Drake argues, central to Galileo's astronomical system, though it was pushed somewhat into the background by papal pressure before the publication of the *Dialogo* of 1632.

Drake does not here defend the scientific adequacy of Galileo's theory of tides, nor the adequacy of his concept of inertia, nor one or two other positions which have seemed idiosyncratic to other scholars. His 'reconstructions' are balanced, clever, and well-documented. As in other books by him, 'the philosophers' come in for a good many hard knocks: 'There is a vast difference between confidence grounded in repeated observations and careful thought, and the confidence of philosophers in metaphysical principles that transcend all experience of mere astronomers', remarks Salviati. Drake (and other scholars) have successfully vindicated their claim for the historical veracity of Galileo's experimental approach to mechanics; here he extends the lesson to the successful

matching of mathematical formulations with carefully compiled observations on Galileo's part. There is a great deal here which is new and really important. Drake stands with those who argue that the historical process of the separation of natural science from philosophy, metaphysics and, indeed, magic was just as important as the fact of the continuity of elements derived from these sources in natural science. For it was by separation that the special character of science was established.

Drake has tried to give a new and more lively form to the often pedantic literature of the history of science, and so to arouse a new curiosity. Whether or not he succeeds in that aim, his imaginary conversations, like those of Galileo himself, contain new truths vividly argued. □

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Stepping through the Universe

A.T. Winfree

Powers of Ten: About the Relative Size of Things in the Universe.

By Philip Morrison and Phylis Morrison and the Office of Charles and Ray Eames.

W.H. Freeman: 1982. Pp.150. \$29.95, £11.95.

TWELVE months ago, the editors of *Scientific American* launched the Scientific American Library as a book club, with books appearing at two month intervals, each being reissued as a trade book 12 months later at a higher price. Intended for a popular audience, the series is pitched at a level somewhere between the monthly magazine articles (which I personally consider demanding reading) and *Time/Life* picture books. Each is written by a scientist, many by Nobel Laureates, not by the editorial staff. Each presents a subject that cuts across diverse specialized disciplines. The first six issues have already been produced.

Powers of Ten is the premier issue and the first available to the general public. It is by far the least technical of the books produced up to now, and demonstrates the publishers' commitment to readability and quality graphics, in 22 cm square format with colour pictures on almost every page. The theme is familiar and not subtle: phenomena in the natural world vary over something like 42 orders of magnitude in linear dimensions (ignoring volume, time scales, etc.), and differ in character according to scale. Many books have presented this theme to diverse audiences. So in this case everything depends on

targeting the right audience and on skill in presentation. The Morrisons' art work is superb, as one might have expected from their track record, and from the immediate antecedent of the book: the wonderfully successful ten minute motion picture of 1968 and 1977 (improved) by the same name.

The core of *Powers of Ten* is a sequence of 42 colour plates, the first suggesting most of the Universe. In the next plate (10²⁴ metres) some galactic clusters become big enough to see, as a giant step forward brings us ten times closer to the nucleus of a certain carbon atom in the very centre of that cosmic field of view . . . and so on through 42 steps. By the 25th step we have converged on a couple lying on a picnic blanket and we continue, ending after 17 more steps in a subnuclear blur that might represent quarks.

Facing the colour plate at each step is a page of text and smaller pictures illustrating some of the phenomena characteristic of that size scale. For example facing the 10 metre to 10⁻⁶ metre pictures, most of the illustrations are biological. On every scale, the chosen examples are rich with surprising tidbits of insight, presented from a unique perspective.

This core is only 60% of the book. The appendices are no less fascinating; in fact the one entitled "Rules for a Journey of Mind and Eye" might be the best place to start: it tells how the pictures were planned. My own taste is then to run backwards through the plates, starting with quark-blur. Other appendices gather some pertinent history of science; the 20 pages of "Sources and Notes" make particularly good reading. □

A. T. Winfree is Professor of Biology at Purdue University, Indiana.

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