The last chapter, written by W. H. Donahue, an author and translator of Kepler into English, describes the careful nuance required in revealing the intention and meaning in translating writing, diagrams, and even print layout of work from a different time and culture. He hopes for more of Kepler's work to made accessible in the form of readable, well-annotated selections, in translation, for the general reader. In that last chapter, on the last page and in the last paragraph, we find this: "Kepler is too good to be constrained within the province of experts". Amen to that. This book is a serious work and not a light-weight popularizing book for public understanding, but it does a very good job in making the astonishing range and achievement of Kepler's work more widely accessible — so much of which is presented in English translation of Kepler's own words. As befits its expert scholarly origins this book is thoroughly referenced at the end of each, well-footnoted, chapter. Additionally, there is a very useful chronology covering the relevant period, from the birth of Martin Luther in 1483 to the end of the thirty years war in 1648, plus a glossary of terms including those that are now obsolete or have changed meaning over time, and finally there is a 28-page index.

This book is an absolute joy; there is not one chapter that does not delight or surprise. It is detailed enough for the serious scholar who might want a jumping-off point to research a particular aspect of Kepler's work, but enough enthusiastic description for the amateur who simply wants to get into the mind of Kepler, to try to understand just how he arrived at his understanding of the cosmos. It should be made available in all libraries wherever science is studied. — Barry Kent.

The Universe: A Biography, by Paul Murdin (Thames & Hudson), 2022. Pp. 288, 24 × 15·5 cm. Price £31·99 (hardbound; ISBN 978 0 500 02464 5).

Not to be confused with *Secrets of the Universe*, *Mapping the Universe*, *Universe*, *Discovering the Universe*, or *Catalogue of the Universe* (all (sub)titles of books (co-)authored by Murdin, who has about a score altogether), this book offers a chronological overview of the history of the Universe (with the time since the Big Bang on the upper right of the rectos), starting off with discussions of Olbers's paradox and the expansion of the Universe, the "questions that revealed the universe was born". Murdin is well known for his work with Louise Webster identifying Cygnus X-1 as the first convincing black-hole candidate; that story is told in more detail in a book[1] recently reviewed[2] in these pages than in this book. The following chapters cover the early Universe, galaxy formation, the dark ages, the Milky Way, the Sun, end phases of stellar evolution, the origin of the Solar System and Earth's Moon, the structure and history of Earth, the future of the Universe, and a discussion of the cause of the expansion. (Note that the last two chapters, though numbered as expected, are referred to as 'sequel' and 'prequel', perhaps reflecting their somewhat more speculative status.) What differentiates this book somewhat from similar books is more emphasis on the people involved (though of course much less than in books on the history of astronomy) and integrating related topics into the appropriate chapters, covering such subjects as big-bang nucleosynthesis, the cosmic microwave background, dark matter, primordial fluctuations, expansion, surveys, gravitational lensing, Messier objects, active galactic nuclei, radio astronomy, gravitational waves, the Lyman-α forest, H I intensity mapping, galaxy mergers, *Gaia*, Sgr A*, meteorites, the faint-young-Sun problem, the Carrington Event, X-ray binaries, chaos in the Solar System, Milanković cycles, life, plate tectonics, planetary magnetic fields, mass extinctions, and *eLisa* — thus fleshing out a more or less standard qualitative history with a bit more astrophysics, in many cases in somewhat more detail than in similar books.

As with many authors, Murdin's discussion of the relationship between the geometry and destiny of the Universe is that of a universe with no cosmological constant, though Murdin, of course, notes elsewhere that that is not our Universe. The ultimate conclusion, that our Universe is (almost) flat and will expand forever, is technically correct, but obscures the important point that the latter (assuming a Friedmann model the parameters of which we

have correctly determined) is certain whether or not the Universe is exactly flat or has a slight positive or negative curvature (whereas in the case without a cosmological constant the flat case is a boundary not only with regard to geometry but also with regard to destiny); also, our Universe will not "slow its expansion but never completely stop" — that is the Einstein–de Sitter Universe with no cosmological constant and the critical density — but rather is now accelerating and will asymptotically approach the exponential acceleration of the empty de Sitter model. (See ref. 3 for more details on that common mistake.) A few other common misconceptions are repeated, *e.g.*, the first indications of dark matter came in 1933 through the work of Zwicky (see ref. 4 for references to earlier work). That the Big Bang resulted in 96 per cent hydrogen and 4 per cent helium is incorrect; closer to the truth are 92 per cent and 8 per cent, respectively (in addition, it is not stated that the values are by number of atoms, rather than by mass, in which case the (correct) values are 75 per cent and 25 per cent, respectively). His discussion of the expansion of the Universe being the outcome of an "explosion in which various fragments are thrown out at different speeds" is more reminiscent of Milne's Kinematic Relativity than standard cosmology. While the former also results in a velocity–distance law of the form $v = HD$ (where v is the recession velocity, H the Hubble constant, and D the proper distance), in standard cosmology the recession velocity is (in general, and in our Universe) not constant. In such a universe (and in the 'equivalent' Friedmann model with neither matter nor a cosmological constant) the reciprocal of the Hubble constant is always the age of the Universe; in our Universe, it is so near the present time; that appears to be a coincidence which holds only near the present time[5] (rather like the coincidence in the angular sizes of the Sun and Moon). Sometimes statements depend on a context which, however, is not always clear; I'm sure that the clustering of galaxies was noted before a 2001 paper by Peacock and Cole. Like his use of Λ-CDM rather than ΛCDM, Henry for Heber Curtis, and Ralph for Rudolph Minkowski (nephew of Hermann who, like Walter Baade, moved from Hamburg to Mt. Wilson), such issues demonstrate an unfamiliarity with cosmology. While no-one can be an expert on everything, either the publisher or the author should get enough experts to read the manuscript so that all areas are covered (including the very confusing last paragraph of the main text). However, those goofs are made up for by Murdin not only avoiding the common misconception that John Wheeler coined the term 'black hole' (though, as Murdin correctly notes, he did popularize it), but (very probably correctly) also attributing it to "Robert Dicke about 1961"[6,7*]. A non-cosmological mistake is mentioning the supernova of 1054 in connection with the Bayeux tapestry; the latter probably shows what was later known as Halley's comet, not a supernova, which was visible in 1066. While I suppose it is conceivable that "*Homo sapiens* took to living in caves about that time, perhaps motivated to shelter because of the risk of severe sunburn", I don't see any causal connection with "that time", which refers to the last major reversal of the Earth's magnetic field about 800 000 years ago.

The book is a bit hard to pigeonhole. Like a book[10] reviewed here a year ago[11] it is a long narrative, though that book is told as a history of astronomy and this one as a history of the Universe; both, however, contain details not always found in similar books. It is mostly up to date (though my former employer was never known as the Nuffield Radio Astronomy Observatory and hasn't been known as the Nuffield Radio Astronomy Laboratories for a long time) and there are many references to other sections of the book. Maryland (mentioned in connection with Gamow, Alpher, and Herman) is not a suburb of Washington, DC, but maybe that is just a typo and an 'in' is missing. Another typo is the depth of the CfA survey at 400 million light years; 400 Mpc is correct (though the caption on the corresponding illustration correctly has 1·3 billion light years).

Note that in addition to the 288 numbered pages (the front matter is also roman-numbered)

*Note that the author of ref. 7 is the same as that of ref. 8, a book, reviewed in these pages[9], which I very highly recommend.

there are 16 pages of colour plates, half of which are near the beginning and half near the end of the book. I probably would have chosen similar illustrations, but not devoted a quarter of the plates' pages to simulated images of the future merger of the Milky Way and Andromeda galaxies. The only other figures are line drawings at the beginning of each chapter, illustrating the corresponding main topic. There are neither footnotes nor endnotes. The main text is followed by a seven-page glossary then, in small print, picture credits and an eight-page index. The book comes with a dust jacket, but beneath that the binding is covered by a CMB map from *Planck* and its mirror image, joined at the spine.

On the whole, this book is a good broad overview of the history of the Universe, but one sufficiently different that most readers will probably run across something which they haven't read before. Despite the qualms mentioned above it could be a good first book on the topic. (I mentioned more qualms than usual as I'm sure that the author will appreciate the curmudgeonly attention to detail and the exacting standards of this *Magazine*[12].) — Phillip Helbig.

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THESIS ABSTRACT

Planetesimal Belts in Misaligned Wide Stellar Binaries

By Steven Young

Some main-sequence and post-main-sequence stars show signatures of close-in hot dust which cannot have formed there or been produced *in situ* as the collisional time-scales at these locations are much smaller than the ages of the systems. Hence, there must exist some dynamical mechanism to deliver rocky bodies to small distances on time-scales of $10–10^4$ Myrs. This thesis examines the feasibility and detectability of one of these potential mechanisms: the eccentric Kozai–Lidov effect (Eccentric Kozai Mechanism, EKM) whereby a stellar companion on a misaligned wide orbit perturbs planetesimals to high eccentricities. First, in order to explain the mysterious light-curve of KIC 8462852, one component of a wide binary-star system in the *Kepler* field with deep, irregular, and aperiodic dips in its