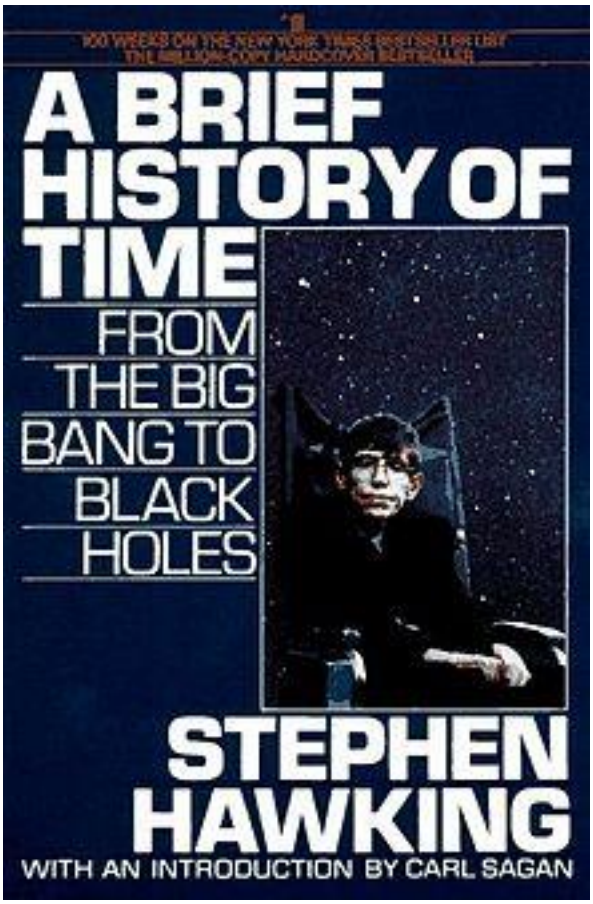
Physics Reading List

A Brief History of Time – Stephen Hawking

Recommended Years: 12-13

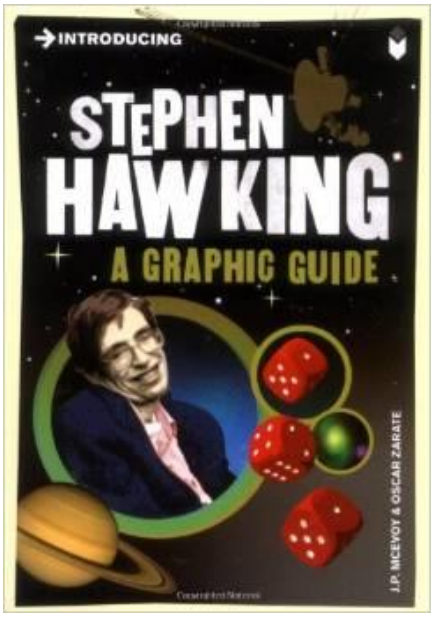


Everyone knows who Stephen Hawking is. He's probably the most famous living scientist in the world. What far fewer people know, however, is what science he's actually responsible for. Some people might know he's a physicist, fewer still might know he works in cosmology, but ask any layman what his key research has been and you're unlikely to get a concrete answer. *A Brief History of Time* guides you through much of Hawking's life work, straight from the horse's mouth. It focuses on his work with Roger Penrose and singularity theory, which he used to prove a theoretical basis for black holes. It also describes how his theories developed over time – the chapter on his discovery of Hawking radiation is particularly interesting. In order to explain his work, Hawking first gives the reader an overview of the big ideas in Physics. He explains the key ideas behind general relativity and quantum theory, and their fundamental disagreement – before bringing them crashing together to explain black hole formation.

Be warned; the book looks deceptively short. It's not the most readable popular science book out there. When I read it, I went through each chapter twice, first to get the general gist, then to actually understand what he was saying. It might be useful to read this sat at a desk with a pen and paper – Hawking explains much of the book through diagrams and thought experiments, so doing a few sketches can really bring it to life.

Stephen Hawking: A Graphic Guide – JP McEvoy & Oscar Zarate

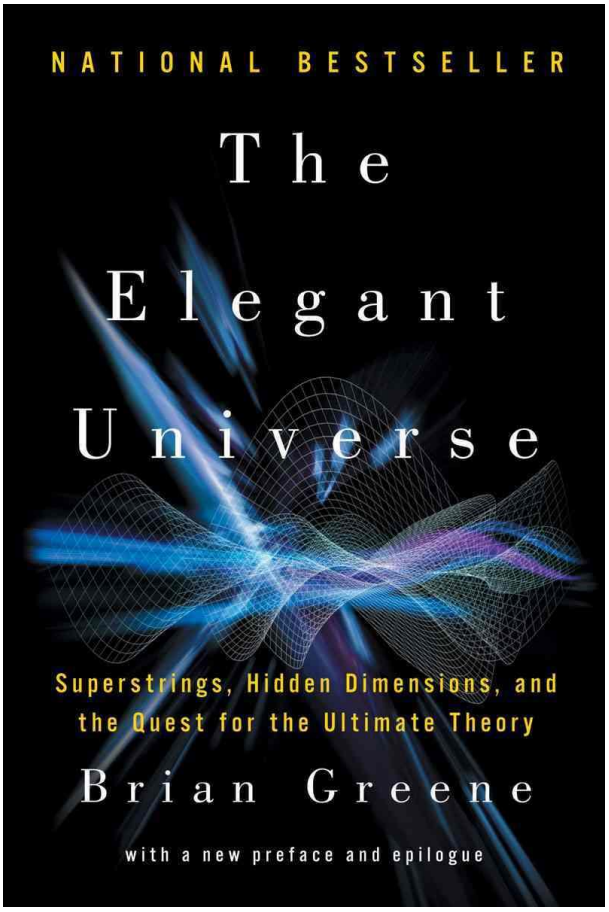
Recommended years: 10-13



This book introduces Hawking in a concise, easy to read form. It's a cross between a popular science book and a graphic novel, so it's really easy to visualise the concepts. This book is really good as a simple primer to Hawking's work, so I'd recommend reading it before tackling *A Brief History of Time.* It doesn't go into as much detail, but it gives you the general idea of Hawking's research, so when you come to read it in Hawking's own words it seems less daunting.

The Elegant Universe – Brian Greene

Recommended Years: 12-13

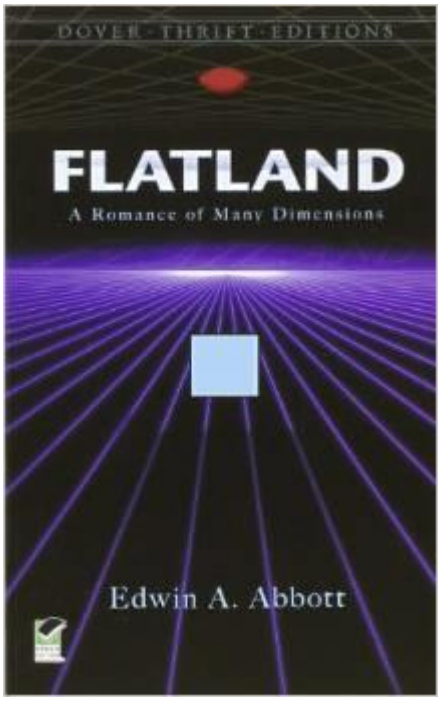


String theory is the cutting edge of modern theoretical physics. It aims to reconcile the disagreements between general relativity – where space is smooth – and quantum mechanics – where, as you look closer, the fabric of space itself becomes chaotic. Greene aims to explain the development of string theory to the reader, by first examining the development of each of the discordant theories, and explaining the problems that arise when you try to combine them. His description of relativity is particularly special. It's a bit more technical than other books, but he conveys really well the elegant symmetries behind it without resorting to maths. He then takes you through string theory – explaining the theories inception, the concept of higher dimensions, the implications of string theory and crucially, how we are going about searching for evidence. This last point is particularly interesting; our current picture of the universe only breaks down in extreme conditions - we would need a particle accelerator the size of the solar system to see the direct effects of strings. As such, the search for experimental data is more indirect – we have to re-examine our interpretation of existing phenomena to find small deviations that can be accounted for by string theory.

Greene aims to keep the main body of the book fairly light on complex mathematics (Popular science book publishers say for every equation you use, you halve your readership)! However, he includes a comprehensive appendix that goes through certain concepts in more detail, for the particularly interested reader. It's worth trying to read through a few of these if you're interested in a subject – some of the concepts are quite complex, but if you take it slow and discuss it with friends or teachers, it can really give you a deep insight into this exciting realm of physics!

Flatland – Edwin A. Abbot

Recommended Years: 11-13

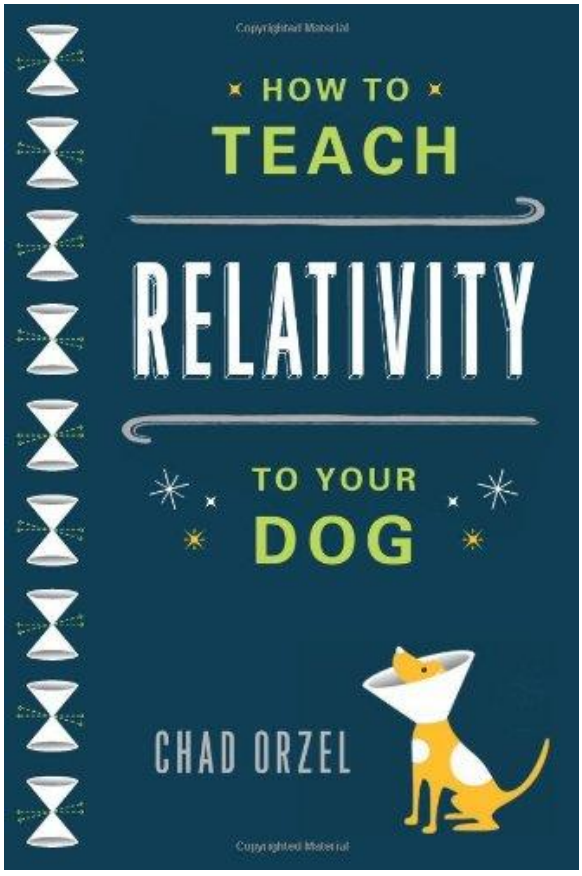


A clever and humorous mathematical essay, Flatland tells the story of a square living in a two dimensional land. The challenges of living in two dimensions mean the society has developed strange customs that our protagonist describes. In a dream, he is transported to Lineland, where inhabitants exist in only one dimension. He cannot fathom how the citizens of Lineland cannot comprehend the second dimension. Once he returns to Flatland, however, he is baffled to be visited by a mysterious visitor who calls himself a Sphere…

This short essay is very easy to read, and is a good accompaniment to *The Elegant Universe.* Greene's chapter on the extra dimensions required by string theory can often be confusing, but Flatland gives a glimpse into the challenges of perceiving extra dimensions.

How to Teach Relativity to Your Dog – Chad Orzel

Recommended Years: 12-13

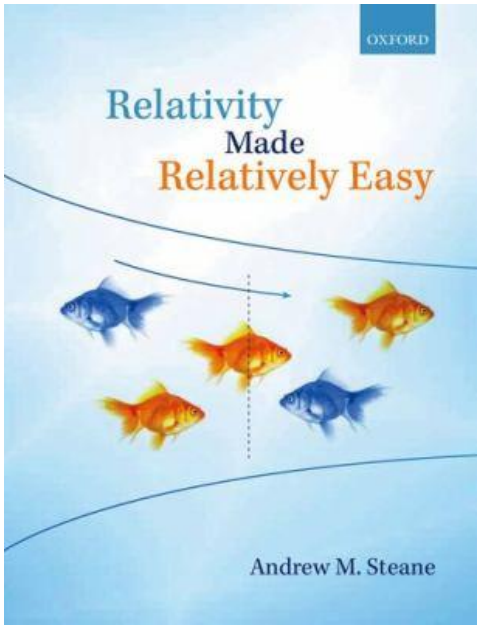


Several of these books give a brief overview of Relativity, as the theory forms one of the cornerstones of modern Physics. However, Orzel's book aims to explain the theory and its implications in detail. There's a good mix of technical and more descriptive elements, as the book is presented as a series of conversations between Chad and his extremely eager, but mathematically inept, dog.

Each chapter begins with one of these conversations, which take you through the key ideas behind relativity, before a more technical and mathematical explanation. This combination means the book is accessible to all readers, but provides the technical aspect for those with a particular interest.

Relativity Made Relatively Easy

Recommended Years: 12-13

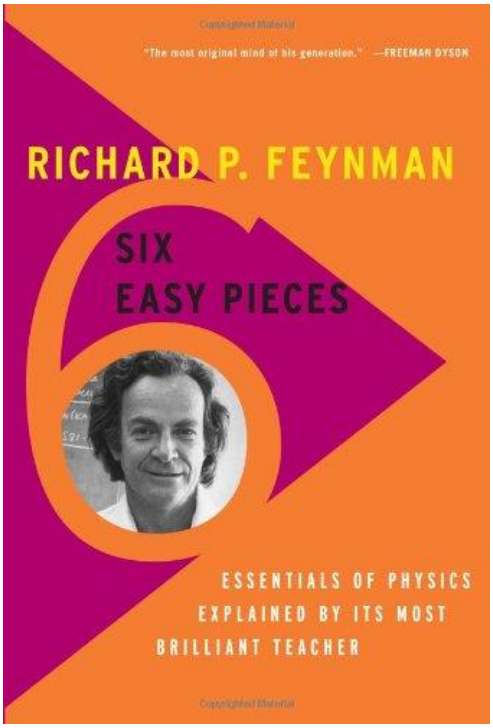


If you find relativity interesting and fancy a challenge, this book is very interesting. It's written for 1st year undergraduate courses, but in a less technical style than most textbooks. It aims to give students a more thorough understanding of the concepts and implications of relativity without getting bogged down in the maths. It was recommended to me by a lecturer as 'bedtime reading', so though it covers high level material, it does it in a readable and understandable way. It assumes 'almost no prior knowledge', and aims to bridge the gap between purely descriptive texts and mathematical textbooks. It's likely that any admissions tutor will be familiar with the book, so it will certainly look impressive when you come to apply.

As is the case with most university textbooks, it can get quite expensive, but if you don't want to shell out, there's a copy in the Nottingham library catalogue.

Six Easy Pieces – Richard P. Fenymann

Recommended Years: 12-13



Richard Fenymann is perhaps the least well known of the giants of Physics. His work on QED and QCD puts his genius on the same level as Newton and Einstein. However, one of Fenymann's most defining characteristics was his love of teaching. He always said that if he couldn't explain a Physics idea to a class of 1st year undergraduates, then he didn't really understand it. It was this attitude that led him to teach the CalTech 1st year physics course in the early 1960s, now immortalised in the *Fenymann Lectures on Physics. Six Easy Pieces* contains the six least technical of these lectures, delving into varied aspects of physics including gravity, conservation of energy and basic quantum theory.

The word 'easy' is perhaps a bit misleading. While the maths in the lectures is easy, some of the concepts can take a few minutes to get your head around. However, if you're willing to work through each of the lectures, you'll find it very rewarding. Ask a physics student who their favourite physicist of all time is, and you're probably likely to hear Fenymann's name pop up often.

Physics Articles

Below are some interesting articles about cutting edge physics research, organised into different areas of physics.

Gravitational Waves and General Relativity

- Einstein's gravity theory passes toughest test yet: Bizarre binary star system pushes study of relativity to new limits: http://phys.org/news/2013-04-einstein-gravity-theory-toughest-bizarre.html
- First Direct Evidence of Cosmic Inflation: https://www.cfa.harvard.edu/news/2014-05
    - This was one of the first articles announcing the discovery of gravitational waves from cosmic inflation in the early universe. However, their experiment was later shown to be flawed – you can read about this in the article below.
- Gravitational Waves from Early Universe Remain Elusive: http://www.jpl.nasa.gov/news/news.php?release=2015-46
- Crashing Black Holes http://calteches.library.caltech.edu/4298/1/BlackHoles.pdf
- CERN's new Einstein Observatory to explore black holes, Big Bang: http://phys.org/news/2011-05-cern-einstein-observatory-explore-black.html

String Theory

- New website dedicated to discussion of string theory: http://phys.org/news/2012-10-website-dedicated-discussion-theory.html
- Scientists find a practical test for string theory: http://phys.org/news/2014-01-scientists-theory.html
- What is string theory? http://www.physics.org/article-questions.asp?id=47
- String theory: it's not dead yet: http://www.newscientist.com/article/dn11882-string-theory-its-not-dead-yet.html#.VQa6AqzLcjU
- Finally, a MAGIC test for string theory?: http://www.newscientist.com/article/dn12609-finally-a-magic-test-for-string-theory.html

Quantum Computers

- How Quantum Computers Work: http://computer.howstuffworks.com/quantum-computer.htm
- The Father of Quantum Computing: http://archive.wired.com/science/discoveries/news/2007/02/72734
- The Revolutionary Quantum Computer That May Not Be Quantum at All: http://www.wired.com/2014/05/quantum-computing/

Materials Science

- Scientists fabricate defect-free graphene, set record reversible capacity for Co3O4 anode in Li-ion batteries: http://phys.org/news/2014-08-scientists-fabricate-defect-free-graphene-reversible.html
- Theoretical physicists design 'holy grail' of materials science: http://phys.org/news/2015-03-theoretical-physicists-holy-grail-materials.html
- Novel crumpling method takes flat graphene from 2D to 3D: http://phys.org/news/2015-02-crumpling-method-flat-graphene-2d.html
- Stanene is ‘100% efficient’, could finally replace copper wires in silicon chips: http://www.extremetech.com/extreme/171551-stanene-is-100-efficient-could-finally-replace-copper-wires-in-silicon-chips
- What is Aerogel? Theory, Properties and Applications: http://www.azom.com/article.aspx?ArticleID=6499

Particle Physics

- Why particle physics matters: http://www.symmetrymagazine.org/article/october-2013/why-particle-physics-matters
- It's a boson! But we need to know if it's the Higgs: http://www.newscientist.com/article/dn22029-its-a-boson-but-we-need-to-know-if-its-the-higgs.html?page=1#.VQfooqzLdVw

- Particle chameleon caught in the act of changing http://press.web.cern.ch/press-releases/2010/05/particle-chameleon-caught-act-changing
- The search for dark matter at the LHC: http://www.symmetrymagazine.org/article/the-search-for-dark-matter-at-the-lhc
- Could the Higgs Nobel Be the End of Particle Physics?: http://www.scientificamerican.com/article/could-the-higgs-nobel-be-the-end-of-particle-physics/

Astrophysics

- How do we know dark matter exists?: http://phys.org/news/2015-03-dark.html
- The corrugated galaxy: Milky Way may be much larger than previously estimated: http://phys.org/news/2015-03-corrugated-galaxy-milky-larger-previously.html
- Solving the riddle of neutron stars: http://www.sciencedaily.com/releases/2015/03/150310074105.htm
- Cosmology: First stars were born much later than thought: http://www.sciencedaily.com/releases/2015/02/150205131233.htm

Other Physics reading lists

http://www.thestudentroom.co.uk/wiki/recommended_physics_reading

http://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0CDUQFjAC&url=http%3A%2F%2Fwww.lowestoftsfc.ac.uk%2Fimages%2Fuploads%2Fdocs%2FA_Level_Physics_Reading_List.pdf&ei=Dey0VPvKKoGpUtr7g9AO&usg=AFQjCNFmdEU1TftbihaGQr99sW9DdtS1CA&bvm=bv.83339334,d.d24&cad=rja

Other Subject Reading Lists

Website list for all subjects, specialised for Cambridge applicants:
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=6&ved=0CEgQFjAF&url=http%3A%2F%2Fwww.tbgs.co.uk%2Fforce_download.cfm%3Fid%3D363&ei=tCe2VPWvOMKxPJqYgeAL&usg=AFQjCNGlB-vrDQHDvqpo8aRNUmFnkE2qUw&bvm=bv.83640239,d.ZWU

Chemistry:

http://www.perse.co.uk/sixth-form/subjects/chemistry/recommended-reading/

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CDEQFjAB&url=http%3A%2F%2Fwww.sjfcc.net%2Fmedia%2Fdocuments%2Ftrinity_intake%2FReading%2520List%2520for%2520A%2520Level%2520Chemists.pdf&ei=tCe2VPWvOMKxPJqYgeAL&usg=AFQjCNH1-QS46u60iQXgI771uqEl5krKKQ&bvm=bv.83640239,d.ZWU

Biology:

http://www.oxfordhigh.gdst.net/senior-school/departments/biology/a-level-reading-list/

https://www.tes.co.uk/teaching-resource/Reading-List-for-A-Level-Biologists-6092577

http://www.perse.co.uk/wp-content/uploads/2011/10/Sixth-Form-Biology-Reading-List.pdf

Mathematics:

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCEQFjAA&url=http%3A%2F%2Fwww.maths.cam.ac.uk%2Fundergrad%2Fadmissions%2Freadinglist.pdf&ei=5y62VLPIKKu5ygPR44GwCw&usg=AFQjCNHwO67PT3KaEw3rorWvj4tSSavtyg&bvm=bv.83640239,d.bGQ

http://www.thestudentroom.co.uk/wiki/Recommended_Mathematics_Reading

http://www.mei.org.uk/books2

http://www2.warwick.ac.uk/fac/sci/maths/admissions/ug/read_list2/

Economics:

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCEQFjAA&url=http%3A%2F%2Fwww.kes.hants.sch.uk%2Fresource.aspx%3Fid%3D31409&ei=uC-2VL66NIf5ygPyoYKgBw&usg=AFQjCNHorSb49918uakjZ9GzmDdQ76UN4A

http://www.economicshelp.org/blog/4208/economics/recommended-reading-list-for-economics-students/

https://www.tes.co.uk/teaching-resource/A-Level-Economics-Reading-List-6191917