J. Chadwick

my time, is known for his work on the energies of the gamma-rays. In spite of suspicious German guards it seems that Chadwick was able to collect a few useful items and set up a sort of rudimentary laboratory in a shed. There was no gas, but the prisoners from time to time received Red Cross parcels containing butter, which was always rancid by the time it arrived. Chadwick went round the camp and bought it all up at a flat rate of two pence a pound. By heating it in some kind of metal container he found that it would generate a combustible gas, which would burn as a flame. In order to manipulate glass he needed a blowpipe flame, and in the absense of any air pump or bellows, Ellis was made to sit under the table and blow hard through a tube while Chadwick did the glass-blowing in the hot flame. Chadwick never spoke of this to me directly, so I cannot vouch for it. But the story was passed on in the Cavendish, and is certainly very much in character.

Chadwick had been through some rough times during the war years. This was reflected in his speech, which, especially in moments of stress or excitement, was rich in expletives. Indeed, he would sometimes go back on a sentence he thought insufficiently emphatic, and put one in. In our first meeting he was explaining to me the neutron sources then in use (Be + Po). "These neutrons", he said, prodding the diagram with a finger, "are shooting out all over the place." He paused, reconsidered for a moment and then added "all over the blasted place!" I came to know him quite well. He would often drop into my room unexpectedly, for he was something of a chain-smoker and knew that I always had matches. After leaving Cambridge I never met him again, though we exchanged letters. He later won a Nobel prize and was knighted, and after some years in Liverpool returned to Cambridge as Master of Caius.

I was fortunate to be in Cambridge during one of the most creative and fruitful periods in the history of physics. Sir J. J. Thomson, who had discovered the electron in 1897, was still around, and though retired he came in every day to continue his work. He was a superb experimenter, though oddly enough not very good, it was said, at the actual handling of apparatus, which he was liable to drop it on the floor. He had no doubt about his priorities, and deeply regretted the ever-growing intrusion of officialdom and administration into science. I heard him comment on this at a Cavendish dinner: "Nowadays", he said, "everyone who can do research is wasting his time administering others who never will be able to do it". A wry comment, possibly, but one that still needs to be borne in mind.

The Cavendish was full of people who made an indelible mark on physics. There was C. T. R. Wilson, of cloud-chamber fame, a quiet, unassuming, lovable man. He was certainly no orator, and unkind critics sometimes dubbed him the world's worst lecturer, for he was liable to turn his back for most of the time and mumble incomprehensibly into the blackboard. But a very modest exterior concealed a scintillating and fertile mind, always producing new ideas. He was troubled by the fact that his cloud-chamber tracks were not critically sharp, because the temperature change which occurred on expansion set up convection currents. But convection, he argued, could not occur in the absence of gravity, so he decided to abolish gravity. He constructed a chamber which was released into free fall at the moment of expansion, and caught in a clamp after falling a few centimetres. The tracks were photographed while the chamber was falling, and as predicted the convective distortion was abolished. The idea did not catch on, it was probably too complicated for routine use, but C. T. R. derived great satisfaction from it. Before returning to Bombay in 1935, I made a point of calling on C. T. R. to say goodbye. I remember it vividly, for I had to cycle through a howling snowstorm to get to his house, something almost unheard of in Cambridge at the end of May.

C. T. R. Wilson

Peter Kapitza was working in the Mond laboratory which had been built for him. He had a large crocodile carved on the outer wall, but when asked what it meant he would always respond with nothing more than an enigmatic smile. It was thought to have something to do with Lord Rutherford, but no one really knew. Kapitza produced enormous magnetic fields by sending a huge pulse of current-- many thousands of amperes-- through a coil. The pulse was produced by running a large generator up to full speed and then short-circuiting it through the coil, a procedure which shook the foundations as the rotor was brought to rest, producing a mini-earthquake. Many of us, no doubt, would have tried to cope with this by mounting the generator, and the apparatus, on shock-absorbers. Not so Kapitza: he simply lengthened the cables so that the coil was 50 or 60 feet away from the generator. In this way the experiment, which lasted only a few milliseconds, was over and done with before the earthquake had time to arrive. This always strikes me as an excellent example of the way a creative mind solves a problem in some brilliant but simple way which would probably never occur to the rest of us. Kapitza went for a holiday to Russia in 1934, but the Soviet authorities would not allow him

to return. It was a great loss to Cambridge.

I returned to Wilson College at the end of May 1935 with a Bombay colleague, and we decided to call in Paris to visit the Radium Institute. It was closed for Ascension Day, but our French was so bad that we did not understand this, and pressed on regardless. In the event we were warmly welcomed by Prof. Joliot-Curie and his wife and co-worker Irène, daughter of Mme. Curie. This highly gifted pair had recently missed, by no more than a hair's breadth, two major discoveries in physics. They were pipped at the post by Chadwick in 1932 in the discovery of the neutron, and by Anderson in 1933 in the discovery of the positron. But they struck gold in 1934 by the discovery of what was then called artificial or induced radioactivity, the production of radioactive isotopes of many of the lighter elements by alpha-particle bombardment. The Joliots showed us round the Institute and were very charming. We managed to converse in a mixture of halting English and bad French.

Back in Bombay I continued to work on radioactivity, having acquired four millicuries of radiothorium as a useful source both of gamma-rays and alpha-particles. In 1937 I was elected to the Academy under the sponsorship of Sir C. V. Raman, who took a great interest

On C. V. Raman and the Indian Academy of Sciences

I was elected a Fellow of the Academy in 1937 at the instance of our founder himself, Sir C. V. Raman, on the strength of work which I began in Cambridge under Chadwick and Rutherford. Although not himself a specialist in this field, Raman had a deep interest in particle physics, and followed closely the immense surge of new knowledge which took place in the mid-thirties. I had many contacts with him over the years, and if I were asked to pick out just one facet of his amazingly versatile mind, it would be his appreciation of beauty. I remember once in Bangalore being shown some of his collection of crystals, including diamonds, and as we gazed I could see that it was not just the geometry and the physics that held his attention but the sheer aesthetic beauty of these lovely things. I also suspect that his spectroscopic studies of flower pigments were prompted in part at least by his great sensitivity to natural beauty. He was a many-sided man, from whom I received much kindness [illegible], and I count it a privilege to have known him.

One thing Raman always insisted on was that the *Proceedings* should be of high standard and absolutely regular in publication. This tradition has been well kept, although a single journal has now blossomed into many. [illegible] *Proceedings* [illegible] and usually without too much difficulty. Today I can only regard at papers which I am seldom able to comprehend, for the level of expertise and mathematical sophistication is now far above my head. But this is a thing to rejoice in, not a thing to regret, and I am delighted with this evidence that both the volume and the standard of research are now so high. The Academy has certainly played a very notable part in the development of Indian science.

A balloon experiment

At least two others who took part in those cosmic-ray experiments of 1950 went on to become very distinguished Fellows of the Academy, Prof. R. R. Daniel and Prof. D. Lal, both of whom have served on the Council. We shared a memorable and indeed quite adventurous experience as we flew clusters of high-altitude balloons across South India, with observing stations ranged between Madras and Belgaum. One vivid day which lives in the memory was December 8th, 1950. We launched the payload, carried by a cluster of 21 balloons, at 7 a.m. from the grounds of the Central College, Bangalore. An hour later I and Mr D. Lal (he was then a research assistant in TIFR) called a taxi. We pointed to the equipment clearly visible high in the sky and said to the driver: 'Follow those balloons!'. Without turning a hair, he set off. All day long the balloons floated [illegible], while pursuing [illegible] day, but we kept up the chase, stopping every hour or so to take theodolite bearings. The taxi, always heading for the balloons, took us to Kengere, Arkawati Bridge, Tavarikeri, and finally Closepet. Here, nearing sunset, the balloons were almost exactly overhead, beginning to break up and descent rapidly in the cool of the evening. The parachute was soon due to open, which would carry the payload safely back to earth. But a fresh breeze, blowing two miles or so above our heads, carried the flight away eastwards. The car had gone in search of petrol, so we rapidly hired a bicycle, and Mr Lal pedalled away furiously in the gathering dusk along the Mysore road, in a mad chase after the falling balloons. They disappeared, alas, behind an inaccessible hill. A little later, when the driver returned, I followed in the car, but could find neither any trace of Mr Lal nor any report of the balloons. It was now pitch dark, and I returned somewhat anxiously to Closepet, only to find Mr Lal firmly clutched in the hands of the police. He had been arrested for riding a bicycle without a light. Such are the vicissitudes of scientific research! Incidentally the payload was never found. We knew within a mile or so where it fell, but the terrain is rough and it must have dropped into some impenetrable bit of jungle. I am sure Prof. Lal, now a pillar of the Academy, will forgive me for recalling this hilarious experience, which naturally did not appear when our results were reported later in the *Proceedings*.

in the spectacular progress being made in nuclear physics. I had met him first at his laboratory in Bowbazaar Street, Calcutta, in January 1928, the year which saw his greatest achievement—the discovery of the Raman effect. He showed me much kindness on that and subsequent occasions. At the Academy meeting in March 1938 he took me a drive round Bangalore to see the sights, then to his home for tea with Lady Raman. Later that year he found himself in disagreement with the authorities of the IISc, where he was then working, with regard to the accommodation necessary for research in physics. The large grating spectrometers he was using required not only ample space but also extreme stability. As an independent physicist I was asked by the Council to visit Bangalore and submit a report on the alternative proposals. The report was confidential, but after more than half a century there is no harm in saying that I came down firmly on Raman's side, much to his relief. We met again only a few months later at the Silver Jubilee session of the Science Congress in Calcutta, held in December 1938.

That was a very special gathering, for it was not only the 25th anniversary of the Congress, but a joint meeting with the British Association. It was surely a tribute to the growing maturity of Indian science that the meeting drew such a galaxy of overseas visitors, including many of the top names in British science. F. W. Aston of isotope fame was there; so was Sir Arthur Eddington. After Rutherford's death on October 19, Sir James Jeans was appointed president, and in his address he gave a long and moving tribute to Rutherford. Rutherford's own presidential address was already in print, and I still have a copy. It includes an able and detailed review of science and industry in India as well as an account of recent developments in nuclear physics. Discussing the openings for Indian students in Britain he had this comment which, with hindsight, is of great interest: "For the first time also, an Indian student in Cambridge, Dr H. J. Bhabha, has been awarded in open competition one of our valuable Senior 1851 Studentships in recognition of the importance of his researches in Theoretical Physics".

It was a very stimulating Congress, including many weighty and fascinating papers. But, as often happens in these gatherings, there were others of a more peripheral kind. One which found its way into the printed abstracts, but not to the platform, had the intriguing title, "The higher harmonics in the waving of a cat's tail". Unlike Schrödinger's famous cat this one, alas, did not make it into the annals of physics.

I was in India throughout the war, and was put on a committee to handle scientific questions arising from the armed forces, especially the naval establishment in Bombay. These were of great variety. A Dutch submarine was held up in the harbour for want of a

---

H. J. Taylor—teacher of physics

The Dr Taylor we knew, as physics students in Wilson College, was not the associate of Rutherford or Chadwick or Bhabha, but to us, he was an enthusiastic physics teacher who actually performed demonstration experiments in his lectures—a rare feat at teaching of physics in India. These experiments not only left us spellbound but brought home the excitement in Physics which Dr Taylor wanted to propagate. He devised (and helped us to devise) experiments such as the Foucault Knife-edge test for testing the surface of optical mirrors (which was, of course, not in our syllabus), which had an element of research to which he introduced us in his unique way. I remember this stocky, jolly, pipe-smoking, fun-loving [illegible] physicist who was my physics teacher in Wilson College during the period [illegible] He introduced the practice of having regular coffee-table discussions in the Physics Department during the [illegible] when we would discuss a number of [illegible] as well as [illegible] developments in physics [illegible] the college. I still remember the day when he was so upset when one of our colleagues had made a serious blunder in drawing the circuit diagram which had a major flaw in it associated with the danger of short circuit. He was very concerned as to how a physicist could make such a blunder. His concern for teaching physics was so much that he was shaken up by this event. But he was soon to forget this folly and went on to teach us photography and making us prepare our own annual departmental group photographs, right from taking the pictures using an old fashioned camera to developing and making the final prints. To us, during those days, these experiments were a source of great joy and accomplishment.

Dr Taylor's interest were indeed very wide and only modesty has prevented him from bringing these out in his beautiful article on 'Seventy years of Physics'. As undergraduate students we did not appreciate his association with distinguished physicists. To us, Dr Taylor was first a physics teacher who could play [illegible] and [illegible] he would take [illegible] and would sing to us his famous song on his small ukulele. I still remember the words of that mischevious song which went as follows:

"When I was a youngster four feet high,
No happier soul in the world than I,
I love to think of the days gone by,
. . . when I was a boy at school."

I am not sure whether Dr Taylor himself made up that song (which he was capable of doing), which had many other interesting verses including pranks played on the teacher, falling in love with a sweet little thing, etc. Whenever we think of Dr Taylor it is this facet of his life which we cherish in our memory. It is from him we learnt that physics could be fun and that to be an experimentalist, one has to work with ones own hands and that physics meant discussing cause and effect. The greatest gift which I still cherish is the way he advised us on how to teach physics with excitement and with the commitment and his advice (which was Lord Rutherford's advice to him) — make it simple. They don't understand.

[illegible]

very special oil required for its gyro-compass. The task was to make a mixture of locally available oils to have the precise viscosity and temperature coefficient prescribed for the compass. We succeeded, and the boat was able to sail. Many ideas were submitted by hopeful inventors. A highly qualified engineer (a refugee, I believe, from Hungary) submitted a plan for protecting ships and buildings from bombs by covering them with a special spring net fixed to a rigid framework, from which the bombs would bounce off. He had actually built a model, some five or six feet square, looking rather like an elaborate spring mattress. We had a spectacular demonstration in which a heavy iron ball was dropped on to the mattress from the top of a four-storey building and, sure enough, the ball bounced harmlessly off. One could show, however, with the help of a little mathematics, that a contraption of this kind could not be scaled up. A small one would work, but a larger one would certainly fail. The engineer whose brain-child this was went away sorrowful and unconvinced.

The 'de-gaussing' of ships—fitting them with demagnetising coils—became an urgent topic when the enemy started blowing up ships by the use of magnetic mines. At first the coils were wound round the outside of the ship, just above the waterline, until it was found that if the coils were inside the ship they would serve just as well. The naval establishment in Bombay found this very hard to believe. I therefore made a model ship about five feet long from an iron plate, fitted it with inside and outside coils, and measured the resultant fields with a fluxmeter. A posse of high-ranking officers attended for a demonstration, and were duly convinced. Shortly afterwards a de-gaussing range was set up in the harbour for testing ships. Large flat coils were laid on the harbour bed and connected to a battery of fluxmeters ashore, which monitored the magnetic fields as the ships went over the range. Several of my colleagues and students took part in this vital work.

In December 1948, Dr Homi Bhabha prevailed upon me to accept a part-time appointment as professor of experimental physics in the Tata Institute of Fundamental Research, recently established and housed in temporary premises in Peddar Road. I retained my responsibilities in Wilson College and could not, of course, have continued indefinitely with both appointments. But I held on for three years, a period I found enormously stimulating. I was responsible for selecting young graduates from all parts of India who applied to join the Institute, and made trips to Madras and other places to interview them. I never restricted myself to the conventional criteria, matriculation marks and examination performance, but looked rather for evidence of keenness and independent thought. In those years we brought together an extremely bright and able group of young researchers, many of whom subsequently attained great eminence. Many continue to adorn the scientific scene and it would be invidious to mention names, so let that of Dr R. R. Daniel, whom we recruited in 1949, stand for all of them. He is now a CSIR Emeritus Scientist.

Shortly afterwards TIFR took over the premises of the old Yacht Club, providing much needed extra space. I had a room with a most spectacular view over the harbour. Though I was mostly concerned with the section on emulsion techniques, many of the research people would drop in to talk to me about their problems. Not that I could

A tribute to a teacher

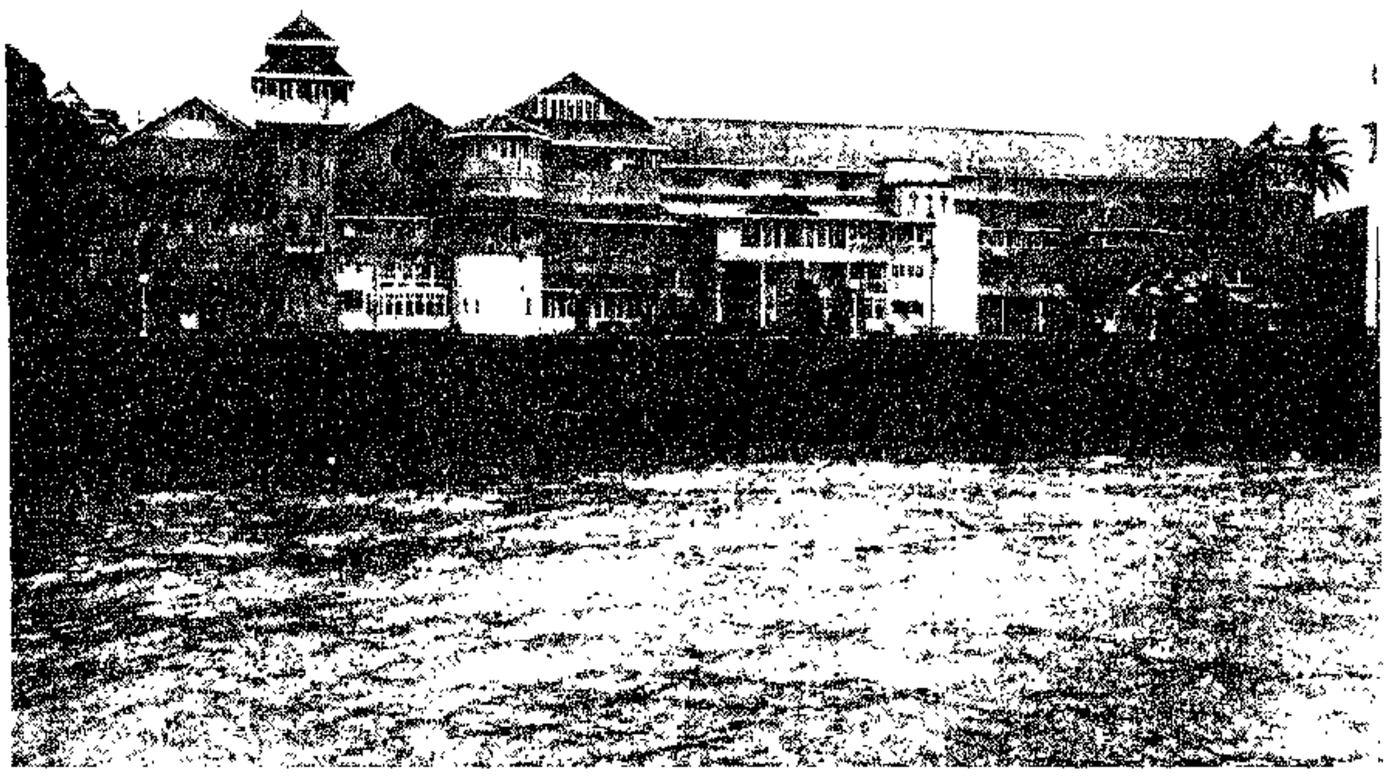
Excellence in educational and research institutions can often be traced back to dedicated and creative teachers. One such is Dr H. J. Taylor. I first came into his influence in 1947 (and not 1949 as he has recorded in his reminiscence). I went to Bombay for an interview at the newly set up Tata Institute of Fundamental Research for the recruitment of the first batch of research assistants in 1947. If I recollect correctly, the interview committee included, in addition to Dr Homi Bhabha, the cigar smoking Dr Taylor of the Wilson College and the versatile Prof D. D. Kosambi. After the interview I returned to my hometown and forgot all about it. I was then pleasantly surprised to receive a letter from Dr Bhabha saying that I have been selected to work on a high-energy accelerator to be set up at TIFR. Thereafter I joined the TIFR two months before India [illegible] attained independence at its first housing in Peddar Road hardly a mile from Wilson College. Regretfully, the idea of setting up an accelerator was given up in view of an US embargo on the export of all nuclear-related equipment that came into force just then. Dr Bhabha then decided that I must work on cosmic rays using nuclear emulsions and the expert at that time in this emerging technique was Dr Taylor.

Thus began my five year association with Dr Taylor which though short was a critical element in shaping my research career. Even today I look back with pride on a number of research papers we wrote together with other colleagues in the *Proceedings of the Indian Academy of Sciences*.

Dr Taylor carried out his pioneering research work in Cambridge, U.K. using special nuclear emulsions developed by Ilford Ltd. I am tempted to [illegible] England after his PhD [illegible] his work with Ilford emulsions, he might have been deeply associated with the discoveries of the forties by C. F. Powell and his colleagues at Bristol using this technique.

He was an affable gentleman and he mixed freely with his students whether it be in the laboratory, the tennis court, picnics or research. During the rubber balloon flights organised jointly by TIFR and the Rochester University, U.S.A., from the Madras Christian College, he lived and worked with us day and night. He could get the best out of his students through his example and also from his sound knowledge of basic physics which he applied with great advantage on numerous occasions. The Indian students who will remember him with pride and satisfaction are numerous.

R. R. DANIEL



BHARAT UPADHYAY

The old Yacht Club

necessarily contribute very much, but they found me useful, I think, as a kind of intellectual grindstone on which to sharpen their ideas. Senior members of the TIFR staff included such formidable intellects as those of Prof. Levy and Dr Kosambi. Profound minds often have other unexpected interests, as we found out when Dr Kosambi donated to the Institute his magnificent collection of paperback thrillers. To save burdening himself with too much detail Dr Bhabha brought in Mrs Vesugar on the administrative side, an able, charming, but slightly daunting lady. He called us all into his office one day to intimate this change. "I hope", he said, "that you will give her your cooperation. But it doesn't really matter, because she will elicit it". And indeed she did!

Towards the end of 1950 we had a major project to investigate cosmic rays, headed by Dr Bernard Peters of the University of Rochester. Stacks of nuclear emulsions were taken up into the stratosphere by clusters of twenty or more balloons, and we used the playing fields of the Madras Christian College at Tambaram as a launching site. Precisely timed theodolite readings from Tambaram, Meenambakkam, Vellore and Kolar enabled us to plot the trajectories of the balloons as they meandered over South India at heights of anything from ten to twenty miles. Towards sunset the balloons cooled off and began to break up, and the payload, weighing up to 40 kg, reached the ground by parachute. A notice in several languages invited the finder to write or phone in and claim the reward. The payloads seemed to have a predilection for landing in the most remote and inaccessible places. One fell in the tiny village of Kandur some twenty miles west of Tambaram, and after a very bumpy ride we arrived there about ten o'clock at night, when everybody was asleep. A good lady had found the payload in a field and was guarding it in her home. From her look of astonishment, I think she found me a very improbable figure to be stepping into her little house late at night, but her astonishment was even greater when I took out Rs 100 in crisp notes and handed them over. Fortunately we had with us Mr P. N. Krishnamurthy who could speak Tamil. He was an able student in my department who became a great friend, and subsequently rose right to the top in the Bhabha Atomic Research Centre.

Mrs Vesugar

These clusters of shining balloons, on lines 100 yards long or more, were always launched in the early morning, and became the talk of the town in Madras. At that time the statue of Our Lady of Fatima was being taken round South India for the edification of the faithful. We were told that some devout catholics in Madras, seeing this strange apparition rise at dawn in the southern sky, looking rather like some fantastic Christmas tree, were convinced that this was the Lady Fatima returning to heaven! Indeed some of the flights might just as well have gone to heaven, for they were lost irretrievably either in the sea or in some impenetrable jungle. But enough were recovered to provide some useful results, which were duly written up (*Proc. Indian Acad. Sci.*, 1952, **A36**, 41).

I came to know Homi Bhabha very well. I was in his house from time to time and we went swimming together. What a paragon of a man! Theoretical physics was his forte, but he would have risen to the top in any of half a dozen other fields. He would have made a brilliant architect, and the TIFR building in Colaba, with its splendid proportions and fine open spaces, bears testimony to his genius for design. It is typical of him that a building dedicated to fundamental science should be filled with one of the finest collections of modern art in India. Bhabha could have made a name for himself as an artist, and some of his paintings, showing a very sensitive awareness of beauty and form, adorned the walls of his house on Malabar Hill. His tragic and premature death in an air crash in 1966 was a great loss to Indian science, and to many of us personally.

I must also pay tribute to Dr K. G. Vohra who was from the Punjab, and had come through very difficult times in the period following partition. He was intent on research but found no opening, so to get his foot in the door, as it

Indian Institute of Science: Proposed transfer of Physics Department

(1938)

The above question arose in 1938 when Sir C. V. Raman was no longer Director of the Institute but was still professor of physics. A proposal was brought to the Council (I do not know by whom) that the physics research accommodation should be moved to a different building. Raman vigorously objected, on the ground that the proposed building was quite unsuitable for the kind of research he was engaged on. In particular large grating spectrographs, of which a number were in use, required not only ample space, but also great stability, freedom from vibration, and good temperature control. The Council was apparently in favour of the proposal, but in view of Raman's very high standing as an experimental physicist they could not disregard his objections. It was therefore decided that some physicist not connected with the Institute should be invited to look at the proposal and give an independent opinion. My name was suggested by Dr C. W. B. Normand, then Director-General of Meteorology for India and a member of the Council.

The relevant plans and papers were sent to me in advance. I arrived in Bangalore on Wednesday morning, July 6, at 8.15 a.m. and was met by the Director, Rao Bahadur Venkatesha-char. After breakfast in the West End Hotel the Director took me to the Institute, where I was able to inspect the buildings concerned. I lunched with the Registrar and attended a meeting at 2 p.m. I then had an hour with Sir C. V. Raman when we again visited the buildings and discussed the various possibilities. I left Bangalore by the night train and returned to Bombay.

[illegible] immediately wrote a report covering five pages and sent it to the Director on July 11th. My main argument, which was set out in some detail, was that the transfer should be made only if considerable modifications were made to the proposed building to meet Raman's objections. I have not had a copy of my report, and after the lapse of years cannot recall the details, but the modifications included the provision of verandahs and the like, and would probably have been fairly costly. I was never informed of what [illegible] Council took after reading my report, or whether the transfer was made or not. Whatever the outcome, Raman was evidently very pleased with it, indeed he went out of his way to thank me for my intervention when we met in Calcutta a few months later.

[illegible]

were, he accepted a junior post as storekeeper in TIFR. He came to me for advice, and I was so impressed by his keenness and evident ability that I invited him to start research in my department in Wilson College. He had an astonishing gift for electronics, and built all his own apparatus. He was amongst the first to measure the radioactive content of the air, and could even distinguish the radon and thoron components. At that time there was no interest whatever in this question, but it became vitally important soon afterwards when the Great Powers began atmospheric tests of nuclear weapons and produced world-wide contamination. Vohra worked for an MSc, but actually got a doctorate, which enabled him to return to TIFR at a more senior level. He was ultimately head of the health physics division in BARC, responsible for radiation monitoring throughout the country and internationally known. He died in 1985 in Vienna, where he had been posted for a two-year assignment. He was a great personal friend.

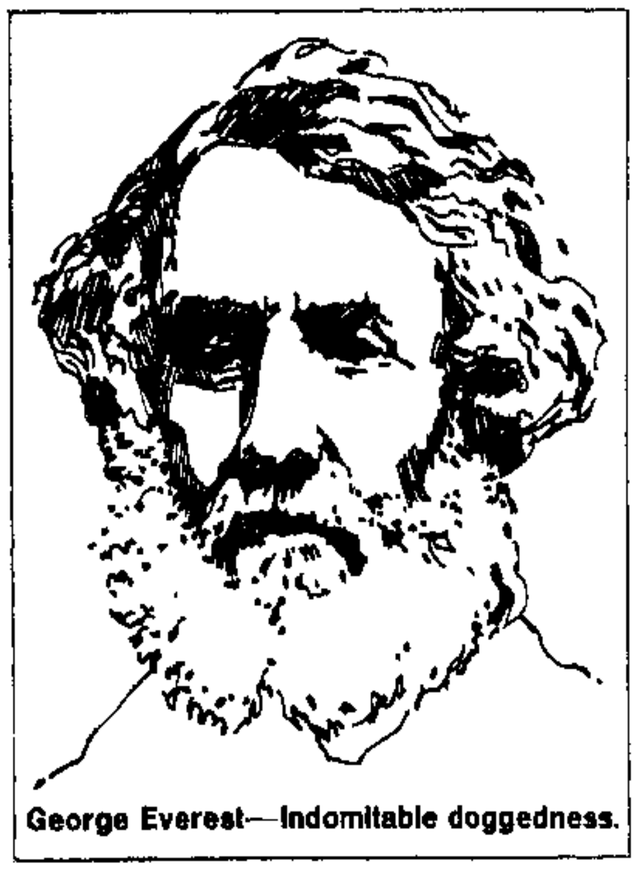
In 1954 I moved from Bombay to Calcutta, and thereafter had much less direct contact with physics. In 1960 I moved to Assam and had the privilege, for some three years, of being Vice-Chancellor of Gauhati University. While there my research interests were concentrated on the theory and practice of examinations, with strong support from the UGC. We published a number of papers which I still think broke new ground and offered a real advance in understanding, but all that is another story. During those years I had many fruitful contacts with the University world in India. In particular it was good to be in touch with Dr D. S. Kothari, another physicist turned administrator, who was then Chairman of the UGC.

As I look back I realise that I have been extremely fortunate to have had a life of such great variety and interest. I was very young when I went to India, but India became my home and still has my heart. India welcomed me with open arms, and has left me with vivid memories and lasting friendships. It has been a privilege to have been in touch for so long with Indian science, and to belong to the Fellowship of the Academy is a distinction I greatly value. I must confess, however, that many of the published papers are now far beyond my horizon, but that is only as it should be. It is a sign of the splendid progress that has been made over the years. To former students and colleagues, and to those of the younger generation who now carry the torch, I send my warmest greetings and good wishes.

Indomitable surveyor of the globe

A bicentennial tribute to George Everest

Two hundred years ago, on 4 July 1790 in Greenwich, England, was born George Everest to Tristram Everest and Ann Fischer. One of the most eminent geodesists that ever lived, he will be remembered for his great achievement of the measurement of the Great Meridional Arc over a distance of 2400 km from Cape Comorin to Banog near Mussoorie. This great national undertaking was hailed as 'the grandest monument of practical science that has ever been or ever can be exhibited in any age or nation'. Everest also completed the trigonometrical survey of India on which depended the accurate mapping of the subcontinent. Elected Fellow of the Royal Society in 1827, Everest was Surveyor-General of India from 1830 to 1843. When he was admitted as honorary fellow of the Royal Asiatic Society of Bengal, the citation said, 'By the light thrown on researches into the figure of the earth it forms one of the most valuable contributions to that branch of science which we possess, which at the same time contributes the foundation for the geography of northern India, the integrity of which must for ever remain unquestioned.' After successfully completing his work on the Great Indian Arc, when he retired from service he brought out his classic *An Account of the Measurement of Two Sections of the Meridional Arc of India* in two volumes in 1847. They received immediate recognition by his being awarded a medal by the Royal Astronomical Society. In presenting the medal John Herschel said, 'It is a trophy of which any nation or any government of the world would have reason to be proud of.'

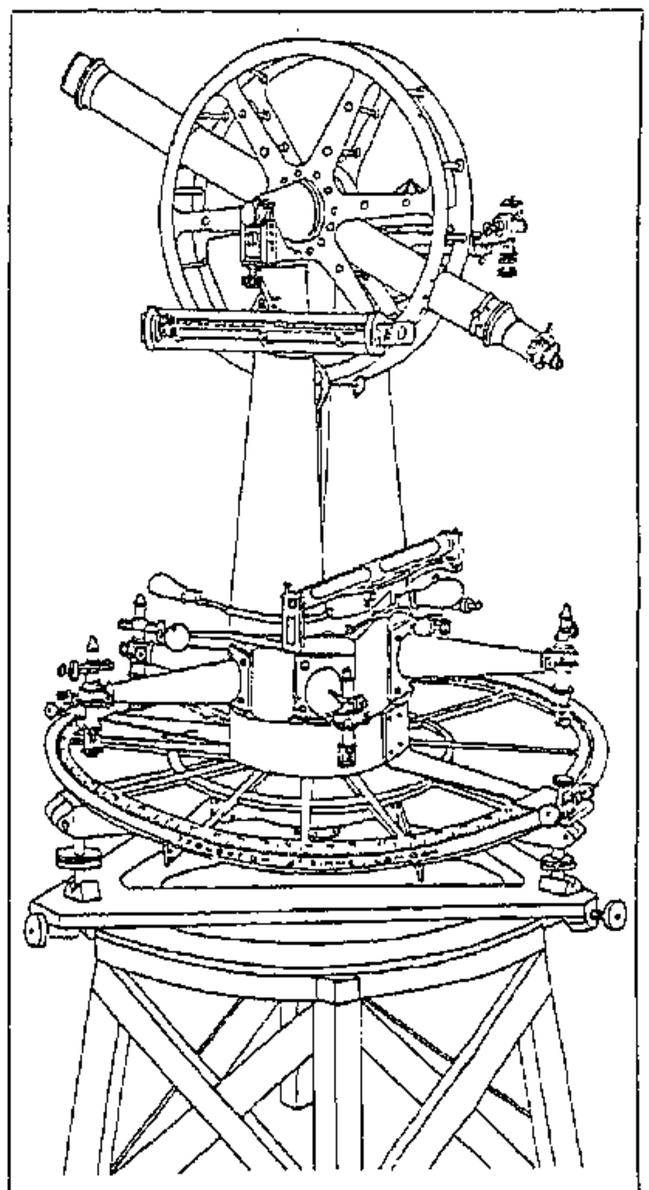


George Everest—Indomitable doggedness.

George Everest joined the East India Company in 1806 and served in Bengal and Java. While serving in Java (1814–1816), he was chosen to assist the Survey of India and was entrusted with the principal triangulation of Central India. He was appointed assistant to Col. W. Lambton (founder of the trigonometrical survey of India). He became the superintendent of the trigonometric survey project in 1823 and eventually Surveyor-General. He studied 'short arc measurement' by V. de Lacaille in South Africa. The whole concept of geodetic control in India is attributed to Everest. Everest invented the now well-known grid-iron technique for the geodetic triangulation, which proved of great use for accurate survey. He gave great importance to instrumentation and used the most accurate instruments of the day for his measurements. For a major part of his life as Surveyor-General Everest was most ably assisted by Andrew Scott Waugh (who was born in Cannanore, Kerala), one of the most talented surveyors in the Survey of India, who later succeeded Everest as Surveyor-General in 1843.

Everest got the services of Henry Barrow, a skilled mechanic from London, as his instrument maker. It was also Everest who noticed the extraordinary skill and innovativeness of one Mohsin Husain, who became an expert in repairing instruments and reconstructing old instruments. Of him Everest wrote, 'He has both genius and originality, his conduct is marked by the highest probity and he is one of the few on whose word I could place entire reliance.' When Barrow left for England, Everest appointed Mohsin Husain as the mathematical instrument maker at Calcutta, and the personal allowance of Rs 150 that Husain received continued even after Everest left.

J. R. Smith, in the biography of George Everest, tells us how he was very sick and how, in spite of this handicap, he carried on with his arduous work with indomitable doggedness and a rare sense of duty. He would not compromise with second-rate work. If there was any reason to suspect that measurements were inaccurate he would reject the whole lot and start all over again with a new set of observations.



Sketch of the theodolite assembled by S. Mohsin Husain and used in the Great Trigonometrical Survey and in the measurements of the heights of several Himalayan peaks (now preserved in the Victoria Memorial Museum, Calcutta).

Three years after his return to England, Everest married Emma Wing at the age of 56 and had six children. He died on 1 December 1866.

Everest's successor Andrew Waugh fixed the heights of many major Himalayan peaks using a theodolite. Of the 79 peaks so determined, the highest, Peak XV, was 29,002 feet above sea level. In 1856 Waugh proposed that this peak be named after Everest for the invaluable services he rendered to India and to geodetic survey. Sir Roderick Murchison, president of the Royal Geographical Society, concurred. As B. P. Radhakrishna says: 'His name now lives for ever enshrined in the loftiest peak in the greatest mountain chain of the world—the Himalayas. He stands today as unique as the mountain peak which bears his name'.

C. R.

INDIAN ACADEMY OF SCIENCES, POST BOX NO. 8005, BANGALORE 560 080

SPECIAL PUBLICATIONS OF THE ACADEMY

Title	Author/Editor	No. of pages	India Rs.	Abroad US$
Physiology of Vision*	C. V. Raman	164	25/-	5/-
Liquid Crystals (Proceedings of the 1973 International Conference)*	S. Chandrasekhar	568	100/-	27/-
Recent Advances in Plasma Physics*	B. Buti	178	50/-	10/-
Scattering of Light*	C. V. Raman	700	180/-	24/-
The "Aryabhata Project"*	U. R. Rao and K. Kasturirangan	234	40/-	8/-
Computer Simulation*	N. Seshagiri and R. Narasimha	171	40/-	10/-
Alloy Design*	S. Ranganathan, V. S. Arunachalam and R. W. Cahn	162	100/-	25/-
Rural Technology	A. K. N. Reddy	330	50/-	20/-
Surveys in Fluid Mechanics	R. Narasimha and S. M. Deshpande	321	30/-	30/-
Nuclear Tracks	J. N. Goswami	124	40/-	8/-
Crystallographic Statistics—Progress and Problems	S. Ramaseshan, M. F. Richardson and A. J. C. Wilson	313	50/-	18/-
Topics in Nonlinear Optics (Collected Works of N. Bloembergen)	N. Bloembergen	291	50/-	25/-
Proceedings of the ICOBAN Conference	V. S. Narasimham, P. Roy, K. V. L. Sarma and B. V. Sreekantan	284	50/-	20/-
Materials Processing in Space—A Workshop	S. Ramaseshan and M. K. Tiwari	321	50/-	20/-
Wood Heat For Cooking	K. Krishna Prasad and P. Verhaart	255	50/-	20/-
Prof. K. R. Ramanathan's Selected Papers—2 Volumes		978	300/-	65/-
Contributions to Crystallography	C. N. R. Rao	252	50/-	20/-
Water Resources Systems Planning	Mahesh C. Chaturvedi and Peter Rogers	355	50/-	40/-
Proceedings of the International Symposium on Biomolecular Structure and Interactions—2 volumes	—	836	150/-	50/-
Extragalactic Energetic Sources	V. K. Kapahi	180	75/-	20/-
Supernovae, their Progenitors and Remnants	G. Srinivasan and V. Radhakrishnan	172	75/-	20/-
Photons, Galaxies and Stars	R. Hanbury Brown	428	100/-	30/-
Topics in Genetic Analysis	G. Pontecorvo	320	100/-	30/-
Laser Spectroscopy and other topics	G. W. Series	632	120/-	40/-
Reactions and Reaction Engineering	R. A. Mashelkar and R. Kumar	332	100/-	40/-
Memoirs on Crystal Physics	C. V. Raman	318	50/-	20/-
Reliability and Fault-Tolerance Issues in Real-Time Systems	N. Viswanadham	280	90/-	40/-
Composite Materials and Structures	K. A. V. Pandalai	166	70/-	30/-
Developments in Fluid Mechanics and Space Technology	R. Narasimha and A. P. J. Abdul Kalam	462	100/-	40/-
Advanced Ceramics	E. C. Subbarao	168	70/-	35/-
Journey into Light**	G. Venkataraman	570		
Scientific Papers of Prof. C. V. Raman—6 volumes**	—	4126		
Essays on Particles and Fields—Prof. M. G. K. Menon Festschrift**	R. R. Daniel and B. V. Sreekantan	324		
From Mantle to Meteorites. A Garland of Perspectives Prof. D. Lal Festschrift**	K. Gopalan *et al.*			

*Discounts up to 20% are allowed: **Distributed by "Oxford University Press, YMCA Library Building, Jai Singh Road, New Delhi 110 001"

Edited and published by Prof. S. Ramaseshan, Current Science Association, Bangalore 560 080.
Typeset and printed at Book-Makers (I) Pvt. Ltd., Bangalore 560 009.