exploitation of marine resources are all too aware of this urgency; they, and indeed all who use the sea, will find in these proceedings both a helpful guide to the current situation and a challenging list of problems which demand prompt solution.

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A Science in the East

A History of Japanese Astronomy. Chinese Background and Western Impact. SHIGERU NAKAYAMA. Harvard University Press, Cambridge, Mass., 1969. xvi + 334 pp., illus. $10. Harvard-Yenching Institute Monograph Series, vol. 18.

The history of astronomy in the cultures of East Asia, developing as that great science did in those regions wholly independently of the West, has always been one of the most fascinating chapters of the history of astronomy in general; but in Western languages there has been much less on Japan than on China. This has partly been because Japanese astronomy, though showing much originality, was fundamentally derivative from the older science of China, and partly also because the Japanese language and sources have been even less well known to sinological historians of science than those of the Chinese. Now, however, Japan has produced a scholar whose supremely competent book, here reviewed, is worthy to be placed on the same shelf as the basic contributions of Gustav Schlegel, Léopold de Saussure, and Henri Maspero. If it was not printed in Japan (and there is no evidence that it was), the Harvard University Press deserves warm congratulations for the masterly intercalation of the numerous Chinese characters in the text, abundant footnotes, and bibliography. This last follows the system of the *Science and Civilisation in China* series, but with the useful modification of keeping italics for the titles of published books, and putting the names of manuscripts within quotation marks—a point worth mentioning because it illustrates another great merit of the work, the author's copious use of manuscript material preserved in the Japanese libraries.

Nakayama's general approach is that of a study in the transmission of ideas. First he follows the absorption and adaptation of Chinese astronomy in Japan during the millennium from A.D. 600 to 1600, then he divides the period of the Tokugawa Shogunate into two. From 1600 to 1720 European astronomy was challenging the older ideas and methods in Japan, but the Chinese influence still remained overwhelming. From 1720 to 1880 the supremacy of "Western" (that is, modern) astronomy was gradually recognized. At this point the author terminates his study, which is illustrated by numerous graphs and geometrical diagrams. Particularly valuable for medievalists are a chapter on astrology and another on Chinese calendrical science. It is true, as Nakayama says, that the latter has been inadequately treated by previous historians, who have not always realized that each "calendar" was really an ephemeris, a treatise in itself and a new set of tables—and there were more than a hundred of them during the past two millennia—but this neglect was not only "because of technical complexity and the lack of a Western counterpart," it came about also because the only really adequate study of the calendars, due to Yabuuchi Kiyoshi, was (and to this day remains) in the Japanese language. Much of the most interesting material in Nakayama's book is contained in ten appendices, from which may be cited such appetizing items as "the derivation of Asada Gōryū's formula for the variation of tropical-year length" and "Takahashi Yoshitoki's epicyclic theory of trepidation."

The admiration of this reviewer for Nakayama's book will have already become evident, but there are two criticisms I cannot forbear voicing. First, it may be a little disappointing to some not to learn more about the observatories of late medieval and early modern Japan—where they were established, who supported them, and how they were equipped. Our author must certainly know, and perhaps could be persuaded to write a further monograph on this interesting subject. Second, one feels throughout a characteristic somewhat grudging tone toward Chinese civilization, mother of all East Asian science (see, for example, pp. 12ff., 15, 63, 74); modification of this would have given an even higher quality of objectivity to the whole. It is probably partly just because the author himself, trained, after all, as a modern scientist, feels he owes more to Western than to Chinese civilization; but possibly also partly because an admiration for traditional Chinese culture has been closely connected at times in Japanese history with the regrettably nationalist and insular outlook of Neo-Shintoism (p. 8), to say nothing of the absurdities of the Buddhist monk Entsū (1754 to 1834), who spent his life fighting against Copernican astronomy in the interests of the traditional Indian-Buddhist Mount Meru cosmology (p. 211ff.). However, there are places where the author speaks in reasonably generous terms of the scientific achievements of the parent civilization of East Asia.

All in all, the present volume must be saluted as one of the most valuable additions of our time to the growth of knowledge about the development of the exact sciences in the civilizations of East Asia.

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Zoological Engineering

Animal Mechanics. R. MCNEILL ALEXANDER. University of Washington Press, Seattle, 1969. xiv + 348 pp., illus. $9.50. Biology Series.

This unusual and interesting book describes the application of some of the principles of mechanics to a wide range of zoological investigations. Although Alexander comments that his book was written for zoologists with a long-forgotten knowledge of physics and no knowledge of engineering, this reviewer, an engineer with a limited background in biology, found the book very worthwhile.

The book is divided into seven chapters, each dealing with a different area of mechanics: force and energy; joints and mechanisms; elasticity and viscosity; strength; pressure, density, and surface tension; motion in fluids; and vibrations and sound. Within each chapter, sections describing the physical theory alternate with sections on zoological applications. The topics covered include such diverse matters as an elasticity theory interpretation of the shape changes of a flatworm, a study of fluid pressures in a burrowing bivalve mollusk, wind tunnel tests of the yaw stability of a gliding shark, and discussions of acoustic impedance matching in the human ear. The numerous comparisons between biological and engineering mechanisms are quite instructive. For example, the author shows that the alula feathers of a pigeon's wings increase the lift coefficient in a manner analogous to that of slots in the wings of a modern airplane. Often a single