on the border between Big Rip and Big Crunch; in fact, there is no uncertainty at all in the concordance model of cosmology that the Universe will expand forever (unless something unknown has not been taken into account, but that would go beyond the concordance model); geometry and destiny are not so simply related. Those are not fine technical details but rather the most basic ideas in cosmology, so I find it rather strange that those and other basic misconceptions are also found within other popular-science books written by people who obviously know more than enough people who could have critically read the manuscript (*e.g.*, refs. 3,4). (There are a few other things a proof reader should have caught: Kirchhoff always has one 'h' too few and Secchi sometimes one too many; Rutherford won a Nobel Prize, but for chemistry, not physics.)

There are a few black-and-white figures scattered throughout the book. The brief bibliography contains twelve references, but it is not clear why those twelve (which are not mentioned explicitly in the text). One hundred and sixteen footnotes (easy to count since numbering doesn't restart with each chapter) will appeal to those who, like myself, like footnotes (especially when compared with endnotes). A twelve-page small-print index ends the book. The book does what it sets out to do well, but shouldn't have included the few pages on cosmology at all; even if they were correct, they don't really belong in a book about the astrophysics of black holes, so I can recommend it if the last chapter is skipped. — Phillip Helbig.

References

(1) B. Cox & J. Forshaw, *Black Holes: The Key to Understanding the Universe* (William Collins), 2023.
(2) P. Helbig, *The Observatory*, **145**, 129, 2025.
(3) P. Helbig, *The Observatory*, **144**, 38, 2024.
(4) P. Helbig, *The Observatory*, **144**, 201, 2024.

Annual Review of Earth and Planetary Sciences, Vol 52, 2024, edited by R. Jeanloz & K. H. Freeman (Annual Reviews), 2024. Pp. 692, 24 × 19·5 cm. Price $529 (for institutions; about £420) $126 (for personal copies; about £100) (hardbound; ISBN 978 0 8243 2052 2).

The latest volume of *Annual Review* covers a nice diversity of subjects that includes the biosphere, mantle composition and dynamics, the atmosphere, and the hydrosphere. An old Icelandic saying is that a good story should start with an earthquake and then build up to a climax. This year's volume seems to have paid attention to this, and starts with chapters on volcanism in Hawai'i and aftershock forecasting. Highly recommended. A chapter on microbial life brings home the message that this is the foundation, both in longevity and mass, of life on Earth. Microbial life is not just the icing on the cake. The development of this is covered by a following chapter on early Paleozoic evolution and the door is then closed by a chapter on the Pleistocene extinction. The interior of Earth is discussed in a variety of chapters on halogen cycling, diamonds, lithosphere, and mantle rheology. As regards the deeper mantle, despite all our work it seems still unclear whether it has a similar composition to the upper mantle (and thus convects as one with it) or not. Differences of up to 10% seem possible. Climate is represented by chapters on the stability of ice shelves and past hothouse climates. A chapter on carbon-climate feedbacks directly addresses the implications of the Paris Agreement. The situation is challenging, even if the main goal is met, which itself seems improbable. Uncertainties are large, but one thing we can confidently say is that natural carbon sinks will become less efficient with time. An interesting chapter deals with that part of deep

groundwater that is locked in the lithosphere. For river-running enthusiasts, a chapter deals with the hydrotectonics of Grand Canyon groundwater, which presents a rare chance to monitor vertical water movement without the use of boreholes. Check out the book and find out what the Indonesian Gateway is! The volume finishes with an unusual chapter on the relationship between grain size and landscape. So if you feel like a bit of a change, then start reading the book from the back. — Gillian R. Foulger.

The Cosmic Microwave Background: Historical and Philosophical Lessons, by Slobodan Perović & Milan M. Ćirković (Cambridge University Press), 2024. Pp. 215, 25 × 17·5 cm. Price £39·99/$49·99 (hardbound; ISBN 978 1 108 84460 4).

As the subtitle states, this is a book on the history and philosophy of the CMB. However, it does not stray far from actual physics, and points are made with the help of concrete examples. The second author is someone I've often encountered in the history-and-or-philosophy-of-science literature, and the authors have a good grasp both of that and of astrophysics. The conventional narrative is that the CMB suddenly proved that the Steady State cosmological model was inviable. While the CMB is expected in the Big Bang scenario, it is not impossible in the Steady State theory, which is based on the idea that on a large-enough scale, the Universe looks the same at all places and at all times. Nevertheless, one would still like to have an astrophysical explanation for the CMB within the Steady State theory. For Fred Hoyle, one of the main motivations for the Steady State cosmology was that it in principle made all processes accessible to scientific inquiry, which might not be true of the Big Bang itself. However, counts of radio sources ruled out the Steady State model. Both supporters of the Steady State model and those of Big Bang cosmology investigated alternative explanations for the CMB, and it was not until features in the power spectrum were discovered about 25 years ago that the scales were finally definitively tipped in favour of a Big Bang origin for the CMB. That is not only an interesting story in itself, but also such dead ends are important because they illustrate how the scientific process actually works.

The thirty-one chapters are clearly structured into seven parts covering the basics of cosmology, the Big Bang, and ΛCDM (referred to, unusually, as λCDM); discovery of the CMB and the current standard model, but including a discussion of shortcomings in usual potted histories; the nature of (un)orthodoxy in cosmology; moderate unorthodoxies (CMB with Big Bang); radical unorthodoxies (CMB without Big Bang); the history of how the current orthodoxy came to be; anomalies in the CMB and wider issues such as the Anthropic Principle, boundary conditions in cosmology, and the Multiverse, using the CMB as a jumping-off point. Too long to quote here, the end of Chapter 9 ('Was the CMB a smoking gun?') is a good summary of the strategy of the book: a balance between questioning a too-streamlined view of history without questioning the state at which that history has (probably correctly) arrived; learning from blind alleys and misconceptions, some of which later proved useful in other contexts; and a good balance between astrophysics and philosophy by authors knowledgeable about both topics. To some extent, this book reminded me of a similar book with much broader scope[1] reviewed in these pages[2], though I found that the latter was sometimes a bit too broad and too forgiving. (At the same time, that book is conspicuous by its absence in the otherwise thorough sixteen-page reference list in somewhat smaller print, though two of his articles, one on essentially the same topic as his book, are