Brain Oil

University is officially about education. You might think that all the Physics education we give is rolled up in the coursework and recommended reading lists for our courses. This certainly isn't true, even as far as reading is concerned. There should be plenty of times when you want to broaden your view beyond the textbooks and there will be plenty of times when you haven't the stamina to study a textbook closely. To add breadth to your reading and to expand your imagination, I offer this 3-page list of worthwhile books. It's a personal choice and could be a lot longer. I started a list like this with a colleague over 20 years ago but I've lost the original so this is a reduced re-boot. Don't judge a book by its age. Some books are worth reading decades after they are produced. I haven't checked but I suspect that most of the ones below will now be available in electronic format. I've just got the hardcopy versions.

Classics books worth knowing about

A. Square (Edwin A. Abbot) *Flatland: a Romance of Many Dimensions* [Blackwell, Oxford. First published in 1884]. A fantasy that should appeal to those with a mathematical or philosophical interest. An inhabitant of a two-dimensional world describes the appearance and customs of his fellow countrymen and women, who are all simple two-dimensional shapes. He goes on to narrate how he struggles to understand the concept of 3D space, his efforts being analogous to the effort we have to make to understand and appreciate 4D space. Better than this summary suggests but also written as a social allegory!

Richard P. Feynman *The Character of Physical Law* [BBC, 1965; modern paperback: Penguin, London, 1992] A personal view of physical laws by one of the 20th century's great physicists. Feynman had great insight and could communicate his enthusiasm for the subject better than almost anyone else in the business.

G. Gamow *Mr Tompkins in Wonderland: Stories of c, G and h* [CUP, 1939 and later] Six dreams in which Mr Tompkins lives in worlds where the speed of light is comparable to everyday speeds, the quantum of energy comparable to everyday energies and phenomena normally experienced by atoms are a feature of everyday life. The appendix contains the text of three talks that inspired the dreams, one on special relativity, one on general relativity and one on Planck's constant.

James Gleick *Chaos: Making a new Science* [Sphere Books, London, first paperback, 1988, and later] A modern classic, introducing current ideas on chaos and fractals through the story of their discoverers. What is the significance of 4.6692…. or the relevance of information theory in modern physics? Gleick not only conveys the excitement and ideas behind two of today's new sciences but brings to life Lorenz, Yorke, Feigenbaum, Mandlebrot, Shaw and many others who have contributed to these disciplines. This is one you must read. By the end, you'll be in danger of thinking that all of modern science is chaos.

E. Bright Wilson jnr. *An Introduction to Scientific Research* [McGraw-Hill, London, 1952] Dated when it comes to the technology with which he illustrates his ideas but deserving a listing in this 'classic' section because it is crammed with good ideas, common sense and the sort of practical advice that it is hard to find elsewhere. Chapters on the design of experiments, the design of apparatus, the statistical analysis of results and other subjects are relevant not just to physics but to much of scientific experimental work.

General interest

There are very many excellent single topic science books around but here are some that have a wider sweep, explicitly or implicitly.

[ed.] Ronald Duncan & Miranda Weston-Smith *The Encyclopaedia of Ignorance: Everything you Ever Wanted to Know About the Unknown* [Pergamon, 1977]. If you find this book in a second-hand bookshop, buy it. Some 50 top scientists have written short articles on subjects they would most like to know more about. The choice of subjects looks amazingly fresh decades later and the calibre of the contributions such that the articles are generally well worth reading.

Ed Regis *Great Mambo Chicken and the Transhuman Condition: Science Slightly Over the Edge* [Penguin, London, 1990]. After reading the title and the first chapter, you probably think that this book is about way-out science fiction. Slowly you will become even more astonished: the events and people described appear to be true. If you think that science is all carried on by sober folks in well-funded labs, read this and stretch your imagination.

K. Eric Drexler *Engines of Creation: the Coming era of Nanotechnology* [Paperback, OUP, 1992]. A visionary book, suggesting that with nanotechnology mankind will be able to do for industry and society what DNA has done for biology. This book is closely argued by a scientist who knows his science and has thought about the problems for a long time. You may be reluctant to agree with him, but the argument is worth following and the vision astonishing.

Roger Penrose *The Road to Reality* [Hardback, Jonathan Cape, 2004]. Coming in at over 1000 pages, you know the road is going to be long. It's also well strewn with obstacles as the book progresses but Penrose makes an engaging attempt at introducing the concepts behind modern theoretical physics. Don't be put off by the length, for this is a work of very wide scope and you don't need to read it all to learn a lot. The bibliography at the end references over 700 books and papers, making our suggested list tiny in comparison.

Bill Bryson *A Short History of Nearly Everything* [Doubleday, 2004]. The hazard of being labelled as a travel writer is that people raise their eyebrows or worse when you attempt something different. Bryson's tome is only half the length of Penrose's and covers a much wider range of science, centred on the question of where we and the world have come from. So, some astronomy and physics, geology, biology, archaeology and anthropology. It's a book full of stories of science, making up in readability what it sometimes lacks in rigour. Don't quote Bryson as a source of your information but unlike Penrose's book, you may well get to the end. It does include 60 pages of notes and a 15-page bibliography so if a story sounds particularly interesting you're likely to be able to follow it up.

Frank Wilczek *A Beautiful Question* [Allen Lane, 2015]. At the time of writing this I'm still reading Wilczek's book but I'm very happy to include it in the list. Wilczek won the Nobel Prize for his work in particle physics and the book is a reflective account of how the idea of beauty has been embedded in fundamental physical concepts through the ages. The text is peppered with insights and links to beauty as conceived in art and architecture, with supporting well-printed colour illustrations. How can you not like the writing of someone whose favourite physicist is James Clerk Maxwell?

Steve Parker(ed.) *Evolution: the Whole Story* [Thames & Hudson, 2015]. This isn't a physics book at all but it is one that should appeal to all lovers of nature. It is beautifully illustrated, authoritative and clearly written by a team of contributing authors. It covers the sweep of the evolution of life through the geological ages. For the physicist whose biology is a bit thin, there is a clear explanation of the tree of life: for the biologist, a clear explanation of how rocks are dated. You can start at the Precambrian and work to the Anthropocene or just dip in to the wonderful colour illustrations of life that has preceded us on Earth and how it functioned. This is one example of where the paper book will exceed an e-book in presentation and it's amazingly cheap for a high quality production.

A few paperbacks from my shelves, mainly on cosmic topics

John D. Barrow *The Constants of Nature* [Vintage, 2003]. The constants of physics underpin the whole of science. Which ones are fundamental? Where do they come from? Are they really constant? This book examines the universal context of the constants of physics with many stories from the history of science and their relevance to the universe at large. Very well written by a well-known cosmologist, there are 50 pages of notes that support his arguments and give his sources.

Graham Farmelo (ed.) *It Must be Beautiful: Great Equations of Modern Science* [Granta Books, 2002]. An impressive collection of notable scientists have each written a chapter on one of a dozen fundamental equations of science. There is no mathematical working in the books but well told stories of what the equations mean, how they were discovered and what their implications are.

Stephen Hawking *The Universe in a Nutshell* [Hardback: Bantam Press, 2001]. Like a great many others, I have Hawking's *A Brief History of Time* sitting not completely read on my shelves. This is both a sequel and a rather different production. Almost every page is illustrated, mainly in colour. Many of the pictures are quite whacky, lightening the tone. For many, a better read than *A Brief History*.

Paul Davies *The Goldilocks Enigma* [Allen Lane, 2006]. Another paperback about the universe at large written by a well-known name in the field. It's a while since I've read this but I remember lending it to someone who wanted to find out more about cosmology, which is a good sign that I thought well of it when it was fresher in my mind. Like other 'serious' popular science books, it has a substantial section of end notes and a useful bibliography.

Ed Regis *Who got Einstein's Office?* [Penguin, 1989]. This is basically the story of the first half century of the Institute of Advanced Studies in Princeton and its occupants. Since they have covered a wide range of science and included at least a dozen Nobel Prize winners the book covers a nice range of science. Looking at the authors I've included above I clearly prefer books written by practising scientists who write with a great depth of knowledge behind them but Ed Regis is an author by trade who doesn't descend to journalese simplification. He writes a good story and this is one of them.

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