

Reflections on the Mentors in My Life

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Friends often tell me that I should write about the experiences of my life. I have wondered what relevance that would have in anybody else's life. This time on the insistence of two of my friends, I decided to write about the mentors in my life, people who shaped my life, directly or indirectly. This is my sincere homage to all of them.

I have often said that I had two blessings in my life: my studentship at Presidency College, Calcutta, and my days at Cornell University, Ithaca, New York where I did my PhD in Theoretical Physics under the guidance of Professor Hans Bethe. While embarking on this writing, I thought of a third blessing in my life, which I will present in due course.

I see my life laid out in a sequence of five years, first 10 years in a village in Khulna, present-day Bangladesh, next 5 years in a small town nearby, next 10 years in Calcutta starting with Presidency College and completing my

Masters in Physics and some post-Masters training in Saha Institute of Nuclear Physics, next 5 years at Cornell, next 5 years in Oxford and Birmingham Universities, in England, next 5 years at the University of Virginia and its subsidiary Mary Washington College, and next 32 years working as a contractor at NASA Goddard Space Flight Center, Greenbelt, Maryland (mostly in a work sequence of five years). I got married while I was a post-doc at Oxford. I am retired at present.

I believe the first mentor in my life was Acharya Dinesh Dasgupta, the spiritual head of our village school and also the spiritual guide of our home. He was imbued with ideas of the Brahmo religious movement and guided us through prayers that he composed and sermons thereafter, throughout my school days. He used to tell us about different religions and different cultures. It was from him that I first learned of 'plain living and high thinking'. It took me many years of my adult life to appreciate that the foundation of my life was

formed under his guidance. The village school that I went to was built by the efforts of my family, starting with the donation of the land by my great grandfather. This also had a soothing influence on me in my later life.

During high school, I had the fortune to have two excellent mathematics teachers. One of them, Nanigopal Nandi taught us in seventh and eighth grades. He used to give me separate homework from the rest of the class, and it was he who first asked me to go to the blackboard and address the class with solutions of some geometry problems. This helped me very much in gathering my self-confidence and overcoming my shyness. Another teacher, Shambhunath Mukerjee, a brilliant person about 10 years older than me, who was restricted to his home because of a serious illness, used to help me with Statics and Dynamics problems and encouraged me in many ways to excel in whatever I was doing. Shambhu-da told me to aim for standing first in the School Final examination, and said I would understand the value of it after I accomplished it. Thanks to his encouragement, I came out in one of the top 10 places in the Dacca Secondary Education Board examination.

The next phase of my life started with Presidency College, in the year 1950. To summarize, the intellectual climate created by my classmates and my professors was probably unrivaled by that of any other institution anywhere. It was a highly challenging place, especially for someone coming from a small town high school. I

had some excellent professors in English, Physics, Chemistry, and Mathematics. Of those who made a lasting impression on me are: Subodh Sengupta, an English professor who taught us short stories. He is the first teacher from whom I learned what analysis of a situation means before I learned it from my science and mathematics teachers. The other person is Purna Mukherjee, one of our physics teachers. Not only he was an excellent teacher, but he took it as a challenge to inspire and motivate his students. Once in a test I wrote a definition of phase in relation to periodic motion that

from innumerable number of addas with my contemporaries in the Hindu Hostel and the famous Coffee House.

My MSc and post-MSc years were uneventful, except that I learned more physics and applied mathematics at greater depth and breadth, in preparation for my future career.

While doing my post-MSc, Prabahan Kabir, our supervisor-in-charge, asked me if I would be interested to go the United States for higher studies. On his suggestion and using his

Cornell are: Hans Bethe and Kenneth Wilson, Nobel Laureates, one exactly my father's age and the other of the same age as me; and Philip Morrison, who was by far the most knowledgeable person I have ever met in my life, in any area of human endeavor. I would like to talk about Bethe and Wilson first and end with Morrison.

My association with Hans Bethe has been one of a mixed blessing. By far one of the greatest physicists of the 20th century, highly honored by many and comparable to people like Werner Heisenberg, Paul Dirac, Eugene Wigner, Enrico Fermi, Subrahmanian Chandrasekhar, and Richard Feynman, Bethe was too busy when I arrived at Cornell, with his own research in nuclear matter and with strong political involvement toward nuclear non-proliferation incentives, while working at the same time as the chief scientific advisor for President John Kennedy. Bethe was well-known for an influential compendium that he wrote summarizing everything known in Nuclear Physics till 1936, known as the "Bethe Bible". In 1938 he propounded in detail how the fusion of hydrogen into helium produces the energy that makes the stars shine. In 1967, Bethe was awarded the Nobel Prize for this discovery. At the beginning of World War II, Bethe, along with many other prominent physicists, was commissioned to work on the Manhattan Project at Los Alamos, where he served as the head of the theory division and was the second in command of the project after Robert Oppenheimer. Bethe was active in research until he

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summarized my understanding of the term in a cogent fashion; Purna-babu appreciated it and read it back to the class. I still remember it as one of the magic touches that a teacher can impart to his/her students. Of our contemporaries who unknowingly influenced me are: Amartya Sen and Sukhamoy Chakravarty, one year senior to me, well-known economists and excellent debaters of our time, and Manjusri Chaki, two years my senior, creator of a new dance form that combined classical dance, Tagore dance, and folk dance. What did I get from my classmates and the overall atmosphere? A keen sense of competition and quest for knowledge, supplemented by love and affection that lasted through our lives. I enjoyed and gained

recommendation, I wrote to four prominent physicists in the U.S. universities, and I was accepted by Professor Hans Bethe at Cornell University as his student. Prabhan-da, one of my mentors, to whom I am greatly indebted for helping me with various stages of my career, had his PhD from Cornell, and he was quite influential in the physics world. He steered several of my contemporaries toward the United States. I arrived in Ithaca, New York, in 1960 and spent some of the best years in my life there. 'Far above Cayuga's waters', a place adorned with natural beauty, great fall colors, deep gorges, and broad woodland – I enjoyed every bit of it!

The mentors I came across at

was 95, and greatly influenced the research at Cornell.

As my primary supervisor, Bethe helped me in many ways. He would call me and ask how I was progressing in my studies and work, and would give general advices to cope with everything. He advised me to work in Particle Physics, rather than his specialty Nuclear Physics, as that was the most upcoming field at the time. Once, right after my first year at Cornell and after I had taken a course in Quantum Field Theory, he asked me if I thought I was ready to start research work. I said, I did not think so and that I needed to understand a lot of advanced theoretical physics before I could do that. It took me two more years to get to that stage. Unfortunately, because Cornell was not equipped with a pure theoretician in particle physics which I wanted to pursue, I had to choose my thesis all by myself and work on it essentially alone. Bethe's contribution to my thesis work was as follows: I passed the final PhD oral exam in 1965, and within a short time, left for Oxford on a post-doctoral job, before submitting my written thesis. It took me one more year to complete the thesis, as I found some major mistakes in my work. Bethe read my thesis very carefully, chapter by chapter, and made many helpful suggestions.

My homage to Ken Wilson will be brief. Ken was a brilliant physicist, with pure mathematics background from Harvard and PhD training with a foremost particle physicist Murray Gell-

Mann of California Institute of Technology. Ken started his research in S-Matrix theory of strong interactions, that was most fashionable and challenging at the time, but he was smart enough to know that it was a dead end. I worked in that area for 5 more years after my PhD and after I finished answering most of the questions that arose in my mind, I found that nobody was interested in that area any longer. At Cornell, Ken started working deeply into Quantum Field Theory, with some very difficult problems, almost tracing a singular path by himself. I consulted Ken on some questions in my thesis, and was astounded

mastery of many languages, and above all an ability and inclination to connect with all cultures of the world, past and present. Morrison knew more about India's past than I did. It was from him that I first learnt that the prevalent theory of emergence of Sanskrit, Greek, and Latin is that Sanskrit came first and Greek and Latin followed. He was fond of Ingmar Bergmann's and Satyajit Ray's films as much as, or more than, I was. He was a charismatic teacher, had many programs on television to acquaint people with science, wrote a book review column in Scientific American in his inimitable style, and spent his later years in

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by the depth of his knowledge and pursuits. In my professional life, I used to tell my colleagues that Ken will get the Nobel Prize one day. He got it in 1982, at the age of 46. After his death in 2013, Steven Weinberg, a Nobel Laureate, wrote: "Ken was one of a very small number of physicists who changed the way we all think." Ken brought revolution in physics, and in my estimate his contributions will be remembered for next 100 years. He was a gentle person with respect for co-workers and very amicable. I have often wished I could work with him in exploring the physics world.

Philip Morrison, to me, was the quintessential, all-round human being, equipped with vast knowledge, dazzling oratory,

MIT to promote science education in the country.

Before closing this tribute to my mentors, I must mention the contributions to my life by some of my close friends, three of them my classmates and two my juniors. They are the ones who believed in me, respected me, and above all extended their love and affection to me that lasted through life. They are: Dilip Bhadra, physicist, my classmate, who, very much like a mentor, kindled the fire in me of staying with physics; Ajit Bhattacharyya, physicist, my classmate for all my college years, who stood by me in good and hard times, over all these years; Jyotirmoy Pal Chaudhuri, historian, my classmate, a family friend during

our stay in Birmingham, and a common link between many of our friends; Kamal Datta, physicist, a brilliant teacher, who loves and respects me like an older brother; and Nand Lal, physicist, whom I met at Cornell and befriended and whose friendship I enjoy on a daily basis. These are the people who helped me in making what I am today. When I think of them, I am reminded of Rabindranath Tagore's "*Je keho more beshechho bhalo, jwelechho ghore Tahari alo*" (Whosoever has shown me love has enlightened me with the clarity of His vision).

What did I do in my professional life with all the great mentors in my life? This is a hard question for me to answer. I will just say the following: Since I finished my PhD, physics professorship positions in the United States universities have been very hard to come by. Eventually, I decided to leave the field of particle physics, after several years of post-doctoral and college teaching positions. I moved into an industrial job supporting research work in satellite data analysis in NASA Goddard Space Flight Center, Maryland. Years later, at a gathering in a friend's house, I found that of the 15 physicists that were there, only two were engaged in doing research or teaching in real physics!

In NASA, I worked on many different projects working with scientists and engineers, and applied myself to the best of my

ability, with all the tools I had in my disposal, to bring in some real elements of physics into all the investigations. I worked on atmospheric physics, planetary fluid mechanics, and some astrophysical applications, and solved many problems in novel ways, not copying or extending other peoples' work. This was in my training – to solve problems in one's own way. I had co-authorship in NASA publications, but, because of diverse entanglements, my days at NASA were never fulfilling from a scholarly standpoint.

Perhaps the biggest blessing and fulfillment of my life came from being a mentor and helping others to achieve their goals. While I was at NASA/Goddard, I made a conscious effort in this direction; I felt the value of mentorship in my own life, and tried to give back some of it to others. I am happy and proud to say that I was quite successful in doing this for several junior colleagues and some applicants to our organization. All I tried to do in each case was to tell the person that he/she has the inherent ability to reach the intended goal, and all that is needed for success is to invoke the self-confidence and put in the best effort. In each case I remember, the person involved came to me after accomplishing the desired goal, to thank me for my advice. It is a miracle that happened every time. One of them called me after many years about the fire I ignited in him and of the

professional results that ensued; another, working for many years as a post-doc and thereby losing all self confidence to reach out, finally attempted a real job search on my words and was successful in that; another, confused about what subject in science he should major in, came back to me after finishing his bachelors in physical sciences, thanking me for guidance; and so on. I wish I knew the magic that does it, and wish I can do it for many others. In the mean time, I recite Tagore to myself: "*E amar ahankar, ahankar samasta manusher hoye. Manusher ahankarpatei viswakarmer viswashilpa*" (This is my pride, pride on behalf of all human beings. It is on the canvas of human pride that the Divine architect manifests His creation).

A reader by now may ask the question: Do you consider Tagore as one of your mentors? My answer: Very much so. I have found in Tagore reverberations of many of my feelings, often elevated to a higher domain.

I end this article with Tagore's words: "This is my delight, thus to wait and watch at the wayside, where shadow chases light and the rain comes in the wake of the summer. In the meanwhile, I smile and sing all alone. In the meanwhile, the air is filling with the perfume of promise."

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