decoration, such as a doctorate degree, nor any inclination for foreign travels. It was through much effort that Sir P C Rây could persuade him to visit Europe on a Ghosh Travelling Fellowship of the Calcutta University. He went abroad as a Visiting Professor to work in the laboratory of Professor Fritz Ephraim in Berne, Switzerland in 1929. Here he had to undergo optical microsurgery to improve the partial vision of his right eye. In 1930, he became associated with the Austrian microchemist, Professor Frederic Emich in Graz. Finally, he made an extensive tour of Europe, visiting many renowned chemical research centres in Germany, France, Czechoslovakia, Hungary, Holland and England and returned to India by the end of 1930. He never left India again in spite of numerous invitations from abroad to attend international seminars and conferences.

He resumed his teaching work as a lecturer in inorganic chemistry in the university. In 1937, he was appointed as Khaira Professor of Chemistry and in 1946 as Palit Professor and Head of the Department of Chemistry.

He was spell-binder as a teacher. Students of inorganic chemistry from all parts of India came to learn at his feet. He taught and guided them with meticulous care. He was passionately devoted to teaching, both in the lecture hall and in the laboratory. What was appreciated most was his ability to explain difficult subjects with great lucidity. He never went beyond what was relevant, having been always precise and to the point. He stood up to the ideals of a true teacher—one who is interested not in the extent of his teaching but in assessing how much his students have understood and learnt of all that has been taught. His detailed guidance in practical work was of lasting value and thus left a deep impression in the minds of his students. Scores of them got doctorate degrees and went abroad to seek fresh laurels. He wrote hundreds of illuminating scientific papers, while world recognition waited at his door.

At the Indian Association for the Cultivation of Science, Jadavpur

While still in service at the Calcutta University, Professor Priyadaranjan Rây kept

intimate contact with the Indian Association for the Cultivation of Science as its Honorary Secretary and subsequently as its Honorary President. It is the oldest research institution in India, having been founded by Dr Mahendra Lal Sircar as early as 1876 with the intention to "combine the character, scope and objects of the Royal Institution of London and of the British Association for the Advancement of Science". After retirement from the Calcutta University, he formally joined the Association as an Honorary Professor with Professor Meghnad Saha as its Director. When Professor Saha died on 16 February 1956, Professor Ray took over charge of the Association as its Director. He was mostly responsible for organizing the chemical research wing, where he activated a new school of modern inorganic chemistry. During this period he donated Rs 30,000/- to the M N Saha memorial fund of the Association out of his remuneration. After he finally retired from the IACS in 1958, he ceased to be actively associated with any research laboratory. Instead, he continued to function as a Supervisor-in-Charge of the History of Science unit of the Indian National Science Academy at the Asiatic Society, Calcutta for several years, guiding the investigations of a team of young workers on the progress of science in ancient and medieval India.

Scientific Contributions

Modern inorganic chemistry is to a large extent concerned with various aspects of chemical species all of which belong to the class of coordination complexes in a broad sense. Professor Rây's contributions cover such diverse aspects of coordination complexes like studies on new types of ligands, stabilization of unusual oxidation states of metals through coordination, structure and stability of complexes etc., and applications of complex-formation and complex-formers in the detection and estimation of metals in macro and micro quantities. An impartial assessment of the quality of his research work is possible only in the context of similar contemporary work in India and abroad, and of the methods and techniques then available for elucidation of structure, bonding, etc. Some of his suggestions regarding structures of some of the compounds investigated by him have been modified in view of data obtained by means of more sophisticated techniques, but these are merely the usual process of evolution in science. But many of his findings and suggestions have withstood critical scrutinity, and are still referred to widely in current lieterature. The honour and esteem in which Professor Rây is held is revealed in an article 'Die neuere Entwicklung der anorganischen Chemie' [Silver Jubilee Souvenir, National Academy of Sciences (India), p. 120] written by Professor Wilhelm Klemm, Director, Anorganisch-chemisches Institut, University of Munster, West Germany. Professor Klamm wrote as follows :

"In giving an account of the modern developments in the field of inorganic chemistry, I cannot conclude without referring to the contributions of the Indian workers in this field. Mention of names like Raman, Krishnan and P Rây will, in my opinion, suffice for the purpose".

The first publication of Professor Rây appeared in the year 1912, on the reaction of hydrazine and hydroxylamine with ferricyanide and its application as a new method of estimating hydrazine. This was followed by studies (1920) with Professor P B Sarkar, on the complexes of the type M $(N_2H_4)_2$ $(SCN)_2$ formed by bivalent metals, which were later utilised by Sarkar and coworkers for the gravimetric estimation of nickel, cobalt and cadmium. The considerable amount of work done by Professor Rây and his associates on organic reagents has led to the introduction of substances like rubeanic acid and its derivatives, quinaldinic acid, dimercapto-thiobiazone (now known as Bismuthiol-I), biguanide, cystin and several substances (amidoximes, hydroxamic acid etc.) as useful analytical reagents for volumetric, gravimetric and spectrophotometric determination of metals.

It may be mentioned that rubeanic acid is still the most sensitive reagent known for the identification Cu^{2+} ion. In faintly ammonical medium it can detect one part of the metal ion in about thirty million parts of the solution (1926). Use of this and of several other complex forming reagents for the spectrophotometric estimations of several metals have been described (1956–60). Precipitation methods involving internal generation of the reagent (homogeneous precipitation) are recognized now a days as much more useful than the conventional methods of adding the reagent from an external source. This principle was applied as early as 1928 by Professor Ray in the quantitative separation of the less basic trivalent metals of the ammonia group of the usual analytical scheme from the more basic bivalent metals like Zn, Mn, Ni and Co, using urotropin (hexamethylenetetramine) for generating ammonia in situ. Mention must also be made of a novel volumetric determination of HgO in mercury compounds, in which HgO is reacted with sodium thiosulphate and the liberated alkali is then titrated with standard acid.

Professor Ray's contributions on various aspects of coordination complexes have been no less significant. Some of the major contributions will be mentioned briefly. The isomerism of thiosulphuric acid was clearly established for the first time by him by isolating two isomeric forms of the complex acid $H_4[Co(CN)_5S_2O_3]$ which exhibit different modes of decomposition corresponding to that expected for the two linkage isomers derived from the isomeric forms of thiosulphuric acid. The complex thiosulphatopentacyanocobaltate (III) ion is a novel one and it forms stable salts; the potassium salt was obtained by treating the complex salt $[Co(NH_3)_5S_2O_3]$ Cl, also prepared by Professor Ray, with excess of potassium cyanide. Several other thiosulphate and sulphito-ammine complexes of cobalt (III) have been prepared and studied by Ray and coworkers.

In 1925 Professor D M Bose, Ghosh Professor of Physics, Calcutta University became interested in the magnetic behaviour of some compounds containing paramagnetic ions of the iron group. Many of these compounds had six molecular groups like water or ammonia and belonged to Werner's classification as coordination compounds. Some ammoniated compounds were found to be diamagnetic, while the hydrated compounds were paramagnetic. To account for such anomalous behaviour, Bose proposed a rule, which subsequently became known as Bose-Welo rule. Bose became interested in the experimental study of Werner's class

coordination compounds, when he came to know that Professor Ray, the then lecturer in the chemistry department was preparing a novel group of coordination compounds. Thus Professor Ray was attracted to the domain of magnetochemistry and became a pioneer in the field in India. His first paper in magnetochemistry is entitled : "Magnetic properties of complex compounds and their electronic constitution."

The constitution of the two isomeric forms of the salts of the complex cation $[Co(NH_3)_5NO]^2$ was established by measurement of magnetic moment (1943). The black form being paramagnetic, was considered as the usual cobalt (II) complex containing coordinated NO molecule, while the diamagnetic red variety was thought as a complex of cobalt (III) containing NO^- ion. These assignments clearly followed from the well known principles of magnetic moment and its relation to valency in complex compounds. The complexing ability of biuret, $H_2N.CO.NH.CONH_2$ is well known, the Cu^{2+}—biuret reaction being a classical example. Replacement of the O in the –CO– groups in the biuret by NH and/or S might be expected to lead to more pronounced complexing ability. In fact, Emisch as well as Friedrich, described a few compounds of copper, nickel and cobalt with biguanide in the latter half of the nineteenth century even before Werner's classical work on coordination complexes. Ray and his coworkers (1937–60) have systematically investigated the ligational properties of biguanide, $H_2N.C(:NH).NH.C'(:NH) — NH_2$ and its derivatives dicyandiamidine, $H_2N.C(:HN).NH.CS.NH_2$, and dithiobiuret, $H_2N.CS.NH.CS.NH_2$. The metal complexes of a large number of Schiff's bases have also been investigated.

The complexes of biguanide and its derivatives are particularly interesting because stable chelate complexes of biguanides have been obtained with a number of common bi-and tri-valent metal ions. The square-planar complexes of the substituted (unsymmetrical) biguanides with copper (II) have been obtained in two different coloured modifications whose infrared spectra have indicated the possibility of cis-trans isomerism. Several nickel (II)-biguanides have also been obtained in different coloured modifications. A series of tris-biguanide and a few bis-biguanide complexes of Cr(III) and Co(III) have been prepared, as also some dicyanobisbiguanide complexes of cobalt (III).

The mode of linkage of the ligand in metal-biguanide complexes was inferred by chemical methods. Complexes of substituted biguanides having an acid group (—SO_3H) in the substituent, present another interesting class of inner-metallic complexes. Ethylenedibiguanide, Etdi (bigH), is a quadridentate ligand which has been useful (1944) to stabilize the tripositive state of silver in the form of orange-red complex $[Ag\{Etdi(bigH)\}]X_3$. This is the most stable compound of silver (III) known so far. Its diamagnetism confirmed the existence of silver (III) in a square-planar structure in the complex. Complexes of Mn(III), Mn(IV), V(IV), Re(V) etc. with biguanides have also been described. The chemistry of the metal biguanide complexes opened up a new chapter in the field of coordination compounds and an exhaustive review on the subject was published by Professor Ray in the Chem[illegible]

Reviews in 1961, on which Professor M T Beck (Hungary) commented : "I am extremely interested in your work on the chemistry of biguanide complexes. So I was excited to read your impressive review which appears to be a real gold-mine."

Mention need also be made in this connection of the preparation and characterization of several complexes of silver (II) formed with pyridine mono-, di-, and tri-carboxylic acids, by Ray and coworkers. Professor Ray's monograph on 'Chemistry of bi- and tri-positive silver' published by the National Institute of Sciences of India (now the Indian National Science Academy) in 1960, is an excellent and uptodate report on the higher oxidation states of silver. Other important contributions in the field of coordination complexes include studies (1946) on a nickel (IV) complex of periodic acid, $MNiIO_6$ (M = alkali metal), complexes of rhenium (IV) with organic acids, some heteropolyacids of niobium (V) and tantalum (V) lead (IV) titanium (IV) etc. and on the constitution of polymolybdates (1941–43).

Reference has already been made to the use of magnetic moments of some of the complexes, studied by Professor Ray for elucidation of the structures of the complexes and the valency of the central metals. From a consideration of the magnetic properties of many compounds of transition metals he suggested (1928) classification of the coordination complexes into two different types, distinguished as penetration and associated complexes. They are now represented as inner orbital and outer orbital complexes respectively, indicating thereby whether orbitals of the penultimate valence shell or the valence shell of the metal are utilized in bond formation with the ligands. He is one of the earliest workers on the systematic application of magnetic properties in the studies on problems of valency in coordination complexes. From a systematic investigation of the magnetic moments of a large number of copper (II) complexes, Professor Ray concluded (1948) that all these can be classified into two groups based on their moment values (1.7 and 2 B.M.). On the basis of the valence bond theory developed by Pauling, these were classified as representing complexes of the inner orbital, dsp^2 and outer orbital, sp^2d, types respectively. In terms of modern views of the ligand field theory, however, these probably represent square-planar and distorted (Jahn-Teller) octahedral complexes respectively.

As early as 1940, making use of radioactive iodide, Rây demonstrated in collaboration with Professor S D Chatterjee, the equivalence of all the bonds in complexes like HgI_4^{2-} and BiI_4^-, showing that Werner's 'primary' and 'auxiliary' valencies are indistinguishable in the complex. They further succeeded in isolating the radioactive isotope of cobalt of long life by a chemical method for the first time.

Professor Rây made an interesting study on the kinetics of racemization of optically active tris-biguanidecobalt (III) ion. Based on the experimental observations he suggested a simple intramolecular twist mechanism to account for the racemization. This work was reported in 1943 and is still believed to represent a probable path for the racemization of many similar inert complexes where metal-ligand bond dissociation process is energetically disfavoured. Its only serious competitor is the intramolecular twist mechanism suggested by Professor Bailar in

1957. However, the "Rây Twist" appears energetically more feasible than the "Bailar Twist". Both, however, involve the concept of distortion of the chelate rings of the metal-bound ligands, resulting in an intermediate which is not asymmetric and hence is not optically active. This, being equally unstable with respect to the d- and l- configurations, has a 50 : 50 chance to revert into the dextro- and levo-rotatory forms causing racemization.

The formation of a number of hydrogen polyhalides was studied by Ray and Sarkar by the distribution method (1922). In a large number of publications Ray and coworkers reported on the stepwise dissociation constants of the metal-biguanide complexes, studied by the pH method. The results provided much valuable information on the relationship between the stabilities of complexes and the best strengths of the ligands. Data on similar complexes of Co(III) and Cr(III) furnished, for the first time (1950-52), quantitative comparative thermodynamic data on the two metals which form a series of similar complexes with a large number of different ligands. It has been shown that Cr (III) complexes are less stable than the Co(III) complexes by about 6 kcal/mole of free energy for each stage in the dissociation of the tris-biguanide complexes of these metal ions. This difference in stability observed experimentally confirms the theoretical prediction, based on the ligand field theory, for complexes of d^6 and d^3 ions in octahedral environment of strong field ligands. The thermodynamic stabilities of the metal complexes of diglycylethylenediamine have also been evaluated by similar pH method. Several bivalent metal complexes of this ligand, which is quadridantate in character, have been prepared (1953).

History of Sciences

Professor Rây was deeply interested in the History of Science. According to him: "History of Science constitutes an integral part of human civilization or of the true annals of the earth; and as knowledge and wisdom grow only on the accumulated interests of the past, it forms an essential element in the study of science itself." And so, at the instance of the Indian Chemical Society he undertook in 1956 the onerous task of publishing a revised edition of Acharya P C Rây's great book *History of Hindu Chemistry* under the title : *History of Chemistry in Ancient and Medieval India*. In this new edition much new materials were added, and all facts were carefully sifted with a view to excluding those of doubtful origin or spurious character. Reference was also made to the social and cultural conditions of the country, associated with different stages of development of chemical knowledge. He was also the chairman of the publication committee appointed to bring out Acharya Prafulla Chandra Rây's birth centenary souvenir volume, published by the Calcutta University in 1962. Furthermore, on the occasion of the golden jubilee of the Indian Science Congress in 1963, at the age of 75, Rây was persuaded to write a comprehensive account of fifty years of Progress of Science in India in Chemistry. Also as supervisor-in-charge of the History of Science Section of the Indian National Science Academy stationed at the Asiatic Society, Calcutta, he was the principal author

the English versions of the synoptic Ayurvedic texts, Caraka Saṃhitā and Suśruta Saṃhitā, which have been acclaimed all over the world.

Membership of Learned Societies and Awards

Professor Priyadaranjan Rây was elected a Foundation Fellow of the Indian Chemical Society in 1924, and an ordinary Member of the Council in 1931. In 1933 he became the Honorary Secretary, holding the office for four successive terms. He was elected Honorary Editor for the Inorganic and Physical Chemistry sections in 1939 and served on the Board of Editors and Publication committee for more than a decade. He was elected Vice-President (1945-46) and finally President (1947-48). During the tenure of his Presidentship, the Society celebrated its silver jubilee year. Besides holding the honorary offices, he delivered the Sir P C Ray Memorial Lectureship in 1954 and Sir J C Ghosh Memorial Lectureship in 1963 of the Indian Chemical Society. He also delivered the Cooch Behar Professorship Lecture (1941) and Mahendra Lal Sircar Memorial Lecture (1960) at the Indian Association for the Cultivation of Science; Rajsekhar Bose Memorial Lecture (1963) and the Siba Priya Chatterjee Memorial Lecture (1973) at Bangiya Vignan Parishad; Shanti Swarup Bhatnagar Memorial Lecture (1968) at the Indian National Science Academy and Acharya Jagadis Chandra Bose Memorial Lecture (1971) at Bose Institute.

In 1935, he was elected a Foundation Fellow of the National Institute of Sciences in India (now Indian National Science Academy).

He was elected President of the chemistry section of the Indian Science Congress held at Bangalore on 1932. His Presidential address on "Doctrine of valency and the structure of chemical compounds" was an authoritative account of the then prevailing views on valency and complex compounds. The same year he was elected an editorial collaborator for the publication of *Chemische Analyse*, a comprehensive and authoritative treatise on Analytical Chemistry with Professor Wilhelm Böttger of Leipzig as the Editor-in-Chief. This was evidently in recognition of his significant contributions in developing new analytical methods for the detection and estimation of metals, applicable in macro and micro scales, based on the use of new reagents including complexing ligands such as rubeanic acid. It was in recognition of his contributions in developing new microchemical and colorimetric methods that he was elected in 1951 one of the seven members of an International Commission of New Reactions of the International Union of Pure and Applied Chemistry (IUPAC) and was entrusted to prepare a comprehensive and critical report in the colorimetric methods of analysis. He worked in this Commission for 8 years and when he was invited to be a member again he declined suggesting the appointment of a younger member. On being unanimously nominated President of the 20th International Conference on Coordination Chemistry in 1979, he in his usual humbleness, replied that it would have been more appropriate if an active chemist had been proposed to this coveted office. These are significant revelations of the quality of his character. In 1957, Professor Rây served as President of a national symposium on the Chemistry of Co-ordination Compounds held at Agra under the auspic

of the National Academy of Sciences. He was elected President of the Indian Science News Association for the term 1958-59 and served for several years in the Editorial Board of Science & Culture. He was also a distinguished Fellow of the Asiatic Society.

He received numerous invitations to attend various international scientific conferences in USA, UK, Germany, Sweden etc. which he politely declined mainly because of his shyness about publicity.

The Universities of Jadavpur, Burdwan and Calcutta conferred on him the degree of Doctor of Science (*honoris causa*). The Indian Chemical Society felicitated him by publishing commemoration volumes on the occasion of his 75th and 90th birthdays.

Views, Values and Ideals

Great as a scientist, Professor Priyadaranjan Rây was greater as a man. He was not stampeded by his researches. To us, it was most refreshing to see a top-ranking scientist stop to examine conscience. He spoke not only of science, but also of the power of love, the force of the spirit and work of humanities. His accent was not only on the problems of science, but also on the awakening of the human spirit. The test-tube cannot be divorced from the man. Man wants not only knowledge and power, but also a standard, a measure of his actions. He wants an ideology and philosophy of life, to assure him of the greatest good on earth, peace of mind. A celibate, Professor Ray roamed in the world of chemistry and soared in the sky of mysticism with equal facility. With his instinctive yearning for knowledge, he explored the explorable and quietly venerated the inexplorable.

He lived a life of austere self-denial. He was a teacher all his life, though remaining a student throughout. He was always alert about the economy of time and money and lived a life of spartan simplicity seasoned with a spirit of humility. He was chaste, self-disciplined, silent, systematic in his daily chores, fulfilled every task he undertook, treated others with love and sympathy, bore unfairness patiently and let not trifles upset him.

In the evening of his life, his failing eye-sight deserted him completely. The sense of hearing was also deeply affected. Amidst encircling gloom he groped for further enlightenment. He developed an acute yearning for spirituality. He engaged a Reader to read religious scriptures and contemporary news loudly into his ears. With his assistance he also carried on regular correspondence with self-enlightened persons like Srimad Anirvan and Sri Dilip Kumar Roy. He discussed with them questions related to human soul and divinity. The letters sparkled with Socratic logic and bore a spirit of scientific enquiry.

A few lines from his almost prophetic writings may be worth-quoting :

"In the face of the impending threat to humanity and civilization created by nuclear neurosis, we feel called upon to repeat that a new outlook in science is urgently needed, so that it may cooperate with religion and spirituality for a new order to emerge out of the travails through which the world is passing to day—

order in which the laws of morality will be as inviolable and as valid as those of nature. For this the humanity yearns."

"There is every reason to expect that science would show us the right way to peace and freedom for mankind by its rationalising influence upon human mind and human ideas."

"It is the feeling of sympathy and spirit of service alone which can make for efficiency and success; whereas high salaries in an atmosphere of scarcity, suffering and starvation become a potent cause for demoralisation at the top besides corruption and discontent at the bottom".

"Individuals must disenthral themselves from the group mentality; they have to think for themselves and assert themselves boldly against whatever is evil and hateful."

"There is an urgent need of a harmonius blending of materialism with mentalism for the good of the society. Exclusive devotion to either creates an abnormal condition in the society which becomes as injurious to its health as the abnormal growth of any part of the body as a whole."

"In reality pursuit of truth appears to be confined more or less to our scientific observations, and leaves our social, political and other relations somewhat unaffected. It should be our duty to advocate pursuit of truth in all walks of life."

"An ideology, when followed with fanatical zeal, does incalculable harm to the society like a religious faith similarly pursued."

Before the end came, he was confined to bed for several months. He lived alone in a sightless and soundless world with an angelic smile on his lips and was always serene. Not even his attending nurse could detect any sign of displeasure or grief in his countenance.

At long last, with the rising Sun on December 11, 1982, his immortal soul left his mortal frame and sojourned towards Heaven.

He reminds us of the poem of Robert Burns :
"Princes and Lords are but the breath of Kings
An honest man's the noblest work of God".

S D CHATTERJEE
D BANERJEA

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1963. Adhyāpak Śiśir Kumar Mitra : *Jñān o Vijñān.*
1964. Sṛṣṭirahasya Vyākhyāy Ādhunik Vijñān o Prācin Bhāratīya Darśan : *Jñān o Vijñān.*
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1967. Mādām Curie : *Kiśor Kalyāṇ.*
— Lesār : *Jñān o Vijñān.*
— Viral Gyaser Yaugik Dharma : *Jñān o Vijñān.*
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1969. Saurasaktir Sañcayan o Vyavahār : *Jñān o Vijñān.*
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1970. Khādya Samasyā o Rasāyan : *Jñān o Vijñān.*
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