

# Christmas books

Ruth Gregory

## The land before time

Mark Garrick/Science Photo Library



### Circular reasoning

The cyclic-universe model suggests that the cosmos dies and gets reborn every trillion years.

### Endless Universe: Beyond the Big Bang

Paul J Steinhardt and Neil Turok

2007 Weidenfeld & Nicolson  
£20.00/\$24.95hb  
304pp

“Before time? What do you mean before time?” says the Doctor to the Beast in a recent episode of the TV show *Doctor Who* entitled “The Satan Pit”. The intrepid Time Lord, as we all know, lives in what we might call the conventional universe, which has a definite beginning, no end and nothing – not even time – exists otherwise. But is this picture true? *Endless Universe* is a highly readable account of two scientists’ struggle to imagine the universe, and what emerges is that this conventional picture is by no means the final word in cosmology.

Our quest to understand the universe has a long and venerable history. But the real thrill of trying to understand nature is that although we come to the table with an incomplete set of tools, we can still fashion theories that are remarkably accurate and effective. Over 70 years after Einstein claimed that the most incomprehensible thing about the universe was that it was comprehensible, his comment still holds true.

The early years of cosmology were heady times. On the one hand, the frontiers of observation and measurement were pushing outwards at an incredible rate, showing that the

universe was a dynamic and evolving place. On the other, the application of the new quantum theories was giving a concrete picture of how elements were synthesized in the early universe, which, when put together with Einstein’s new theory of gravity, gave a compelling history of the universe. Yet this new “cosmology” was a marginal area of science, because adding up the numbers between observation and theory was fiendishly difficult.

Gradually, however, these details were refined and the rough and ready Big Bang model was spectacularly confirmed. There was just one niggling problem: the universe had to have started out in such a precise – and unlikely – state that it seemed as if it must have been created rather than

**The conventional picture of the universe is by no means the final word in cosmology**

just having happened. Such a conclusion is perhaps theologically acceptable, but, as the authors of this book are at pains to point out, science is about what can or cannot be proved, not about what we wish to be true.

The real narrative of the book begins at this point, with the theory of inflation – the first attempt to take the Big Bang beyond the frontier of tested physics. Inflation was an attempt to take ideas from (then) contemporary high-energy physics and apply them to the early universe to provide a moderating effect. The result was a kind of cosmic smoothie maker that could take a wide range of possible beginnings, and churn out very similar cosmologies. Yet inflation does not answer the question of the beginning, and – like the Doctor – we are left wondering if anything could indeed happen “before time”.

Paul Steinhardt and Neil Turok ask us to contemplate the startling possibility that this question has meaning. Having built the case for inflation, they proceed to pick at the detail, describing how inflation has its own “niggling problems”, and they argue that the time is ripe for a new idea. One by one they show that the problems inflation was designed to solve can also be solved by an alternate idea: the cyclic universe. In this model, the universe has been in existence forever – dying and then undergoing a cosmic rebirth every trillion years or so. This may sound far-fetched as it is difficult to see how we can go through a singularity where everything, including space and time, ceases to exist, but as the authors explain, this difficulty arises because we are used to thinking in three dimensions.

String theory – the biggest theoretical advance in cosmology since inflation was suggested – has brought with it a new understanding of space and time. It achieves Einstein’s goal of bringing gravity under the quantum umbrella, but it does so at a price. In order to be consistent with quantum mechanics we need to live in 10 (or even 11) dimensions! For many years, string theorists avoided cosmology because it was not possible to build a realistic universe, but recent developments in the understanding of the structure of these extra dimensions, as well as a revolution in the way we deal with them, meant the time was ripe for a radically new cosmological model.

Steinhardt and Turok stepped in to

provide one. In their model, the universe is simply a slice (known as a brane) through these extra dimensions, and the Big Bang was a collision of branes – a huge cosmic thunderclap. This model builds on an idea called M-theory, in which the strings live on two walls at the end of an 11D space–time. Applying the usual rules of string theory leads to a general picture in which these walls can move across the canyon separating them, and occasionally (every trillion years or so according

to Steinhardt and Turok) slam into each other. It is this slamming together that is responsible for what we see as the Big Bang, although from a higher-dimensional point of view it is a collision rather than a singularity.

This book may not convince you that the authors are right. In fact, it is only fair to point out that most of the scientific community does not accept their model; and that many key tenets have not been proven. Nevertheless, this book captures excellently the

excitement of scientific advance, and the real thrill of coming up with a new idea. One message the authors communicate clearly is that we should never accept something simply because most people say it is true, but should constantly challenge and look for alternatives to any picture that cannot be rigorously proven.

**Ruth Gregory** is a theoretical physicist at Durham University, UK, e-mail r.a.w.gregory@durham.ac.uk

### Physics books crossword

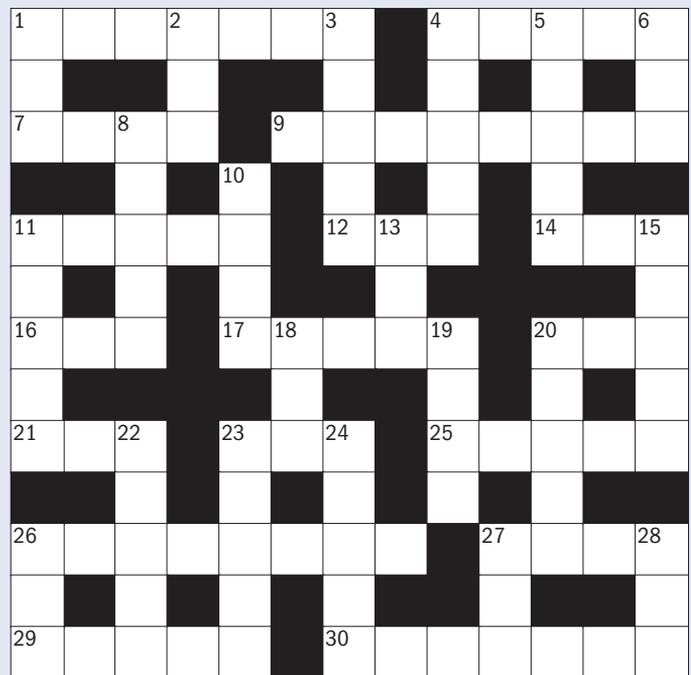
Welcome to the *Physics World* Christmas books crossword compiled by Peter Wade-Wright. The across and down clues are cryptic, and the answers are all physics related. To help you along, there is also an extra set of clues based on the titles of science books, although you'll have to work out for yourself which number each of these relates to. There is no prize except the satisfaction of completion and the solution is given on page 47.

#### Across

1. Discretely energetic (7)
4. Mould or strip the modus operandi leaving a backdoor Trojan, or a very positive anode (5)
7. Move off quickly down a Devon river (4)
9. Featureless plain until you pass through it (8)
11. Instinct leading to a computer language (5)
12. Association for Science Education gets all mixed up over a large amount of water (3)
14. A or B? Neither is a logical choice (3)
16. Squared-up to a statistical test (3)
17. A drop in the Pacific or Atlantic isn't noticed (5)
20. Currently resistant (3)
21. It reflects your PIN as a gap between rollers (3)
23. Dan messed-up his testing but didn't break anything. By 15 Down possibly? (abbrev.) (1,1,1)
25. I? No! No! It's enough to make you weep (5)
26. Topsoil shifter uses Italian light to produce bonded atoms (8)
27. Just go with it! (4)
29. Father of geology impressed Darwin (5)
30. Passes completely over the document, but gets the information (7)

#### Down

1. What was to be proved? (1,1,1)
2. 2240 lb upwards is a logical step down (3)
3.  $\cos^2$  law polarizes (5)
4. It's just beyond, as far as the Romans were concerned (5)
5. Huck's creator makes 30 Across a compliant interface (5)
6. Perch on a reactor fuel element (3)
8. Italian "Smith" made major contributions to particle, plasma, cosmic-ray physics, etc (5)
10. On reflection it does sound like it (4)
11. Viscount established the scientific method (5)
13. Abbreviated operation outside a space-vehicle with life-support (1,1,1)
15. Just a light scattering by 26 Across causing frequency changes (5)
18. Absolute boulder helps in designing (1,1,1)
19. Noble? What a gas! (4)
20. The role I mess up becomes an Oxford College where Gilbert White studied (5)
22. Obsolete impulse takes a step, then reverses after a time (5)
23. Crystal-based prism showed 3 Down (5)
24. Celestial sphere holder confused a salt (5)
26. SI abbreviation that doesn't save much, and it matters (3)
27. Playful and enjoyable aspects of physics that should be stressed (3)
28. Conflict regrettably ensures scientific progress (3)



Readers will find 24 of the puzzle answers in the titles of the following works.

- Francis \_\_\_\_\_: *The Major Works* by F \_\_\_\_\_  
 A Guide to \_\_\_\_\_-Squared Testing by P E Greenwood and M S Nikulin  
 Experimental \_\_\_\_\_ NMR by E Fukushima and S B W Roeder  
 \_\_\_\_\_ of the Big Bang by M D Lemonick  
 How to Do Everything with Your \_\_\_\_\_ by D Huss  
 Reminiscences Chiefly of \_\_\_\_\_ College and the Oxford Movement by T Mozley  
 It's a Science Thing: A \_\_\_\_\_ Look at Matter, Energy and Gravity by K Swain  
 The Search for Poison-\_\_\_\_\_ Frogs by R Fridell  
 \_\_\_\_\_ Even Wrong: *The Failure of String Theory and the Continuing Challenge to Unify the Laws of Physics* by P Woit  
 Micro machines: \_\_\_\_\_-Small World of Nanotechnology by D Jefferis  
 Mapping the Deep: *The Extraordinary Story of \_\_\_\_\_ Science* by R Kunzig  
 The Fruits of \_\_\_\_\_ by M White  
 Principles of Geology by C \_\_\_\_\_  
 \_\_\_\_\_ Mathematics for the Physical Sciences (ed) R Lambourne and M Tinker  
 Viscous \_\_\_\_\_ by H Ockendon and J R Ockendon  
 Semiconductor \_\_\_\_\_ Lasers by K Suto and J Nishizawa  
 The New Cosmic \_\_\_\_\_: *Quarks and the Nature of the Universe* by F E Close  
 The \_\_\_\_\_ Hunt by M Jones  
 The \_\_\_\_\_ Around Us by R Carson  
 \_\_\_\_\_ A Romance of Many Dimensions by E Abbott  
 \_\_\_\_\_: *The Strange Theory of Light and Matter* by R Feynman  
 The New \_\_\_\_\_ Universe by T Hey and P Walters  
 \_\_\_\_\_ of the Universe by P Moore  
 Lightning \_\_\_\_\_: *A History of the Air Force Chief Scientist's Office* by D A Day