A walk down memory lane

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ONE of my early school recollections takes me back to standard III when I was seven. The class teacher was asking each one of us: What does your father do for a living? When my turn came I replied that he was a professor. Professor of what? asked the teacher. I did not know. My friend sharing the desk had just answered smartly that his father was a physics professor, although I doubt that at the time he knew what 'physics' was. Nevertheless I felt ashamed that I did not know what my father taught as a professor.

The teacher himself enlightened me: 'Don't you know that your father is a professor of mathematics?' Mathematics? Suddenly I felt elated. This happened to be my favourite subject and I was glad to learn that it was also the subject my father was expert in. The father is usually a hero to every child, but that day my respect for my father went up.

A doctor wants his son to be a doctor, a businessman wants his son to succeed him in business, a politician...well, I think I have made the point. But I was never pressured to like maths... never told that I must like the subject because my father was a star wrangler and prize-winner from Cambridge. Which is why my discovery of my father's profession came as a delightful surprise.

But having a wrangler for a father certainly helps, especially if he is willing to stoop to the school level

to encourage you to develop your taste for the subject. My father bought me several books on recreational maths and opened a wide vista of the beauty and power of the subject that a school syllabus succeeds in hiding. Although I never attended his classes as a student, those who did spoke very highly of him as a teacher. There were several occasions in my life when I unexpectedly came across his students in so many different walks of life all over the country...students who would fondly remember him as a teacher. These tributes stand out all the more in today's sadly deteriorating academic ethics.

I also recall my father as an excellent administrator who went by the rules but at the same time interpreted them in a humane way. As the Principal of Central Hindu College, Banaras Hindu University and as the Pro Vice-Chancellor of BHU, he had already established his reputation in this difficult field. This was further enhanced when he went to Ajmer as the Chairman of Rajasthan Public Service Commission. All those who came in contact with him recall his integrity and how he went by the rules despite pressures from high quarters. Again, these qualities are becoming more and more rare in today's public life.

But, to return to my childhood days in Banaras. Our house in the staff colony was big by modern standards, but my father managed to fill it with books to the point of overflow. Some of his voracious appetite for books may have rubbed off on me but I consider myself illiterate by his standards. For, his interests extended well beyond science and maths, to literature, the arts, humanities, comparative religions, philosophy, etcetera. He would be well known to the library staff of any institution that he was associated with. For us, the family members, the grouse was that he would be tight-fisted where luxury items were concerned but would welcome any bookseller with open arms.

Another inspiring personality in my schooldays was my uncle Morumama...who later became better known as Professor M. S. Huzurbazar at the Institute of Science, Bombay. At the time he was staying with us in order to do his M.Sc. in mathematics, which he got with flying colours and the Chancellor's Gold Medal. But as a student he was a constant source of problems and puzzles for me. On the blackboard (another speciality of the Narlikar house) he would write a *Challenge Problem for JVN* and it would remain there till either I solved it or acknowledged defeat. It was great fun and through such victories and defeats I learnt maths well beyond my school level.

I cannot bid good-bye to my BHU days without acknowledging the salutary influence of my mother, an influence that extended well beyond the scholastic aspects. I think, in general, the father's influence on the child is external and more perceptive while the mother's influence is subtle and intrinsic. Perhaps her greatest impact on my way of life has been in self-organization. She was and still is extremely meticulous (sometimes to a fault!) in organizing her daily routine. In Marathi there is a saying that a disorganized person starts digging a well when he is thirsty. My mother will not be comfortable until she has three good wells at her disposal at all times.

A Sanskrit scholar in her own right, my mother got me interested in several Sanskrit classics, besides getting my brother and me to memorize by heart several stotras and shlokas. And, whereas my father bought books, it was she who read them to us right from our primary school days, until we got into the habit of reading them ourselves.

Seeing my progess with maths, my father felt that I should follow in his footsteps and go to Cambridge for the mathematical tripos. Admission to Cambridge was difficult but fortunately my father's old college, Fitzwilliam House (now known as Fitzwilliam College) admitted me. But the financial problem still remained: I needed some scholarship to support my education. The annual cost of Rs. 8,000, during 1957-1960, seems ridiculously low compared to the present figure of some Rs. 600,000 but it was beyond the range of a university professor. So, like my father had done in his time, I applied for support from the J.N. Tata Endowment. No less a person than Dr. S. Radhakrishnan, then the Vice-President of India, wrote in support of my application.

My academic record was excellent on paper, but I do not know to what extent it counted towards my getting a Tata scholarship. My real test, rather an ordeal by fire, came when I was to appear at an interview in the office of the Director of the Endowment. Those who have known the then Director would appreciate my plight, for Mrs. Piroja J. Vesugar was a formidable character. Tata scholars of my generation have numerous Vesugar stories to tell.

My assets, i.e., first class first in B.Sc. and a distinguished father who did well at Cambridge as a Tata scholar counted for nothing, she told me in our very first meeting. She cited cases of a similar kind where the sons did miserably at Cambridge (or the other place, Oxford). What mattered most was my own hard work and capability in coping with the rigours of the Cambridge tripos.

In the end I did get a generous grant from the J.N. Tata Endowment to cover my expenses. While Mrs. Vesugar's lectures reduced my ego and overconfidence down to zero, I found that in the long term they were in my own interest. For, the spoonfeeding one is accustomed to in our universities is hardly a good preparation for the academic environment at Cambridge where only the fittest can survive. I also found that beneath her stern demeanour, Mrs. Vesugar concealed a soft corner for those who really did well in their careers. As a raw student at Cambridge, I found her regular letters a great source of strength.

Mrs. Vesugar ensured that I carried sufficient warm clothes and of the right cut (she herself supervised their tailoring), that I knew the right table manners and that I had acquainted myself with how the university and college system functioned. In all this I was fortunate in having guidance from another uncle of mine, Vasantmama, elder brother of

Morumama, who (himself a Tata scholar) had been to Cambridge for a Ph. D. a few years earlier. Thanks to the very detailed description and meticulous instructions I received from him, Cambridge did not appear a strange place when I first went there.

It was again thanks to Vasantmama that I could call on several academics in Cambridge with letters of introduction. These included Sir Harold and Lady Jeffreys (whose book on the methods of mathematical physics had become a classic), and W.S. Thatcher, the Acting Censor. Of these, the first two had been around even in my father's time during 1928-32.

The mathematical tripos course, unlike other triposes, normally takes four rather than three years to complete. Since I had provision only for three years at Cambridge, the choice before me was either to do the first two years' or the last two years' courses in one year. Although I was new to the Cambridge method of teaching, and had not sorted out all the problems of settling down in a new place, I opted for the former course of action. This meant doing double the work of an ordinary undergraduate: that is, lectures all through the morning and three tutorials per week. It meant a lot of work in my first year, but it turned out to be a wise decision. For, the tripos course gets progressively more difficult and the last year (Part III) takes you to the threshold of research.

But working in Cambridge was an inspiration in itself. It is hard to see so much of tradition and so much of academic excellence concentrated in one place, hardly more than a square mile. Nobel prizewinners could be seen cycling down the street or walking down the towpath of the river, people whose names you read in textbooks were there to teach you and then there were equally distinguished visitors on the college campuses and departments drawn by the aura of Cambridge. The atmosphere itself was awe-inspiring to begin with.

Letters from my parents came regularly like clockwork and so I also got into the groove of the weekly reply. (It is a measure of the advance in technology over the last 35 years that my daughter, now studying abroad, communicates with us over the electronic mail: but it is not the same thing! I sometimes wonder if the classic letters from father to daughter would ever have their counterpart in this electronic age.) Also regular were the missives from Mrs. Vesugar containing numerous do's and dont's. Vasantmama wrote with further helpful advice. But as I discovered, in the last analysis I had to fend for myself.

Coping with the tripos turned out to be managable, thanks to my tutorial supervisors Dr. R.A. Lyttleton and Mr. Murphy both of St. John's College. At the end of the first year I did not do badly, getting a good first in both my exams. Due to obvious reasons of economy, when I drafted the cable with the one word message 'doublefirst', the man at the telegraph office congratulated me. By coincidence, he was there on each of the two succeeding years when I had occasion to send home cables of my further successes.

However, Fitzwilliam was 'non-collegiate' in those days and I was missing the camaraderie of college life. With reserved Englishmen all around me, it was not easy to make friends. However, it took a traumatic experience to bring home to me the latent goodness of the institution. This happened on 9 February 1959 when, crossing a small lane, I was knocked off by a scooter.

I was admitted to the Addenbrookes Hospital where it was discovered that I had managed to break my leg. An operation was duly performed to fit a plate to the broken bone and I had to spend four weeks in a nursing home followed by three months in plaster. My tutor R.N. Walters and several others were a great help; but I made a new friend in this adversity, in the College Chaplain the Rev. Peter Schneider. Peter took great pains to ensure that I was not bored by this enforced inactivity. He even brought curry from a local Indian restaurant. The chessboard I have with me even today was presented by him. And, he arranged for me to go for a one-week vacation to North Devon along with a college group.

Going to the Lee Abbey at Lynton was no problem thanks to the special coach that took us door to door. But I had to return ahead of others to make up for my lost days of study. How was I to make the return journey in the 'plastered' state with crutches? This is where I found another friend. Dr. W.W. Grave, the newly appointed Censor of Fitzwilliam, offered to drive over with his wife and fetch me. I was deeply touched with this kind offer which solved the problem.

When the Graves arrived to fetch me I was waiting at the doorstep with my suitcase. They made me comfortable on the back seat of the car but in their anxiety to settle me properly, they forgot to load the suitcase. After half an hour's drive they discovered the lapse and had to turn round. To my great relief, the suitcase was still there on the footpath!

Thanks to the morale boosting I received from so many quarters, I decided to go ahead with my attempt for the second part of the tripos that year. For me it had a special significance: if I got a first, I would be called a 'wrangler' like my father. I had dreamed of appearing in this examination for so many years... but not with plaster and crutches which now were unavoidable.

The real ordeal, however, lay not in the exams themselves but in the ceremony where the results are announced. Mathematical tripos being the oldest of all tripos examinations has a special place in Cambridge and the results of Parts II and III are not simply posted on the noticeboard but announced by the Chairman of the Examiners from the inner balcony of the Senate House. He starts reading the results at the stroke of nine from the clock of the University Church across the King's Parade. Only the hardy souls confident of success can listen to the names being read out this way. For they are read out alphabetically in each class and I waited with baited breath as the initial 'N' appeared. Will he skip my name from the 'Wranglers' list? The relief was im-

mense as I heard it, despite my confidence in my performance. I had to undergo a similar suspense the following year when I was waiting to hear if I had scored the distinction (star) in Part III and qualified for the Tyson Medal in astronomy like my father thirty years earlier.

The tripos was only the beginning of my long association with Cambridge. The natural follow-up was research for a Ph.D. and here one of my dreams was realized when I was informed that Professor Fred Hoyle had agreed to accept me as his research student. For, although I had gone to Cambridge with an open mind regarding the branch of mathematics I would do research in, by my third year I had narrowed my options to astronomy and that too under Fred Hoyle whose lectures I had immensely enjoyed as an undergraduate. A great many things were happening in astronomy and I could see that a research career therein would be full of excitement.

I recall the warm and sunny morning on 17 June when at ten o'clock I rang the doorbell of 1 Clarkeson Close, to be greeted by Fred Hoyle in his shirt sleeves. Being accustomed to the rather formal interaction with teachers and tutors till then, Hoyle's informality was totally unexpected. At that first meeting we discussed a variety of research problems that I might take up. At the end I asked: 'Could I not work on the steady state cosmology?'

This cosmological theory had been proposed in 1948 by Hoyle (along with Hermann Bondi and Thomas Gold) as an alternative to the so-called big bang cosmology which assumes that the universe was created with an enormous explosion (the big bang) and has been expanding ever since. Hoyle's alternative cosmology assumed the universe to be always in the same state as seen at present. Thus the universe according to Hoyle is without a beginning and has been steadily expanding with creation of matter going on during all epochs. Considerable controversy was taking place at the time between these two rival theories.

Hoyle's reply to my query was: 'Although there is a lot of work to be done in that field, being controversial I do not feel it proper to involve a research student in it.' In other words, he preferred to give me a 'safe' problem to work on. So with some disappointment, I selected a problem on spinning universes. As I was planning to return to India for the summer vacation and Hoyle himself was planning to visit Caltech next term, there was obviously not going to be much interaction between us for the next six months. Still, I decided to time my return before Hoyle left for the United States in mid-September.

I had left India on 5 September three years earlier. Somewhat arbitrarily I decided to leave for Cambridge also on the same date in 1960, only this time by plane rather than by boat. Boeing 707s had just started operating and the journey took some eighteen hours instead of as many days. On my return to Cambridge I rang up Hoyle's number only to be informed that he had advanced his departure and was due to leave the very next morning. Could I meet him somehow for future instruction? Yes, I could, but he was free only at about 10 p.m. after supper at St. John's College if I could meet him in Leo Smit's rooms. I did.

The meeting was important since he gave me directions on how to carry on in his absence. I already had a problem to work on and had made some progress with it. Hoyle advised me to make weekly visits to King's College, London to have discussions with Felix Pirani. These visits turned out to be very useful in firming up my understanding of the mathematical aspects of general relativity.

Nevertheless, my research career was to take a dramatic turn in a few months' time. When Hoyle returned in December I informed him that I had more or less finished with the problem he had given me to work on and was waiting for some new inputs. While I was at a loose end, the Hoyle-Ryle controversy broke out once again.

Martin Ryle, the Director of the Mullard Radioastronomy Centre at Cambridge had long been a staunch opponent of the steady state theory. Twice earlier he had claimed to have found observational evidence from radio surveys of the universe disproving that theory. On both occasions he had underestimated the observational errors thus rendering the claims groundless. In January 1961 he came up with fresh and improved data, with which he claimed once again to have disproved the steady state theory. He was planning to present his results at a meeting of the Royal Astronomical Society in London.

This was a personal challenge to Hoyle who felt that, unlike the previous occasions, Ryle's present data deserved to be taken seriously even if his conclusions might be prejudiced. He asked me if I would like to work with him on an alternative interpretation of Ryle's data, to show that they were not inconsistent with the steady state theory. Thus I had my wish fulfilled... and willy nilly I, a raw research student whom Hoyle wanted to keep away from controversy, was plunged into what promised to be a scientific brawl of the first magnitude. But to proceed further we needed the actual data.

We had a meeting with Ryle and his colleagues who were very unwilling to part with their data. After some persuasion we had their main diagram to look at, a crude copy of which was given to us. 'Explain this curve within the framework of the steady state theory if you can!' was their challenge to us. And we had barely two weeks to do it.

So, working more details into Hoyle's nebulous idea, we did some crucial calculations, tried out a few parameters to match Ryle's curve. And, to our surprise, we succeeded. Armed with this work, Hoyle asked the Secretary of the RAS to allow us to present our reply to Ryle's claim after his talk. The Secretary agreed.

However, there was a snag. On the very day of the RAS meeting (held traditionally on the second Friday of every month) Hoyle had another previous lecture engagement in London which he could not change. So how would he present his reply? There was only one way. 'Jayant, why don't you do it?' he asked. I reeled at this suggestion. I

was a research student with not even six months' experience; how could I reply to such an important challenge and before such an august gathering as the Fellows of the Royal Astronomical Society? But Hoyle reassured me. If I had confidence in the correctness of our approach then nothing else mattered in a scientific debate. The only danger to avoid was that of running out of time while presenting our model. To take care of it we carefully rehearsed what I would say (and, more importantly, what I would avoid saying) within eight minutes, leaving a buffer of two minutes.

In the end it went off well and several persons in the audience told me afterwards that I had put forward our point of view clearly and calmly. Thus, although to begin with I had felt that Hoyle was putting too much of responsibility on my inexperienced shoulders, I found that I had immeasurably benefited from the experience. Indeed, the self-confidence I acquired that day helped me stand up to even greater challenges in the future. I think a research supervisor should encourage his students to take initiatives at an early stage...a practice I have followed with my own students where possible.

My interaction with Hoyle became closer as a result of the Ryle episode. I will not go into details of our long research collaboration covering several fields which lasted till I left Cambridge in 1972, and continues intermittently even today. I will content myself with three highlights.

Much has been made of our work on the new theory of gravity based on Mach's Principle which we presented at the Royal Society in June 1964. This work gave me great intellectual satisfaction as it provided a direct link between Einstein's general relativity and Mach's ideas on inertia. Einstein, who had been an admirer of Ernst Mach, had tried to find such a link but had not succeeded. For, Mach had argued that there should exist a long range effect which gives the property of inertia to any particle of matter. Thus a lump of matter has a mass and requires a force to change its state of rest or uniform motion (Newton's first law of motion) because it exists in a universe filled with matter. This idea of Mach had never been explicitly and quantitatively stated. Einstein had felt difficulty with it because it seemed to involve action at a distance, a concept which was introduced by Newton in his law of gravitation and had been used by Coulomb to describe electric and magnetic forces but which had fallen into disrepute by the beginning of this century.

As it happened, by 1963 Hoyle and I had made considerable progress with the revival of the concept of action at a distance so far as electromagnetism was concerned. We had managed to resolve most of the lacunae that had prevented its being taken seriously by physicists and had found that the concept worked as well as if not better than the prevalent field theory. Our next hurdle was to find a way of describing gravity through action at a distance. The breakthrough came in late 1963 when we found that it was not the property of gravitational attraction that held the key to the solution but the property of inertia. Once this fundamental issue was clear, it was like working on the final stages of a jigsaw puzzle, when the remaining pieces readily fell into their appropriate places.

I still recall the excitement both of us felt when after starting from the *Mach* end by defining inertia, our equations led us to a theory of gravity, to the so-called *Einstein* end! The gravitational equations turned out to be more general than those of Einstein's relativity, but we could see how the latter followed as a special case. This was the work we presented at the Royal Society.

This was not, however, an end in itself. We had further to go. During 1967-72 we were concerned with the quantum aspects of action at a distance and it was only very recently that we were able to show that the role of the large-scale structure of the universe can be very vital to our understanding of the microscopic quantum phenomena. I also suspect that our gravity theory may be able to throw light on some of the mysterious results on the redshifts of the quasars and galaxies...results that do not seem to fit into the framework of general relativity.

My second highlight was the hikes and trips both of us went on. Hoyle, or Fred as I came to address him, is fond of mountains and had made extensive trips of the Lake District and the Scottish mountains. I went with him on some occasions and have very rewarding memories of those trips. For, these were occasions when he would freely speculate on physics, astronomy on the one hand and sports, world affairs etcetera on the other. Often, the change of gears would be quite drastic! Camping, trekking, caravaning in the unpredictable weather of the region had their own excitement, like doing research in uncharted territory.

Fred Hoyle has influenced astronomy profoundly and in so many different ways. Yet he is often called an iconoclast, because in several important scientific issues he has taken a stand contrary to the conventional majority view. His argument is that if the conventional approach were correct, then with so much brainpower applied along it a breakthrough would have been made long before; the fact that this has not happened means that the majority view must be wrong. It is a bold position to take and requires considerable strength of mind to sustain it. Also, being regarded anti-establishment has its own drawbacks in denials of recognitions and awards (in Hoyle's case the Nobel Prize). Having followed Fred's example in a more modest way, I have similar experiences. Nevertheless, working in uncharted territory instead of along the beaten track has its own creative satisfaction.

The third highlight of my Cambridge research career was the foundation of the Institute of Theoretical Astronomy (now Institute of Astronomy) at Cambridge by Fred Hoyle. In the early sixties, foreseeing the revival of astronomy, Hoyle had pressed for a new institute devoted to the subject to be created at Cambridge. For political reasons the claims of Cambridge with its long tradition of astronomy were ignored and a new centre was set up in the

new university of Sussex. One reason given was that the centre would benefit by nearness to the Royal Greenwich Observatory (RGO) at Herstmonceux, Sussex. Hoyle was invited to head the centre but declined and continued his efforts to set up an institute at Cambridge. Since no government help was forthcoming he approached private foundations and thanks to the support of the Nuffield and Wolfson Foundations, he succeeded in setting up the Institute of Theoretical Astronomy in 1966. It brought a breath of fresh air into astronomical research in the U.K. and IOTA quickly acquired international reputation; so much so that when in the late 1980s, for reasons of economy, the RGO was required to make a shift from Herstmonceux to another part of the country, it opted for Cambridge so as to be next to Hoyle's institute!

I had the privilege of being one of the founder members of this institute and I worked there for six years before returning to India in 1972. In 1992 I had the honour of dedicating a bronze statue of Fred Hoyle to the institute on behalf of several donors, including numerous friends and admirers of Fred...the dedication took place in Fred's presence. On that occasion I recalled that although Fred had refused to move to Sussex in the 1960s to be near the RGO, the RGO ultimately moved next to his institute; thus Fred had been more successful than Mohammed had been in the tale of Mohammed and the mountain.

One summer afternoon during my undergraduate days, a friend and I were relaxing on the backs of King's College. Looking towards King's Chapel we could see the stream of tourists flowing in and out. Far from the madding crowd an old gentleman was shuffling across the vast expanse of the back lawn. He must be an old fellow of the college, I thought enviously. My friend was better informed. 'That is Forster... E.M. Forster, you know,' he said.

'*The* E.M. Forster? Of *Passage to India* fame?' I asked, impressed. Yes, that old gentleman was *the* Forster all right. A thought crossed my mind: how nice to be a fellow of this college, to be able to walk on this lawn in the company of this great figure. Little did I expect that in a few years' time I would have that privilege.

That happened in early 1963 when I was elected to the Berry-Ramsey Fellowship at King's in an open competition. I was duly admitted to the Fellowship in the famous chapel and dined at the High Table after the ceremony. There, seated across from me was E.M. Forster. As we introduced ourselves he asked me about my family and place of birth. When I mentioned Kolhapur, an instant smile of pleasure crossed his face. He had intimate connection with the state of Dewas which was related by marriage to the state of Kolhapur. So, interested as he was in our subcontinent, for him I was specially welcome as a friend.

Later, when I moved into college, my set of rooms were next door to Forster's...a fact which was no coincidence but arranged at his request. Forster himself was an Honorary Fellow of the college but, as an exceptional case he was living in. And, as we became neighbours, his first request to me was to address him by his name Morgan. At first it was awkward for me to address a person more than three times my age by his first name; but Morgan's informality soon put me at ease.

One of my doubts was also about our totally different backgrounds: I was a science graduate raw in humanities and literature; Morgan had received the classical Victorian education, was a humanist and a great literary figure but with no background in science. I came from an India of a period fifty years later than the India he knew. And both of us were shy: so how would we get along? But Morgan broke the ice. He had a great curiosity about modern ideas in fundamental science, about the astronomical observations and about the cosmological speculations. He set me going by asking me questions.

We had many discussions on these topics and I could see that his perception was as good as if he had an education in science. He later showed me a science fiction story that he had written long ago called 'The Machine Stops'. Again, it showed his power of observation and study of human nature.

But perhaps my most memorable recollection is the meeting between him and Fred Hoyle, arranged by me in Morgan's rooms at his instance. They talked for over an hour on a wide variety of topics, a dialogue that was possible only because they shared so many common interests. Later, I learnt from each of them how impressed one was with the other. My only regret is that I did not think of tape-recording the conversation that Sunday afternoon.

I feel I have gained a lot from Morgan's company: his humanist attitude, his observation of human nature, his gentleness that hid firm views and above all his cheerful demeanour in spite of the problems of old age. He suffered from occasional attacks that left him partially and temporarily paralysed. Once when he had recovered from such an attack he confessed to me: 'I am a little disappointed that I didn't have anything so grand as a stroke. The doctors tell me that it was just a fit.'

Another topic we shared was, of course, India. He had a great affection for the subcontinent. During 1965 he was invited to visit the country by the Government of India but had to decline because of his frail health: he was already in his mid-eighties then. But he was always very cordial towards visitors from India. He was specially pleased to meet my parents who had come on a visit and had a long chat with them on the princely courts of Dewas and Kolhapur. When my mother asked him if he had brought any formal court dress from his Dewas days, he produced two from an old chest and insisted that my brother (who was also in Cambridge then) and I wear them. We have a photograph in those dresses with Morgan!

As I wind up this random walk into the past I recall the tribute paid by a Fellow of King's who had observed Morgan over several decades: 'If I live a long life I would like to grow old like Morgan'. I cannot think of anything that would express my own feelings better.