Encounters with Chandra

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It was a warm summer morning in July 1962, with time coordinate around 7.30. The space coordinate: a country house (which was used as a conference centre) in Jablonna, near Warsaw. The occasion: the third international conference on general relativity and gravitation. I was attending the meeting as a research student working in cosmology under Fred Hoyle at Cambridge.

It was too early for breakfast and so I was taking a stroll through the spacious and well kept grounds of the estate. There I saw another Indian similarly occupied. He was in his fifties, distinguished looking, and dressed immaculately in a dark grey suit. We greeted each other and introduced ourselves.

That was my first meeting with Professor S. Chandrasekhar, or *Chandra* as he became popularly known. But what was he doing at a relativity conference? I knew of him as *the* Chandrasekhar of the celebrated *Chandrasekhar Limit* of the white dwarf stars. I had also known of his work on stellar dynamics. Perhaps he saw my puzzlement on my face, for he went on to explain that he was attending the conference to find out what were the interesting areas to pursue in general relativity, a field that he wished to enter anew.

I could not but admire the decision, which I termed to myself as *adventurous*, for was it not so to embark on an entirely new research area in one's fifties?

During the conference Chandra did not present a paper but listened quietly to the stalwarts holding forth on gravitational radiation, exact solutions, cosmological models, geometrical classification of spacetimes, etc. etc. There was also some discussion of spinning models, a topic that had been introduced into relativistic cosmology by the classic paper of Kurt Gödel in 1949 in the Einstein Seventieth Birthday Volume of Reviews of Modern Physics. From Chandra's subsequent work this paper seems to have excited him... as I discovered the following year.

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In the spring of 1963, there was an unusual meeting hosted by Tommy Gold at the Physics Department of Cornell University, which I had the opportunity to attend. I was still a research student and as luck would have it I was to appear for my viva-voce for Ph.D. at this meeting!

The meeting was on *The Nature of Time* and was conducted round a long table amongst a few selected invitees. These included such luminaries like John Wheeler,

Dick Feynman, Fred Hoyle, Hermann Bondi, Dennis Sciama, Phillip Morrison, Adolph Grunbaum, etc. And, of course, Chandra, who now had something to report at the meeting. His contribution, amidst a quasi-scientific and quasi-philosophical discussion was characteristically *exact*. He had worked out the geodesics in Gödel's universe and had found that the much publicised claim of existence of closed timelike lines was not correct in the sense that these trajectories did not allow one to travel into one's past.

It was at this meeting that he invited me to visit Williams Bay whenever I was passing through the Chicago area.

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Opportunity to visit Chandra came not on that trip but six months later when I was again in the United States to attend the Dallas Symposium (the first of what subsequently became known as the *Texas Symposia*) on the newly discovered quasi-stellar objects, the phenomenon of gravitational collapse and the whole new area of relativistic astrophysics that had opened out. I wrote to him enquiring the possibility of visiting him and he readily invited me to give an account of the conference in the form of a seminar.

Thus is early January I took a train from the Chicago station for Williams Bay, following the meticulous instructions sent by Chandra. Chandra was at the other end to meet me and we went straight to lunch at a pleasant restaurant. On the way Chandra casually mentioned to me that at seminars he became quite critical of the work presented, but not to mind it as it was not personal. He mentioned an anecdote: "When Professor X was here giving a seminar on his work I kept on interrupting him with queries as to how he got there, because I was not satisfied with his reasoning. As he was feeling increasingly cornered, he finally burst out saying that an elephant may trample a fly and say that he did not know how the fly got there."

It was a sobering thought! I hardly had much experience of giving seminars; but one comforting thought was that here I was going to describe not my own work but that presented by others at the symposium.

During the seminar there was one occasion when Chandra became quite agressive. I was describing Willy Fowler's argument using the gravitational binding energy curve of a supermassive object to show how it leads to the onset of gravitational collapse. Chandra's comment was that such arguments were imprecise: that one must do a small-oscillations analysis in order to decide if an equilibrium configuration was stable or not.

Sure enough, within a few weeks a paper by Chandra appeared in Phys. Rev. Letts carrying out the small oscillations analysis and demonstrating instability *precisely* and *rigorously*.

But, to return to that day in Williams Bay. After the seminar Chandra took me to show the place of his other incarnation: the editor's office for *the Astrophysical Journal.* This was the place from where the journal was being shaped, almost single-handedly by Chandra, from a journal of moderate reputation to one that brought it to the top section of the league of science journals. He described how he divided his time between his own teaching and research and the management of the *Ap. J.*

Then Lalitha joined us and we went to their home for a South Indian meal, one I was having after a long time. Here Chandra's reserve melted and we had a nice chat. I was, however, anxiously looking at my watch for the train back to Chicago.

"Don't worry. I have the time table worked out: I will get you onto the train on time", assured Chandra. Faith though I had in his mathematical precision, having been brought up in an Indian environment where there are many imponderables, I kept worrying secretly. But here like the equations and boundary conditions that Chandra concerned himself with, everything was under control and he brought me to the station a couple of minutes before the train rolled in.

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I never met Chandra in Cambridge. Even when I returned to India I had very few encounters with him. But those few that I had were worth remembering.

Like in the early 1980s when he visited the Tata Institute of Fundamental Research at Bombay. I invited Lalitha and him for tea at our flat on the campus. My parents were staying with me and my father was meeting Chandra after five decades. They were contemporaries at Cambridge in the early 1930s when my father was a student of Eddington.

I remember that reunion as a delightful occasion with some exchanges about old Cambridge personalities. It seemed as if the gap of fifty years had never existed at all.

Later that evening there was a dinner hosted by TIFR at which I was sitting next to Chandra. He gradually opened out in his conversational topics sharing his experiences about managing the *Ap.J.*, about his policy of selecting his research areas, about students, about his reasons for staying abroad after completing his doctorate at Cambridge... I could catch glimpses of the human being behind the formal and reserved demeanour.

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During his visits to India there were two occasions when I had the chance of interviewing Chandra on TV: in 1984, at TIFR and in 1992 at Pune. Of the many topics that we talked about in 1984, was one on black holes about which he had just spoken in his Birla Award Lecture in the most glowing terms. While the decade just over had seen the black holes rule high energy astrophysics with their being quoted

as panacea for numerous astronomical observations, what made them "beautiful" in Chandra's eyes was their mathematical symmetry. Indeed he had just brought out his book on *The Mathematical Theory of Black Holes*. Where do you go from here ? I asked. Now that he had closed the books on black holes which new area was he going to tackle?

"Well, I am in my seventy fifth year; which is hardly the stage for someone to take up a new subject... but ..."

And he went on to describe his ideas on colliding gravitational wavefronts! It was a subject daunting enough for someone fifty years younger; but he did continue working on it. And in 1992 when at IUCAA (Inter-University Centre for Astronomy and Astrophysics) I invited him to deliver a lecture at the dedication ceremony of the Centre's buildings, he chose a topic which drew heavily on this work. He compared the beauty of Claude Monet's Series Paintings with the symmetries and similarities of special solutions in general relativity that described wildly different objects like the spinning black hole and colliding gravitational waves!

But 1992 already saw him embark on yet another venture. While he was extoling the beauty of general relativity and the genius of Albert Einstein, he was engaged in the task of explaining the grandeur of another scientific work. In 1992 he spoke at IUCAA also on : *Newton's Principia and its Relevance for a Student of Today*. In private conversation Chandra regarded Newton as a greater genius than Einstein. In the lecture Chandra's adulation of Newton came through clearly, on how the great man had proved the propositions in the *Principia* so elegantly using the now outmoded methods of geometry, on how the Newtonian solutions were superior to Chandra's own alternative proofs using techniques of calculus (which Newton himself had invented but forbore to use so as to make his work more understandable to his contemporaries). And, of course, all this was to form the part of his last book.

But the age was catching on... as was evident from the slowness of the body which could no longer match the ever agile brain. There were other signs too. Like when getting up to deliver his Dedication Lecture, he fumbled and kept looking for his glasses until it was pointed out that he already had them on!

The 1992 visit was his second one to IUCAA, the first one being three years earlier when we had just started at Pune under rather primitive conditions. But even in 1989 he could see what was to come up and encouraged us on. He was visibly pleased to see all the buildings in place in 1992. More encouraging to us was the optimism he expressed in his 1992 TV interview about the potential of Indian universities and the salutary outcome of the universities sector being provided with new opportunities at places like IUCAA.

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This brings me to the question of Chandra's interaction with and influence on

the astrophysics community in India. The question of his settling abroad has been extensively discussed. Was he ignored by the powers that be in India in the thirties and forties when he could have been persuaded to return ? Would he have been as effective in his own work had he come back ?

On the first question I have heard of at least two serious offers made to him in the forties to work in India. The first was from Pandit Madan Mohan Malaviya, Founder of the Banaras Hindu University and its Vice-Chancellor Dr S. Radhakrishnan to set up an astronomy observatory and work in the B.H.U. campus. The second came from Dr Homi Bhabha, the Founder of the Tata Institute of Fundamental Research, Bombay inviting him as a Professor in the newly set up institute.

The answer to the second question may hold the key to why he did not accept such invitations. He may have felt that within the Indian environment with its officialdom and social pressures his work might not flourish. Although I did not have any direct discussion with him on this issue his passing comments nurtured this impression.

But the budding astrophysics community in India had always looked up to him as a source of inspiration and he in turn had been sympathetically concerned with its welfare. His visits to the native land were not frequent but on those occasions encounters with him had always been worth cherishing.