



04 December 2008

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Book of the week: The Atom and the Apple

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A physicist's stories captivate Chris Sachrajda

The Atom and the Apple: Twelve Tales from Contemporary Physics is a delightful ramble through many areas of science as well as through the experiences, opinions, passions and frustrations of a leading research physicist. Unlike most books describing scientific ideas to the wider public, Sebastien Balibar does not attempt to present a systematic discourse on a single area of physics, but tries instead to convey a wide range of scientific concepts together with the excitement of research and a description of the environment in which the physicist works. It is a very refreshing read that will do much to bring an understanding of scientific culture to the reader.

This book is certainly provocative and stimulating, and it frequently challenges political correctness. One can imagine discussing some of Balibar's opinions with him over a glass of Vosne Romanee, a favourite wine of his, in a crystal glass (whose structure we read about in the chapter "Crystals and glasses", where we learn that "crystal glass" is scientifically a contradiction in terms). In this way, for example, we might explore the contents of the must-read chapter "From pianos to the Sun", in which the author analyses the scale of the world's energy requirements, the potential of each source of energy to contribute towards meeting these requirements and the need for physicists to inform the public and to help look for solutions. Readers will find some of the conclusions in this chapter disappointing and disturbing; it is sometimes not possible scientifically or technically to achieve the situation we would like. For example, the author cannot see wind power becoming an important source of energy; he argues that nuclear fusion is not "just around the corner" and will not be a commercial source of energy in the next 50 years or more; he discusses the technical difficulties in exploiting solar power in a major way; and he states that although he'd like us to be able to do without nuclear power with its principal problem of handling and storing the waste, he cannot see how we can. The chapter presents an excellent introduction to the framework for the debate about the future of our energy supply.

The concepts of modern physics are challenging for professionals and amateurs alike because they are so far removed from our everyday experiences. We read in the chapter "Is my table quantum?" that "everything about quantum physics is bizarre" and this is certainly true. Attempts by John Bell and others to make it a little less bizarre end with discrepancies with experimental measurements. The author leads us through a number of examples of quantum physics including superfluidity, the phase of liquid helium in which there is no resistance to its flow, which has been a major area of Balibar's research. In spite of his familiarity with the phenomenon, the author still finds it fascinating - "In my own laboratory I have seen superfluid helium almost every day for the last 20 years and it continues to surprise me even now." It is a sentiment shared by researchers in many areas of physics.

In 1930, Wolfgang Pauli, one of the fathers of quantum physics, wrote a famous letter to the participants of a conference on radioactivity in Tübingen in which he conjectured the existence of the particle we now call the neutrino to explain the apparent violation of the conservation of energy. He begins the letter by addressing his fellow physicists as "Dear Radioactive Ladies and Gentlemen". This letter is recalled to my mind by the title of the compelling chapter entitled "I am radioactive". However, Balibar is making a different point with this title, namely that all objects, including human beings, contain radioactive elements and that there is a natural level of background radioactivity. This chapter beautifully illustrates the interconnectedness of scientific ideas. The author starts by introducing radioactivity and ends with a discussion of the probability of extraterrestrial life. In between, we learn that carbon dating (and the use of other radioactive elements) has opened up new possibilities in archaeology and in determining the history of the Earth, we hear about the speculations on the reasons why dinosaurs became extinct

and read about the importance of the Moon in stabilising the Earth's axis of rotation and therefore contributing to the possibility of life on Earth. Quite a journey.

In between the descriptions and explanations of physical phenomena, there are some beautiful insights into the life of a research physicist. In the chapter "The power of words", the author describes how he was asked for 20 words related to his work together with their definitions. Some of these are reproduced in the book together with commentaries (rather than definitions). Many of the chosen words are surprising; one that particularly resonates with me is "coffee", which comes with an explanation of the importance of an informal meeting place where unscripted and unplanned discussions between scientists with different expertise, can lead to truly original multidisciplinary ideas. The author was using the coffee club at the Kapitza Institute in Moscow to illustrate this point. In my field, the cafeteria at the Cern Laboratory in Geneva is legendary as the cradle of key advances in the subject. I very much share the author's regret that such opportunities for natural collaborations to form are shrinking.

Science teachers are often frustrated when students submit manifestly absurd answers, and then compound the offence by saying that this is what the calculator or computer yielded. The ability to think before doing a detailed calculation and to estimate approximately what the answer should be is an important skill in science (and more generally in life) and yet does not come naturally to everyone. In the chapter "From pianos to the Sun", Balibar reminds us that Enrico Fermi developed these skills in students with questions such as "How many piano tuners are there in Chicago?" - a nice challenge for readers before they see Balibar's estimate.

The author also articulately expresses his irritation at the media exploiting the public's natural ignorance of specialised units to exaggerate the point that they are advocating. For example, when we read in Le Monde that after the accident at Chernobyl the contamination in certain parts of France reached 50,000 Bq/m², should we be outraged or not? That's a lot of becquerels per square metre, but is it a dangerous level of radiation? If instead we read that the contamination level was about 1? millionths of a curie (which is equivalent) or approximately equivalent to the radiation levels of six people in an elevator, would the level of our outrage change? Balibar is making the point that if society is to debate the risks and benefits of scientific and technological decisions that will be vitally important to the future of our planet, such as the future of our energy supply and climate change, the data must be presented not only accurately but also in context and with the correct perspective.

The Atom and the Apple provides an accessible introduction to a wide range of physics topics: the Big Bang, superfluidity, chaos and turbulence, quantum computing and cryptography, the matter-antimatter asymmetry of the Universe and many more. At least as importantly, however, Balibar explains the framework that underpins scientific knowledge and research. Since attempts to solve the major challenges facing society will require an assessment of the scientific and technological options, the insights provided in this enjoyable book help to make an informed debate possible.

THE AUTHOR

Physicist Sebastien Balibar has spent the entirety of his career, spanning nearly four decades, at the Ecole Normale Supérieure, where he also studied for his PhD. Now director of research at the Centre National de la Recherche Scientifique - a post he has held for 16 years - he has also travelled to visiting posts at institutions across the globe, including the universities of Nottingham, Exeter, Kyoto and Harvard. He is a member of the European Physical Society, as well as the American Physical Society, of which he was elected a fellow in 2005, and he has authored or co-authored four books, not to mention an astonishing number of articles on physics and particularly his specialist research interest of fluidity. In his spare time, Balibar enjoys listening to chamber music and cycling, and spends his summers climbing high passes in the Alps.

The Atom and the Apple: Twelve Tales from Contemporary Physics

By Sebastien Balibar

Princeton University Press

200pp, £14.95

ISBN 9780691131085

Published 20 November 2008

Reviewer :

Chris Sachrajda is professor of theoretical physics, University of Southampton.