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.

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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

being quite rapidly resolved in favour of the former by the first thermal-plasma measurements by Soviet and US spacecraft. However, the subsequent issue of the distance to the shock that terminates the supersonic outflow, and from thence to the heliopause boundary with the interstellar medium beyond, was only resolved by *Voyager* particle and field data during the past ~20 years, following a debate that lasted for almost 50 years. The third issue covered in space-plasma physics concerns the properties of the Earth's magnetosphere, whether magnetically 'open' as proposed by Jim Dungey in 1961 or closed as argued by Alex Dessler, on which indirect evidence in the 1960s and 1970s and direct evidence principally in the 1980s and 1990s ruled in favour of the former.

In addition to briefer discussions of some less-controversial topics such as the discovery of the Earth's radiation belts by James Van Allen, the book also covers four significant debates in planetary physics. The first two concern the origin of the Earth–Moon system, the subject of many past hypotheses but now considered to have resulted from the impact between a Mars-sized body and the early proto-Earth, and, much later in Earth's history, the cause of the Cretaceous–Paleogene mass extinction event and its association with the Chicxulub asteroid-impact crater originated by Alvarez *père et fils*. A related topic concerns the depth of the dust layer on the lunar surface produced by meteorite bombardment, which Tommy Gold in 1955 suggested might be sufficiently deep in some locations that astronauts would disappear up to their armpits or beyond, a speculation happily disproved by space missions preparatory to the Apollo landings.

More infamously, in 1986 Lou Frank proposed on the basis of spacecraft ultraviolet imaging initially intended for auroral studies, that the Earth's upper atmosphere is being continuously bombarded (several per minute) by small cometary bodies that would have profound significance for Earth's water budget. This assertion triggered 17 years of lively debate involving no less than 32 papers, comments, and rebuttals published by Frank and colleagues, together with experimental studies by others, that ended with the general perception that these signals were, after all, due only to instrumental effects within the auroral-camera system, a conclusion that appears never to have been acknowledged by the proponents. As the contents of this fascinating book make clear, though the 'scientific method' of testing, verification, and refutation does eventually sift the scientific wheat from the chaff, the length and nature of that process may depend significantly on the human personalities involved. — Stanley W. H. Cowley.

The Era of Multi-Messenger Solar Physics, edited by Gianna Cauzzi & Alexandra Tritschler (Cambridge University Press), 2023. Pp. 160, 25 × 18 cm. Price £120/$155 (hardbound; ISBN 978 1 009 35288 8).

This volume is the Proceedings of IAU Symposium 372, co-ordinated by IAU Division E with other working groups, which was held in Korea in 2022 August at the tail-end of the Covid pandemic. The nearly 80 contributors were mostly from Asia but with some from the US. The main motivation for the meeting was the recent solar space missions, *Solar Orbiter* and the *Parker Probe*, and the *Daniel K. Inouye Solar Telescope*, largest ground-based solar observatory in the world, still in its commissioning phase at the time of the conference. The 'multi-messenger' of the conference title refers to the way these and other solar observatories are gaining knowledge of, for example, the connection of the magnetic fields in the distant solar atmosphere with the magnetic field at the solar surface.