to what sort of research, education and exhibitions were appropriate and effective: systematics or ethology, immersive or interactive.

With this exhaustively researched and seamlessly co-authored book Rader and Cain have given us a much-needed history of debates about the function of museums and about their internal and external political context, and a structure within which to explore the history of twentieth-century life-science collections. For *Life on Display* is a history of writing about museums, of advocacy and arguments, 'chronicling the social history of their exhibits to explain how science and natural history museums have conceived and reconceived their institutional roles in relation to one another, as well as in relation to life science and society in the twentieth-century United States' (p. 280). The challenge is now for others to propose complementary histories of the collections and objects themselves, of the visuality of exhibits and the practices (rather than the proclamations) of curators, conservators and visitors. We also sorely need a transatlantic equivalent to this worthy tome, which for anyone interested in American museums during the last century will remain essential reference deep into this one.

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Francis Graham-Smith, **Unseen Cosmos: The Universe in Radio**. Oxford: Oxford University Press, 2013. Pp. vii + 256. ISBN 978-0-19-966058-2. £20.00 (hardback).
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In this book Sir Francis Graham-Smith, former Astronomer Royal and vice-president of the Royal Society, speaks from over seven decades of personal involvement to describe the rise of radio astronomy 'from the first discovery of cosmic radio waves to its present role as a major part of modern astronomy' (p. vi). The expansive subject matter is organized by chapters centred on objects, from natural objects such as pulsars or black holes to the technical objects – dishes, arrays and so forth – associated with their discovery. This is a technique familiar in popular physics books, from Stephen Hawking's *A Brief History of Time* (1988) to Michio Kaku's *Hyperspace* (1994). At its best this structure allows neat linkage between some key ingredients of popular science writing: specific details of objects become part of engaging discovery narratives, and then are connected to the rest of the universe through broader physical theories. However, in this work all the experimental narratives, technological developments, biographies, astrophysical crash courses and often over-specific details arrive and supersede one another at an alarming rate. The cumulative effect energetically conveys the breadth and activity of radio astronomy, but does little to aid understanding.

The problem seems to stem from a lack of clarity over audience. This is most notable in the inconsistent levels of basic familiarity expected of readers. The basics of the electromagnetic spectrum are given as much space as spherical harmonics and Fourier analysis; familiar descriptions of Newtonian and Einsteinian gravity rub shoulders with graphs and figures lifted, with little elaboration, from more technical spheres; and terms like 'azimuth' and 'arcsecond', the bread and butter of the field, are brought in without definition. But this scattergun approach is perhaps more problematic in the level of detail readers are expected to engage with. An extremely large number of astronomical objects, technologies, techniques, characters and developments are introduced throughout the book. Some are introduced in great detail, arguably too much detail – a whole page on the emission spectrum of carbon monoxide, for instance (pp. 76–78). Others are passed over with frustrating scantiness; in particular, Graham-Smith has a habit of omitting dates from many of his historical accounts. Of all these details, some disappear quickly while others reappear unexpectedly in the midst of fresh new information; to give just one example, the story of Karl Jansky's radio emitters features in a discussion of telescopes (p. 15), but is then brought back in a discussion of synchrotron radiation (p. 71). Such connections between

stories and objects are interesting, but there are simply too many to make this a casual read. The risk of overwhelming the reader is compounded by intermittent signposting, in particular the lack of real introduction or conclusion to any of the chapters. The net result feels like reading a peculiarly themed build-your-own-adventure story from cover to cover, rather than following any of the singular plot paths offered.

This is a shame, because many of these narratives are of great interest in their own right. Some, such as the formation of cosmology as an observational discipline, have been told in more detail elsewhere (in particular in the work of Helge Kragh). However, others are greatly enhanced by the personal narration of Graham-Smith. Anecdotal mentions only appear infrequently, but still serve to convey the unpredictability and excitement which clearly permeated the field. His description of the tracking of Cygnus A by observatories in Cambridge, Jodrell Bank and Australia – 'the moment when radio astronomy showed its potential in observational cosmology' – points to a time of continual trying-and-finding, and shows the importance of multi-location collaboration while subtly hinting at the drive of competition (pp. 85–90). Equally, many interesting segments arise from the author's expertise in the factors which set radio astronomy apart from other techniques of astronomical surveillance. In particular, there are fascinating technical challenges around the size required of the apertures, leading to the international development of kilometre-sized connected arrays (pp. 187–223). These could, if arranged more clearly, prove excellent grist to an internalist historian's mill.

But these criticisms are perhaps unfair given that this is a work intended as popular physics – which brings us back to the problem of audience. In a work of this subject matter, it is perhaps difficult to know whether readers are looking for personal stories to flesh out the physics bones, or for a focused account of a particular scientific field. But in order to include all those narratives, this book would have benefited from an alternative format – perhaps some way of distinguishing discussions of natural and technical objects, or separating different levels of detail, or a way of visually tracing the recurrent stories. As it is, I suspect that only a select proportion of readers could really engage with all the material; personally speaking, even degree-level physics knowledge was not sufficient equipment. If the only reader who can mentally catalogue the oncoming stream of information is an already astronomy-literate one looking to broaden their knowledge, then we must ask the question of what the book adds over a series of Wikipedia searches. One answer to this question is the charming glimpses into Graham-Smith's personal enthusiasm. But in this case enthusiasm needs to be balanced with control of the subject matter, tighter editing and much greater awareness of the recipient. It is a cliché that too much expertise can inhibit the ability to teach, but this work seems to be a case in point.

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Catelijne Coopmans, Janet Vertesi, Michael Lynch and Steve Woolgar (eds.), **Representation in Scientific Practice Revisited**. Cambridge, MA: MIT Press, 2014. Pp. ix + 366. ISBN 978-0-262-52538-1. £24.95 (paperback).
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Entangled hybrids, material and corporeal enactment, ephemeral instruments, qualitative versus quantitative negotiation, dynamic simulation, incorporated measurement and the ethics of digitization – these are just a handful of the themes that emerge in *Representation in Scientific Practice Revisited*. The volume, edited by Catelijne Coopmans, Janet Vertesi, Michael Lynch and Steve Woolgar, takes stock of the manifold approaches to scientific imaging that have emerged in the twenty-five years since Lynch and Woolgar published *Representation in Scientific Practice* (1990). If the earlier volume awakened a consciousness about graphic intervention, this collection of essays lays bare two important vectors along which such study has expanded: first, the profusion