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The Father of Statistics in India

The centennial of P. C. Mahalanobis falls this year. He is no doubt 'the father of statistical thought' in India. C. R. Rao (**page 90**), one of the distinguished alumni of the Indian Statistical Institute, at Mahalanobis' funeral oration, quotes the American clergyman Edwin Hubbell Chapin (1814–1880), 'not armies, not nations advance the race; but here and there in the course of ages—an individual has stood up and cast his shadow over the world'.

Long ago I once had an engagement to meet Mahalanobis. At the appointed time I found him surrounded by large numbers of young colleagues. I passed on a note but he did not have the heart to dismiss his admirers. In theory I should have been annoyed—but I was not. I liked the old man—his bright eyes, his enthusiasm, his charm and his accessibility—a quality shared only by a few of our ancients like C. V. Raman, Birbal Sahni and Satyen Bose. I never saw him again, therefore, I could not discuss with him *crystallographic statistics*—the new field which I was sure he had never heard of; but I knew that he was of that ilk who could persuade his colleagues or students to take up any such new idea.

We also reproduce an article by him on Ramanujan (**page 94**) which contains the sad and touching story of the great mathematician shivering in the cold at night wearing an overcoat as he did not know how to 'get into' an English bed. Mahalanobis went to Cambridge (1913–1915) to study physics but turned to statistics (it is said) because in a railway train he was hit by a thick tome of Karl Pearson's *Biometrika* falling from the upper berth.

He came back to India full of enthusiasm to do statistics and it was Brijendra Lal Seal—the patriarch of Indian philosophy—a mathematician in his earlier days and later Vice Chancellor of the Mysore University who encouraged him and gave him his first task in statistics. The next one was what really made him—a problem from Annadale, the Director-General of the Zoological and Anthropological Survey. Annadale had measured the physical and facial characteristics of many Anglo-Indians and asked Mahalanobis to analyse the data. During this study Mahalanobis invented the D^2 statistics which became a powerful tool to discover the affinity or divergence between groups. He then began worrying greatly about the process of collecting statistical data avoiding various biases including that of choosing samples. He evolved mathematical tests necessary to distinguish many such errors like variances of different interviewers etc. This resulted in his classic paper on the 'interpenetrating network of samples' for the estimation of these errors and even those of non-sampling. His paper in the Anthropological Section of the Science Congress (1925?) was considered a remarkable one—and perhaps one of the earliest to deal with biologically mixed population—a field we are afraid of touching these days. He tried to get a special section allotted to statistics but the Committee of the Science Congress pooh-poohed it saying that if Statistics is to be given a special section they could as well give one to *Astrology*. From what has happened and is happening, the day astrology may have an honoured place at the Science Congress is in not too distant a future.

In identifying Mahalanobis as one who established statistical science in India, we must not forget that the English Civil servants did start it in India—and made use of it for the needs of their administration. Special mention must be made of the work of Sir Herbert Risley (*Tribes and Castes of Bengal*, 1891) or that of Dobbs or (Sir) John Hubback (ICS-later Governor) of random sampling of crops to estimate the rice yield of Bihar and Orissa—a state which was often hit by incredible famines. One is tempted to say that this and such work greatly inspired Mahalanobis to propagate after Independence the concept of large sample surveys in India. He helped Jawaharlal Nehru in his five-year plans. One story (apocryphal, perhaps) says that Mahalanobis could not convince a cabinet minister that the large sample surveys of jute and rice crops were not wasteful. Mahalanobis finally won (by default), it is said, as the election cleared the minister and the air.

Gilbert Walker who played a positive role in the growth of science in India (in the lives of Ramanujan and C. V. Raman) was responsible for Mahalanobis' interest in meteorology.

Mahalanobis saw statistics everywhere. Not too well known is his paper on how statistical ideas were introduced two millennia ago by Jaina logicians who felt that nothing was 'certain'. The term *may be* or *perhaps* must always be attached to all predications as there is always a margin of uncertainty. This is very similar to the concept of 'uncertain inferences' in the modern theory of probability. To show that there were even quantitative ideas 2000 years ago, he quotes Brijendra Lal Seal—the author of the *Positive Sciences of the Hindus*. To the question, 'Is the custom of giving alms to Brahmins justified? Are the recepients deserving?'. The answer given in the literature is 'Giving alms to Brahmins can be supported as only ten out of a hundred are probably undeserving' — quantitative probabilistic view on social questions.

Of Mahalanobis it has been said: 'He was eternally, perpetually and continually in a fever of work. Greater agricultural and industrial output through statistical methods—better planning through better sampling surveys'. This was his method of contributing to the good *of India.*

But by far the greatest achievement of Mahalanobis was the founding of the journal *Sankhya* (Sankhya means *number* in Sanskrit) in 1933. (This year is its diamond jubilee year.) Few statistical journals have surpassed it in excellence, scope of content, quality of papers, or even in its typography — a journal which would arouse the envy of any.

The second was his founding the Indian Statistical Institute and the quality of men that it attracted, produced and still produces whether it is in mathematics or statistics (theory and practice). One finds them all over India and the world. The Indian Statistical Institute is his great gift to the Nation. One hopes the Nation can take care of it.

Solid state and solution structures of metal complexes

Inorganic complexes can adopt a great variety of structures. If the metal is capable of clustering and the ligands offer multiple coordination sites, fascinating possibilities arise. However, structural characterization is non-trivial and represents the key challenge to chemists. While X-ray structure determination offers the most unambiguous information, alternative spectral techniques are also valuable. Multi-nuclear NMR is particularly effective to probe the chemical environment of different elements in complexes. Vijayashree *et al.* (**page 57**) report a detailed structural characterization of dinuclear copper complexes using a variety of modern physical methods.

Copper (I) forms several dinuclear complexes with 1,2-bis(diphenylphosphino)ethane (dppe) depending on the reaction conditions. Single crystal X-ray diffraction has been carried out for one of the complexes. The nature of dppe coordination, chelating or bridging, has been characterized in all the systems using IR spectra. The authors also have used *solid state* ^{31}P NMR, solution phase NMR of ^{1}H, ^{31}P and ^{63}Cu nuclei, as well as variable temperature ^{31}P NMR. The dynamic processes occurring in the solution phase and the key features of solid state structures have been unravelled. The study reflects the effort involved in adequate characterization of transition metal complexes.

Chemiluminescence using fullerene

Buckminsterfullerene, C_{60}, continues to fascinate chemists and physicists. The delocalized framework offers a manifold of low energy unfilled orbitals and relatively high energy filled levels. Not surprisingly, many of the initial studies focused on the fluorescence and phosphorescence properties of the fullerene. From these experiments, the relative energies of the low lying excited states are well characterized. Gupta and Santhanam (**page 75**) have used this information in conjunction with the known electrochemical behaviour of C_{60} and other π delocalized molecules to devise a chemical reaction which would generate C_{60} in its excited state. Electrochemically generated fullerene radical anion and thianthrene radical cation undergo an electron transfer reaction which leaves C_{60} in its lowest triplet state. The subsequent triplet annihilation is accompanied by photon emission. The chemiluminescence has been experimentally characterized. Apart from the intrinsic interest in such processes from a photophysical point of view, the study is likely to generate additional work in optimizing the strategy by designing other fullerene–arene combinations which may lead to greater chemiluminescence intensity.