

tions and expeditions, cathedrals and universities, roads and canals, books and instruments. Every society must make some investment for the future, and space exploration is certainly an exciting and promising item for investment. The difficulty in making allocations arises only because no man can foretell the future very accurately.

Nonetheless, in the desperate need to keep science and technology from alienating themselves from society, can one render some plausible connection between the potential of space science and our crying social needs? Here are two examples; the first was not anticipated, but currently attained, the second is the converse. "... Project Apollo developed techniques for directing the mass efforts of thousands of technical minds in a close-knit combination of government and industry. It may be possible to adapt these techniques to large social

and environmental undertakings such as control of earth's complex ecological system." (*Fortune*, July 1969) The second example is "Space communications ... may result in the disintegration of the cities and a great reduction in travel, as telecommunication and telecontrol will allow ... men ... to live wherever they please." (*The Promise of Space*, page 109)

The question then becomes "What portion of the nation's disposable income should be invested in the space program—civilian and military?" No man knows the proper balance point. But from Clarke's inventive mind has come this book that will entertain and inform the neutral inquirer, and that will render more difficult the task of the detractors of the space program.

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The reviewer, a physicist and materials scientist at Michigan State University, spent some time in the space program.

Astronomical history

VISTAS IN ASTRONOMY, VOL. 9: NEW ASPECTS IN THE HISTORY AND PHILOSOPHY OF ASTRONOMY. (Conf. proc.) Arthur Beer, ed. (Univ. of Hamburg) 317 pp. Pergamon, New York, 1967. \$22.00

VISTAS IN ASTRONOMY, VOL. 10. Arthur Beer, ed. 214 pp. Pergamon, New York, 1968. \$16.00

by JOHN SUTTON

In this technological era, when historical studies are so often neglected, it is encouraging to find 1.5 books dealing with recent research into the history of astronomy.

Volume 9 of *Vistas in Astronomy* is devoted to the proceedings of a joint symposium of the International Astronomical Union and the Union Internationale d'Histoire et de Philosophie des Sciences held at Hamburg in 1964. It contains 32 contributions by scholars from 11 countries, and includes four in French and one in German. Many of the articles are concerned with the description and classification of manuscripts and astronomical devices such as sundials, astrolabes, armillary spheres and clocks. There are also studies of individual astronomers, observatories and astronomical movements in several countries, including Tibet.

The more interesting articles, particularly for the nonspecialist, are

those that go beyond description and classification. For example, Owen Gingerich demonstrates with an electronic computer that Kepler's crucial calculations of the orbit of Mars would have required much less effort had he not been plagued by numerical errors.

This profusely illustrated volume is not an encyclopedia, but it does present an overall picture of research in the field, at least as it was several years ago. Although it is primarily a book for specialists, it does contain much of interest for other scientists.

The flow of history continues in volume 10. O. Neugebauer has produced a fascinating and devastating exposé of the mathematical methods of Copernicus. He shows that, contrary to popular belief, the Copernican theory of the solar system is as complicated mathematically as the Ptolemaic theory and produces no better planetary positions.

Herman Zanstra's defence of the occult world, based on his personal preferences and the poorly established phenomenon of mental telepathy, is unconvincing and rather unscientific. The republication of 24 pages of ancient star positions in Gerald Hawkins's article on astroarcheology is an unnecessary extravagance.

There is finally a return to conventional astronomy and the familiar for-

mat of this series. Of particular merit is Tibor Herczeg's thorough and systematic examination of theories of the origin of the planetary system.

Except for the objections mentioned, volume 10 is a worthwhile contribution to astronomy. Finally, radio astronomers will find it curious to note that *Vistas in Astronomy* has not contained an article on radio astronomy since volume one.

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Thermometry to date

PRECISION MEASUREMENT AND CALIBRATION, VOL. 2: SELECTED NBS PAPERS ON TEMPERATURE. NBS Special Publication 300. J. F. Swindells ed. 513 pp. National Bureau of Standards, Washington, DC, 1968. \$4.75

by JAMES B. KELLEY

When completed this series will contain twelve volumes, of which the present one on temperature is the first despite its designation as volume 2.

It has reprints of articles on temperature measurements made at the National Bureau of Standards through June 1967. Plus, there is a bibliography of temperature-measurement articles drawn from all over the world from January 1953 to December 1965. Hence, the total impact of this volume is to put in one place the most complete reference work on temperature in the English language.

The book is divided into seven sections: expression of uncertainties, temperature scales, resistance thermometry, thermoelectric thermometry, liquid-in-glass thermometry, optical pyrometry and spectroscopic thermometry.

Without meaning to be prejudiced, I found the section in resistance thermometry the most interesting. Here, the introductory paper by H. F. Stimson is of such basic importance that it could easily be made the basis for several lectures in an undergraduate thermodynamics course. Following this paper there are "Notes to Supplement Resistance Thermometer Reports" that go into some of the details, including the calibration of a Mueller bridge.

There are also interesting papers on low-temperature resistance thermometers going down to 2.1 K. Altogether