The Allure of the Multiverse: Extra Dimensions, Other Worlds, and Parallel Universes, by Paul Halpern (Basic Books), 2024. Pp. 308, 23 × 13 cm. Price $30·00 (about £24) (hardbound; ISBN 978 154160217 5).

[*The Observatory* has received two reviews of this book and the Editors feel that our readers will enjoy both, coming as they do from our two most prolific and experienced reviewers.]

Most people…many people…well, anyhow your present reviewer, sometimes wish they had done some things differently, rent or buy, accept that job instead of this, maybe even marry someone else*. This must be part of the attraction of the idea of reincarnation. Could it also be part of the charm of multiverses? Maybe you don't get to try the other fork in the road, let alone a spoon†, but somewhere/when another 'you' does. This frivolous thought is just about the only motivation for multiverses not addressed in this volume by the science historian and author Paul Halpern, professor of physics at St. Joseph's University.

Not that the book is wholly solemn! If you enjoy a chase sequence, I recommend pp. 174–175, the lead up to inflationary cosmology, and there are leaking balloons among his highly original analogies. *Allure* is organized in a semi-historical fashion. Chapter 1 starts with Kepler. Later chapters each take one sort of multiverse idea and follow it down to extinction of viability or the present. These include additional dimensions (with a fine explanation of Kaluza–Klein theories); Hugh Everett's many-worlds interpretation of quantum mechanics (in which everything that can happen does happen, just mostly not on our time line, so that somewhere, Schroedinger's cat lives to be at least a 100); anthropic and Mixmaster universes; inflation, strings, and cyclic universes. As well as many ideas, many people appear, some with firm views pro or con on the ideas. Stan Deser, for instance, appears just before page 1 saying "I think we have enough *tsuris* with one Verse." Deser had in common with Halpern childhood knowledge of Yiddish from parents and grandparents. With some embarrassment, I found myself on page 24 (part of the Introduction) quoted on the 'pro' side, on the grounds that there have turned out in the Universe to be many planets, many stars, many solar systems, many galaxies, clusters, and superclusters thereof, so why not many universes? (I meant to count the number of people indexed and the fraction you might have been expected to have heard of before (in a sort of inverse of *Wer zaehlt die Voelker — nennt die Namen*) but kept getting interested in what Halpern had to say about my favourites and so never got past the middle E's (Queen Elizabeth II and George Ellis) with the count.) So, acquire the book, count how many of your scientific and other heroes are mentioned, and generally enjoy it all! — Virginia Trimble.

Paul Halpern, professor of physics at St. Joseph's University in Philadelphia, has written 18 popular-science books, though this is the first I have read. In

*Not your present reviewer, who continues of the opinion that Joseph Weber (who makes a cameo appearance in this volume as a participant in the Chapel Hill conference on General Relativity, later called GR1) was unquestionably the best husband in all the possible multiverses.

†The suggestion "when you come to a fork in the road, take it," is attributed to Yogi Berra. Stanley Deser made use of the phrase in a recent autobiography reviewed in these pages (143, 242, 2023), but we are saving him for a quote later about multiverses.

contrast to some other books mainly about the Multiverse[1–3] or dealing with it to some extent[4,5], some reviewed in these pages[6–9], this book is somewhat less technical and takes a broader perspective (*e.g.*, pointing out that the term 'Multiverse' was coined by William James, though in the context of moral philosophy rather than cosmology); as such, it is perhaps a good first book on that topic (but shouldn't be the last). The introduction sets the stage, introducing various types of Multiverses and discussing historical ideas. The first chapter is basically an overview of classical physics, starting with the idea of recurrence, which is a sort of Multiverse in time rather than space, including ideas which were once taken more seriously than they are now, such as a putative connection between spiritualism and the fourth dimension. The second chapter is devoted to the first serious attempt to incorporate higher-dimensional space into physics (though not — yet — in the context of a Multiverse), Kaluza–Klein theories, the idea being to describe electromagnetism as well as General Relativity in the language of a geometrical theory with one more spatial dimension, and explaining quantization by having that dimension curled up. It is a very good non-technical description. While such theories themselves are now a backwater in the history of physics, they later influenced other ideas such as string theory. The next two chapters cover quantum mechanics and cosmology, providing an overview of those aspects relevant to the idea of the Multiverse. The next few chapters discuss various ideas which lead to the concept of a Multiverse, such as eternal inflation, string theory, and cyclic cosmologies (again, more a Multiverse in time than in space). Chapter 8 explores time travel, which in some interpretations can lead to multiple universes if a traveller returns to the past: one in which he returned to the past and one in which he didn't, perhaps because he had killed his grandfather (or taken some less drastic but just as effective measure).

The first three of Tegmark's[1] four Levels of Multiverses are all discussed: the part of our Universe beyond our horizon, different universes of which ours is but one example, and the many worlds of the many-worlds interpretation of quantum mechanics. The idea of a universe splitting due to the actions of travellers in time is a new aspect. However, the emphasis is not so much on different types of Multiverses but rather on different ideas which can lead one to the concept. On the other hand, Tegmark's Level II Multiverse — which is probably the one (apart from the trivial Level I) most are most willing to accept — is discussed mostly in the context of eternal inflation, although the general idea is much older (*e.g.*, ref 10). In general, the title is a good description of the book: it is about the allure of the Multiverse, *i.e.*, what makes it an attractive idea in various contexts, rather than more technical aspects. As such, the necessary background material blends well with and complements those parts more about the Multiverse *per se*.

The final chapter, somewhat misleadingly entitled Conclusions, spends, in my view, too much time discussing the general idea of a Multiverse, or parallel worlds, in popular culture. While Halpern makes it clear that such ideas have practically no overlap with the scientific ideas of the Multiverse, by the same token they really don't belong here. Towards the end, though, is a good summary, emphasizing the fact that in many other contexts most are content to accept things which are not *directly* observable (*i.e.*, the interior of black holes, the inflaton, the 'dark ages' of the Universe), even though they might use the lack of direct detectability as an objection to the Multiverse.

My copy is an uncorrected page proof, courtesy of the author, though presumably very close to the final product since, apart from figure captions at

the end of the book rather than accompanying the figures, it looks very much like a normal book; the contents as well appear to be almost final. There are only a few actual typos and a couple of phrases which probably read other than intended. As usual, I would have phrased a few things differently, but on the whole the book is well written and one notices Halpern's experience as an author — not just in terms of style, but also with regard to presenting everything at the right level. Although it is not a highly technical book, there are none of the typical oversimplifications often encountered in popular-science books. All but one of the 22 black-and-white figures scattered throughout the book are of people. There are no footnotes and endnotes are all references to sources such as articles and interviews, most by Halpern himself with the scientists he writes about (a frequent contributor to this *Magazine* also makes an appearance). There is no index (a possible difference from the final version); the further-reading list (three-and-one-half pages of small print) is particularly thorough.

This is an enjoyable book which manages to weave well together the concept of the Multiverse, current ideas in physics related to it, and the (sometimes quite old) history of those concepts. — Phillip Helbig.

References

(1) M. Tegmark, *Our Mathematical Universe* (Allen Lane), 2014.
(2) S. Friederich, *Multiverse Theories: A Philosophical Perspective* (Cambridge University Press), 2021.
(3) B. Carr (ed.), *Universe or Multiverse?* (Cambridge University Press), 2007.
(4) G. F. Lewis & L. A. Barnes, *A Fortunate Universe: Life in a Finely Tuned Cosmos* (Cambridge University Press), 2017.
(5) P. Nahin, *Time Machine Tales: The Science Fiction Adventures and Philosophical Puzzles of Time Travel* (Springer), 2017.
(6) P. Helbig, *The Observatory*, **134**, 150, 2014.
(7) P. Helbig, *The Observatory*, **141**, 267, 2021.
(8) P. Helbig, *The Observatory*, **137**, 243, 2017.
(9) P. Helbig, *The Observatory*, **137**, 299, 2017.
(10) V. Trimble, *Astr. Nachr.*, **330**, 761, 2009.

Scientific Debates in Space Science. Discoveries in the Early Space Era, by Warren David Cummings & Louis J. Lanzerotti (Springer), 2023. Pp. 264, 24·5 × 16 cm. Price £64·99 (hardbound; ISBN 978 3 031 41597 5).

Although the subtitle of this book is 'Discoveries in the Early Space Era', it might equally have been 'The Scientific Method in Theory and Practice', for its focus is not so much on informing us of present understanding of a number of high-profile topics principally in planetary and space-plasma physics, but unusually and interestingly on providing an account of how such status was achieved through the contentions of past years. Typically, the time-frame considered spans the 1960s to the 1990s, some controversies lasting longer than others, with emphasis on the protagonists involved, many now deceased, and their mutual interactions. To this purpose, the authors have evidently immersed themselves at length in the literature of the period, allowing the proponents to speak directly for themselves by quoting short sections verbatim from key published works, illustrated by original figures. Each topic is rounded out, however, with a 'Continuing Understanding' coda, bringing things briefly up to date.

Of the topics considered, three lie in the field of space-plasma physics, two of which concern the solar wind. The first deals with the nature of the outflow, whether supersonic as proposed by Gene Parker or subsonic as suggested by Joseph Chamberlain, an issue debated in the late 1950s and early 1960s before