Quantum Generations – A History of Physics in the 20th Century. Helge Kragh. Princeton University Press, 41, William Street, Princeton, NJ, 08540, USA. 494 pp. Price: $29.95.

Science is not neat. It is complex and messy. The picture of a brilliant scientist working in isolation, suddenly getting a great idea which revolutionizes thought is a false one. More often, many scientists in many labs around the world are working on similar if not the same, problems. Each scientist builds on others' works, the subject itself making only incremental progress, with many a backward step. To present a history of physics is then a monumental task. What threads does one follow, what dead ends does one describe, how much of the background does one present? Should one take a chronological path or topicwise route? The threads go back and forth in time, sometimes stretching as far back as the ancient Greeks. What overall picture guides the presentation? Does not the historian impose *his* order on the events?

The book under review by Helge Kragh is a remarkable one. The author, a Professor of History at Aarhus University, Denmark, has produced a scholarly work that is an absolute pleasure to read. He does not simplify the history (the maxim 'God is in the details' applies here). Nor does he write in the breathless style that has sadly come to characterize most popular books on science. He has taken great pains to trace the history of each idea and theory making the process of science as transparent as possible.

In the history of science, many ideas have emerged, only to die out in time. Simetimes they reemerge in a modified form, or cross-pollinate in complex ways, often going through a tortured history before becoming orthodox wisdom. In the process it is usually difficult to establish parentage for discoveries and theories. Credit does not always go to the originator. Consider the history of the electron.

We learn in our books that J. J. Thomson discovered the electron by measuring its charge-to-mass ratio. That discoveries do not happen in a vacuum emerges clearly in Kragh's book: when Thomson did his experiments the electron was well-known, if hypothetical. The idea that matter consists of electrical corpuscles goes back to Ampere and Mossotti in the 1830s and even earlier. Later in the 19th century it was developed by Clausius, Weber and Zollner. Attempts were made to construct theories of matter and ether with negative and positive charges (+e and –e).

In the 1870s and later, Stoney in Ireland and Helmholtz in Germany proposed the concept of the electron to interpret Faraday's electrolytic law. This concept had yet another birth, in another form, in the theories of Hendrik Lorentz in The Netherlands and Joseph Larmor in England. Their conception was part of their theories of the electromagnetic fields and that of ether.

In 1896 Zeeman came out with his discoveries of the influence of the magnetic field on the frequencies and polarization of light. This confirmed the electron theory. Lorentz immediately showed through calculation that the original sharp frequency would split into two or three frequencies with a widening depending on the ion's e/m. Guided by this, Zeeman, who had originally seen only a blurring of the lines, discovered the predicted splitting in subsequent experiments.

So the electron was already a theoretical entity with several estimates of its e/m value. It was in this atmosphere that Thomson did his celebrated experiments to establish its e/m value accurately. Placing each discovery in its historical context gives us a completely different perspective on the scientific progress, while removing much of the mystique in the process.

Kragh has set every scientific event in its social and cultural context. There is the interaction of science and industry, for instance, exemplified in the discovery of superconductivity. Carl von Linde was the founder of a successful company that developed refrigerators for industrial use. In 1895 he invented an efficient method of gas liquefaction based on the Joule–Thomson effect, which was modified by Dewar to successfully further lower the temperatures in his lab, winning the race to liquefy hydrogen and finally to measure its triple point. The race was mainly between scientists in Britain, Poland and the Netherlands, each out to achieve lower temperatures than the others.

But the next race, to liquefy helium, was won by Kammerlingh Onnes, who as we know, went on to discover superconductivity. A rich history of Onnes' Leiden Laboratory is presented by Kragh. Every page sprinkled with delicious historical tidbits (like the price of helium, which sold at $2500 per cubic foot in 1915, falling to 3 cents per cubic foot in 1926).

There are detailed accounts of physics in Hitler's Germany, of the militarization of science in USA, the development of the bomb, fission and fusion, accelerator physics, the birth of solid state physics, and electronics. Each topic is thoroughly researched with helpful graphs plotted at every point to show trends (for instance, the number of publications in solid state physics from 1900 to 1970). A detailed appendix listing sources and suggested material for further reading and a twenty-page bibliography make this book an invaluable starting point for anyone with an interest in the history of twentieth century physics. Whom would I recommend this book to? To anyone who loves physics. To the student of physics it will be an eye-opening experience. To the teacher, the book is a treasure house to be mined for historical detail.

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Hot Topics: Everyday Environmental Concerns. S. A. Abbasi, P. Krishnakumari and F. I. Khan. Oxford University Press, YMCA Library Building, Jai Singh Road, New Delhi 110 001. 1999. 208 pp. Price: Rs 495.

What are the environmental benefits of trees? I have posed this question to various non-expert audiences, from social science graduates and activists to forest management trainees, and invariably one of the responses is the claim that 'trees produce oxygen for us humans to breathe'. If then asked, 'So, if we were to instantaneously fell and burn all trees on the face of the earth, what would be the consequence?', the answer usually is, 'we will not have enough oxygen to breathe'! This common misconception provides a pedagogically useful starting point for a discussion about the global carbon cycle

and the role of trees in it and hence in climate change mitigation. The fact that whatever net CO_2 a tree sequesters during its lifetime is almost entirely returned to the atmosphere when it dies and decays and thus a typical tree provides almost no net O_2 to us over its entire life cycle is something the average 'environmentally conscious' listener finds hard to digest. Of course, not all dead plants decay, some may get buried or sink to the bottom of the ocean. This 'leakage' in the carbon cycle through organic matter burial over geologic time-scales is what has led simultaneously to the enhancement of the oxygen content of the atmosphere and the creation of fossil fuel stocks and carbonate deposits. But this historical role should not be confused with the current role of trees as one relatively small repository of carbon, and it should be clear that the impact of the approximate doubling of atmospheric carbon that the hypothetical mass tree-burning might achieve would have drastic consequences for climatological reasons, not respiratory ones!

Misconceptions such as this one, and the general lack of appreciation amongst even well-educated laypersons of the complexities of burning environmental problems, provide a strong rationale for a book that explains important environmental issues to the layperson. When such a book is written by Indians and published by an Indian press, one would also expect it to provide an Indian context to the subject, by choosing problems of greater concern to readers in this part of the world, by giving examples from environmental disasters that have occurred here, and also by indicating how apparently 'global' problems are actually highly uneven in both cause and impact, leading to serious political complications in science (such as in the assignment of 'responsibility' for global warming across countries). The book under review, with its enticing title, a backcover blurb which claims that it 'demystifies and explains' terms such as the 'greenhouse effect', 'acid rain' and 'ozone holes', and coming from a reputed popular Indian press, naturally raised such expectations.

Unfortunately, the book belies these expectations, and the giveaway comes even as we scan the rest of the blurb, where important environmental *science* questions such as 'what are the likely impacts of a "warmed" earth?' sit awkwardly cheek-by-jowl with rather mundane environmental *engineering* questions such as 'what are the basic methods of water disinfection?' and downright arcane management questions such as 'how does the disaster management software MAXCRED work?'! The contents of the book are just such a mish-mash, with a chapter each on the greenhouse effect, acid rain and the ozone hole, followed by one and a quarter chapters (quarter because it is just four pages long) on hazardous waste management, one on water treatment, and two on disaster management. The last topic may be 'hot' in certain academic circuits, but it does not fit into my book of 'hot environmental topics'. And one topic that definitely concerns the typical reader of an Oxford University Press publication, viz. urban air pollution, does not get mentioned at all.

The discussion of the three global environmental problems is reasonably comprehensive and is perhaps the most interesting part of the book, covering their origins, the biogeochemistry and physics involved, likely impact and some policy issues. The authors have attempted to enliven the (otherwise humdrum) tone by taking a slightly provocative position on the possibility of climate change. They argue 'that, although air [sic] is regulated in the very long term by the doings of living things, the accumulated store of gas [sic] is now so vast as to be almost independent of life processes for its maintenance' [p. 21]. Unfortunately, their simplistic arguments that 'the shock absorbers [the oceans] are working, but slowly. [B]efore the absorber can catch up, maybe CO_2 levels will have doubled... [t]his will not be a catastrophe for life' are neither convincing nor do they serve to illuminate the subtleties of the global climate system, or the complex set of positive and negative feedbacks that make climate modelling so difficult and also so fascinating a topic. And this skeptical stance does not last beyond the first chapter; acid rain and ozone depletion, which are arguably less globally catastrophic than the greenhouse effect, are in fact described as 'scourge' and 'serious [problems]'. One also wishes that, in the discussion of mitigation efforts, they had gone beyond a simple passing mention of the Kyoto and Montreal Protocols for climate and ozone, respectively, and discussed the theoretical adequacy of the former and the practical effectiveness of the latter, which have been in force since 1987.

The chapters on hazardous wastes, [industrial] disasters, and water treatment are largely confined to the engineering aspects of defining and controlling these problems, with only anecdotal description of their prevalence and very little on the complex ways in which toxic wastes or pollutants, whether biological, chemical or radioactive, cycle through the ecosystem. While the engineering descriptions are no different from those available in the plethora of unoriginal 'environmental engineering handbooks' being cranked out by streetcorner publishers in India, even the anecdotal descriptions of various accidents display the usual tilt towards the West in terms of details provided: while the 1974 Flixborough (UK) disaster that killed 28 persons gets two pages plus two diagrams, the Bhopal disaster gets only half a page!

The book is rather stodgily written and poorly edited: technical terms are not introduced (nor is a glossary provided), material is sometimes repeated almost *in toto* within a few pages, and most shockingly, the referencing style changes from 'author–year' in the first seven chapters to 'numbered endnote' in the last chapter (which in any case reads like a 'literature review' chapter cut-and-pasted from a technical dissertation)! On the whole, it is a rather disappointing treatment of important environmental issues of the day, meeting neither the crying need for a lucid 'everyday/every person's environmental science' nor providing a much-needed Indian context to a subject extensively covered by more erudite but US or Europe-based authors, thus representing a largely missed opportunity for a renowned publisher of Indian social science books to make a mark in the natural science arena.

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