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Geomagnetism gave me my bearings

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Among the people that I knew an acceptable career in science, for a woman in the 1960's, would be teaching in a school or college. At least that allowed for long vacations, which coincided with school holidays! However, for a teaching career or even joining the highly coveted Indian Administrative Services (IAS), it was not necessary to study science. Therefore, my wish to move from a girls' school where no science (except 'domestic science') or higher mathematics courses were offered, to another where I would be able to study these subjects, was not encouraged initially. However, my love for mathematics prevailed and I was eventually allowed to change my school.

I was fortunate to take up the study of science at a time when the government of India had just started to offer scholarships in undergraduate and postgraduate studies in basic science. As one of the first batch of all-India 'science talent' scholars, not only did I get a good scholarship throughout my B.Sc. and M.Sc. days at the University of Delhi, but also had the opportunity to attend summer school at the Tata Institute of Fundamental Research (TIFR) and Indian Institute of Science (IISc). This kind of exposure strengthened my feeling that I would enjoy a research

career in theoretical physics. For my Ph.D. at Northwestern University in the United States, I worked on a problem in condensed-matter physics. This gave me the opportunity to experience the joy of traveling into uncharted territory and deciding my own trajectory, which I think is the ultimate reward of a research career in science, and which cannot be measured in terms of monetary benefit alone.

A couple of months after I defended my Ph.D. thesis, my daughter was born, and I decided to take a break, because I felt that I was not capable of doing justice to a post-doctoral position at a good university and handling a small child when my husband, also a physicist, was starting his second post-doctoral assignment prior to entering a difficult job market. A three-year break immediately after my Ph.D. made me open to the idea of taking up research in an interesting area of physics different from my Ph.D. research topic. That is how I discovered the Indian Institute of Geomagnetism (IIG), a small institute tucked away at the southern tip of Mumbai. Its proximity to where my husband worked and where we would live certainly made it a more attractive option and in 1978 I joined IIG as a research associate. I was so thrilled with the idea of getting back to a research career in physics that I did not even find out before joining IIG that a research associate was not equivalent to a post-doctoral position. However, to my great delight, I found that there was much more to geomagnetism than the name suggested. Physical processes occurring deep inside the Earth, in its fluid outer core, as well as events on the Sun leave their signatures on the measured geomagnetic field. The influence of the geomagnetic field on the electrodynamics of the ionized part of Earth's upper atmosphere – ionospheric and magnetospheric plasma – creates a wonderful natural laboratory to study a variety of plasma instabilities.

In the early 1980's, I was asked by the then Director of IIG to initiate a study of 'ionospheric scintillations' using digital data. Although this phenomenon, which involves scattering of incident radio waves by inhomogeneities in the ionosphere caused by plasma instabilities, was being studied in India using analog records, no Indian scientist was working on the theoretical aspects.

With my interest in theoretical problems related to ionospheric scintillations, began my solitary journey into the intricacies of this subject. An opportunity to work at the University of Illinois in Urbana-Champaign during 1986-88 proved to be a turning point in my career, as it brought about international exposure, and on my return to India, I was able to chart out my area of research much more freely than was customary for scientists at my level in IIG those days.

Around this time I found that though geomagnetic secular variation models were being used to obtain fluid flow on top of Earth's fluid outer core, no attempt had been made to extract additional information from secular acceleration of the main geomagnetic field, which became available after regular satellite observations of the geomagnetic field started. Using secular acceleration models, I estimated the radial gradient of the unobserved toroidal part of the main geomagnetic field at the core-mantle boundary, an important component of the geodynamo. This gives an idea of the broad range of problems that the area of geomagnetism has to offer.

My study of plasma instabilities in the equatorial ionosphere, which have particular relevance in our region from the point of view of their impact on space-based communication/navigation systems, such as the Global Positioning System (GPS) and which form an important component of 'space weather', continues. Transient events on the Sun such as coronal mass ejections, under certain conditions, affect earth's magnetosphere giving rise to magnetic storms and sub-storms, and to changes in the ionosphere. A major goal of a number of international programmes today is to make predictions of 'space weather'. 'Climate and Weather of the Sun-Earth System' (CAWSES) is one such programme, with which I am involved.

As Director of IIG since early 2005, I now have to devote considerable time to science administration, a redeeming feature of which is that I have been able to broaden the scope of research at IIG. If I had to do it all over again, I would definitely be more proactive in planning my career. I am happy to see that young women today have more well-defined goals.