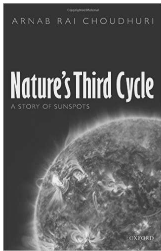

A Scientific Autobiography

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Nature's Third Cycle – A Story of Sunspots

Arnab Rai Choudhuri

Going through *Nature's Third Cycle – A Story of Sunspots* by Arnab Rai Choudhuri is equivalent to having a ringside view of the gradual unveiling of one of the abiding mysteries associated with the Sun. In the emergent era of gigantic telescopes, expected to straddle continents and sometimes place another foot far beyond mother Earth, Big-data (with a definitive capital B) is inevitably giving rise to humongous collaborative groups in astronomy and astrophysics, the sizes of which can sometimes even shame an army division. The old world scientists, working with a handful of associates and students, building numerical codes from scratch on their puny desktop computers are but a vanishing breed. Arnab Rai Choudhuri, of the Indian Institute of Science (IISc, Bengaluru), is one of these last Mohicans, belonging to the genre of theoretical astrophysicists whose ranks are dwindling rapidly. He has even displayed the audacity of devoting his entire scientific career to stellar physics, wondering about the mysteries of our friendly neighbour-hood Sun,

an area which happens to be at the bottom of the pecking order as far as the current astrophysics snobbery goes. *Sun*, the ultimate arbiter of human civilisation's fate, has fascinated mankind from the beginning of history. And yet the attraction of Sun in popular psyche has waned over the years to be replaced by newer frontiers of science like cosmology. The author correctly notes that “The unwritten assumption (about solar physics) is that the underlying science is a kind of dry, boring science best left to the experts, unlike the science behind cosmology or particle physics that can excite general readers”. So the author wishes to go against this bias by trying his hand at a popular account of the physics and the sociological effects of the solar cycle after writing two completely pedagogic textbooks which have been very well received by practising astrophysicists and graduate level students (*The Physics of Fluids and Plasma*, 1998 and *Astrophysics for Physicists*, 2010, Cambridge University Press).

Our lives literally revolve around the Sun, a rather ordinary main sequence star, through the diurnal and the annual cycles. Both of these cycles are imposed upon us by the motion of the Earth – the spin around its own axis, and the rotation in an elliptic path around the Sun. The other natural cycle is provided by the Sun itself, in the form of the eleven-year sunspot cycle which is at the heart of all the unusual solar activities. It is this third cycle that Rai Choudhuri talks about in his *Nature's Third Cycle: A Story of Sunspots*.

He accepts the challenge of explaining this behaviour to people not involved in Solar science research and intertwines this account with the tale of his own career.

Interestingly, we have witnessed a recent revival of an interest in the Sun primarily because of two reasons. The more dramatic of these is the arrival of space weather upon us. Solar flares launching bolts of hot, electrified gas stir up magnetic storms around the Earth. Earlier, the effects of such space storms were hardly noticed. But in today's electrically powered, space-based technology-dependent society, the impact of the space storm induced by such solar activities is quite significant. The other story is related to long term climate changes. Accumulation of large timescale data on climate change and its correlation with solar cycles has finally made the connection clear. As a result, popular accounts of the solar activity affecting climate change, its history and its effect on space weather have recently made their appearance on bookshelves (for example, Hoyt and Schatten 1997, Carlowicz and Lopez 2002, Brody 2002, etc.).

In contrast, *Nature's Third Cycle* is unique in its subject matter as it explains the physics behind the solar cycle itself. And it certainly is not a popular science book intended for lay readers. The author expects the readers to, at least, have worked through Resnick and Halliday (1966) (the absolute last word in high school physics) and, in some places, the expectation is even higher. The real intended readership is the aspiring physicists at under-

graduate level upwards, the physics teachers and, of course, the practising physicists.

Sunspots are dark areas of irregular shape on the Sun's surface, some as large as 50,000 miles (80,000 km) in diameter, i.e., they can even be seen by the naked eye. Their incidence varies cyclically and has an average period of eleven years. They move across the surface, contracting and expanding as they go and actually correspond to regions of higher magnetic field that inhibit convection and result in reduced surface temperature compared to the surrounding photosphere. This is the reason why they appear as dark spots compared to the surrounding regions. Because it is rather difficult to observe the Sun directly, records of sunspots are almost non-existent before the seventeenth century but have only been observed through telescopes since the time of Galileo. *Nature's Third Cycle* traces the history of sunspot science from the first discoveries through the numerous stages of unscrambling the puzzle to the latest results on the magnetic cycle of activity.

Magnetohydrodynamics (MHD), governing the behaviour of plasma in a magnetic field, is a difficult subject. The author manages to bring the basics of MHD and dynamo theory, underlying the physics of sunspots, to a level accessible to a large non-technical readership. In the academic community, Rai Choudhuri is known as a wonderful teacher and a brilliant scientist. He uses his expertise as a teacher to take the readers effortlessly through the complexities of solar physics. One of the interesting plus points of this

book is the section entitled Notes in the end. Apart from a list of popular and technical books as suggestion for further reading, the author provides a compilation of chapter-wise appropriate research articles and his own clarifications on various issues. This would be invaluable for experts and aspiring students alike.

As far as the style goes, it is an unusual offering from a practising scientist though not entirely unexpected. Arnab Rai Choudhuri is known for his brutally honest opinion about everyone and everything, sometimes even to the discomfiture of the listeners themselves. It is no wonder then that he bares his soul in this book and gives the reader a glimpse of the real world of research, contrary to the sanitised and impersonal fares that we have typically come to expect. I myself have seen part of the story narrated in this book, unfolding in front of my own eyes while I was a graduate student in the physics department of IISc. And we all know that such stories inevitably abound the corridors of every department of every research institution. On the one hand, there exists an unwritten code to keep scientific writing objective and impersonal. On the other hand, the practice of science is a very human enterprise, and personal clashes and disagreements are very much a part of this process.

To be honest, the maximal impact of the book comes from this particular aspect as it also makes the book compulsive reading. While this may inevitably attract controversy, in my view this also would be of immeasurable

Quite aptly, Nigel Weiss terms this book as the ‘scientific autobiography’ of Rai Choudhuri, written at a time when the author was undergoing treatment for a life-threatening illness.

Also, Rai Choudhuri's personal commentary on the struggling phase of Indian academia is quite valuable. After completing his graduate studies in Chicago, he made the decision to return to India. At that time, research facilities in India were limited and funding was minimal. Yet, like many of his peers, he and his students persevered and developed a theoretical model of Sun's magnetic cycle which has been quite successful in predicting the nature of the upcoming solar cycle. Over the years, Indian research infrastructure has improved significantly. But it needs to be remembered that the bunch of foreign returnees like Rai Choudhuri have made an invaluable contribution in shaping the Indian scientific scene the way we see it today.

There exist some other minor points which many people may not agree with. For his doctoral thesis, Rai Choudhuri worked with Eugene Parker, regarded as the most influential solar physicist of our time. He is one of the originators of the flux transport dynamo model, the currently favoured theoretical model of the 11-year sunspot cycle. My personal feeling is that a somewhat impersonal depiction of this giant would have been more appropriate. Since there does exist the possibility of a reader automatically assuming a not-quite-objective view of the author precisely because of his close association with Parker.

I also have some reservations about the author's faith in the citation index. It is, at best, a rather faulty indicator. We are forced to use it for want of something better. But readers outside the research community may not be aware of the pinch (or the sackful, that is needed in some cases) of salt that should go with it. Also, for the general reader the author order may not make much sense. In fact in many branches of physics the author order is strictly alphabetical. The Physical Review Letters (PRL) may not be a very good indicator either to illustrate the import of a research article. Because while PRL is arguably the last word for areas like condensed matter physics, it certainly does not enjoy the same status in the astronomy & astrophysics community.

One of my personal complaints about this book is the absence of a photograph of the physics department of IISc. Since the author has included a picture of his PhD institu-

tion, it would have been appropriate to also include a picture of his workplace from where significant contribution of India to solar physics has emerged.

In summary, this delightful, most unusual book on the solar magnetic cycle, explains the complex science behind sunspots in a wonderful manner and goes far beyond being a simple popular science book. It provides more than a glimpse behind the professional curtains of leading scientific research, and would probably end up greatly influencing many a young minds preparing to be the practitioners of science in not-too-distant a future.

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