It doesn’t seem that long since “Einstein Year”, the worldwide celebration held in 2005 to commemorate the great physicist’s extraordinary scientific output a century earlier. 2015 will mark another important Einstein anniversary: the centenary of the presentation of his general theory of relativity.

Among physicists, this theory is regarded as Einstein’s greatest achievement, a towering scientific theory that remains unsurpassed in terms of its originality, elegance and predictive power. By replacing Newton’s force of gravity with a warping of space–time, Einstein transformed our view of space, time, force and gravitation, a revolution that continues to deliver astonishing insights into the world of the very large.

The general theory stands alongside quantum theory as one of the great pillars of 20th-century physics, but where quantum theory had a long and difficult birth, with multiple modifications and many “parents”, general relativity sprang from the mind of one man and has remained virtually unchanged ever since. Over the years, the theory has provided the framework for almost all of our knowledge of the universe, from the “Big Bang” model of the evolution of the universe to our understanding of black holes.

In The Perfect Theory, Pedro Ferreira provides a timely, expert and highly readable history of general relativity. An astrophysicist at the University of Oxford, Ferreira is renowned for his work on the problem of galaxy formation and his research into alternative theories of gravity. His biography of the general theory is affectionate and meticulous, although the narrative is that of a physicist rather than a mathematician or relativist. This approach is neatly summed up in the book’s excellent prologue, where Ferreira writes that “The reward for harnessing Albert Einstein’s general theory of relativity is nothing less than the key to understanding the universe, the origin of time, and the evolution of all the stars and galaxies in the cosmos.” At the same time, the book is firmly aimed at a public audience and is a welcome addition to popular books on the topic such as Jean Eisenstaedt’s The Curious History of Relativity or God’s Equation by Amir Aczel.

From a cosmologist’s point of view, the story of general relativity can be usefully divided into five distinct periods. The first era saw the formulation of the theory and its initial application to the universe as a whole, resulting in the “static” cosmic models of Einstein and Willem de Sitter. In the second epoch, time-varying models of the cosmos were proposed by Alexander Friedmann and Georges Lemaître; such models were further explored by Einstein, De Sitter, Lemaître, Howard Percy Robertson, Richard Tolman and Arthur Eddington in the wake of Edwin Hubble’s observations of the recession of the galaxies in 1929. Little theoretical progress was made in relativity during the third period (1940–1960), but the era did see the proposal of a hot, radiation-dominated infant universe by George Gamow, Ralph Alpher and Robert Herman, and the rise of a rival “steady-state” cosmology proposed by Fred Hoyle, Hermann Bondi and Tommy Gold. Next came the “golden decade” of 1963–1973, which saw the discovery of radio-galaxies, quasars, pulsars and the cosmic microwave background, and parallel progress in theoretical work on singularities. This period was followed by the modern era of precision measurements of the cosmic microwave background and the emergence of theories such as cosmic inflation and dark energy.

Ferreira covers each of these periods in an engaging, conversational way. He does not skimp on detail in most instances, yet the lively narrative holds the reader’s attention throughout. I particularly enjoyed the section on the renaissance of general relativity, from John Wheeler’s famous presentation “The issue of the final state” at the 1963 Texas Symposium on Relativistic Astrophysics to the furious efforts of the world’s top relativists at Cambridge, Princeton and Moscow to crack the problem of black holes in the 1970s. Another unusual section is the description of attempts by some theorists to reinstate the cosmological constant before the discovery of the universe’s accelerating expan-
That said, there is some unevenness in the level of detail in the narrative, no doubt owing to considerations of length. For example, there is surprisingly little discussion about the plethora of dynamic cosmic models that were proposed in the early 1930s, almost no details are given of the pioneering work of the Gamow group in the 1940s and very little information is presented on modern measurements of the cosmic microwave background by the COBE, WMAP or Planck satellites. On the other hand, the author does present an intriguing chapter on alternative theories of gravity that have recently come to the fore, and expertly conveys the excitement of future experiments that “could confirm or refute the fundamental tenets of general relativity”.

With regard to audience, the book will be an enjoyable read for physicists in any field. Some physics teachers and students might be disappointed by the complete absence of equations and diagrams, and wonder what the mathematical machinery of general relativity looks like – in this respect, the story is less satisfying than the author’s earlier book *The State of the Universe*. Mathematically inclined readers might also be disappointed that there is very little description of the theoretical development of general relativity by key players such as Hermann Weyl and Cornelius Lanczos in the 1920s, or John Lighton Synge and William McCrea in the 1950s and 1960s. On the other hand, the book is very approachable for a lay audience, despite the level of historical detail.

Historians of science may notice some minor historical errors. For example, it is known from Einstein’s travel diaries that his conversion to the expanding universe was influenced by discussions with Tolman (not Hubble, as stated). It is also known that Einstein first formally embraced the expanding universe and banished the cosmological constant in the Friedmann–Einstein model of 1931 (not the Einstein–de Sitter model of 1932 as stated). The existence of a universal background radiation was first predicted by Alpher and Herman (not Gamow). Finally, it is not made clear that Alan Guth’s proposal of cosmic inflation addressed a theoretical puzzle concerning spatial flatness, rather than an observational problem. Useful historical notes are given for each chapter at the end of the book, but they are easy to miss because they are not flagged in the main text.

The above are minor criticisms. In this book, the story of general relativity is told with clarity and authority, and the narrative speeds along at a cracking pace. I particularly admired how the book opens with Eddington’s 1919 address to the Royal Society in which he announced the observation of a warping of space by our Sun – an experiment that was carried out on the island of Principe during an eclipse – and closes with a description of the author’s visit to the island 90 years later to lay a plaque in honour of that landmark experiment. All in all, this is a masterful, well written and timely addition to the literature on the greatest theory of them all.

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