posium. There are 61 papers in English, 8 in French, 4 in German.

The physical format is impressive: 542 pages of glossy paper; pages wider than usual, being 6½ inches rather than 6 inches; the excellent photographs show up to their best advantage on the glossy paper; and a wealth of diagrams and graphs supplements the text. X-ray microscopy and microradiography are particularly amenable to illustration with photographs. Hence there are well over 400 photographs ranging from x-ray diffraction patterns of diamond to tissue-cell radiographs. For instance, there are 3 papers on microangiography, which is the visualization of microscopic blood and lymph vessels. The vessels are made opaque to x rays by injection of a high atomic numbered colloid substance such as Thorotrast. The paper by R. L. De C. H. Saunders has 12 superb x-ray micrographs of the vessel structure of brain, iris of eye, and spinal column. Even a nontechnical layman will find pictures such as these fascinating because they give one a direct schematic view of incredibly complex systems. Thus surrounding the aperture of the eye, the iris diaphragm has many hundreds of vessels that appear to extend right up to the periphery of the aperture. The very last living cell, in this case on the periphery of the iris, has its logistics problems solved by means of these microscopic vessels.

The excellent presentation along with bibliographic documentation in each paper makes this volume a highly commendable landmark in the history of the subject.

The Physical Principles of Astronautics. Fundamentals of Dynamical Astronomy and Space Flight. By Arthur I. Berman. 350 pp. John Wiley & Sons, Inc., New York, 1961. $9.25. *Reviewed by Jacques E. Romain, General Dynamics.*

THIS is one of the first introductory textbooks, known to the reviewer, that spans the field of astronautics from basic principles to rather elaborate problems. No other background is required than some knowledge of introductory physics and calculus; the first principles are recalled or explained when needed. Of course a vector formulation is used throughout, but the reader who is unfamiliar with that formalism can find an introduction to vectors in an appendix, as well as one to polar coordinates. So there is really no reason why any student, or even any general reader somewhat acquainted with calculus, could not read the book with profit.

The emphasis is on scientific principles rather than on technology. The purpose is to offer a unified exposition of topics otherwise scattered in elementary physics or mechanics textbooks. The coverage is extensive and up to date; it was clearly chosen to make the book self-contained. Part 1 is a semiquantitative astronomical description of the Earth-Moon and solar systems. In Part 2, the foundations of mechanics are discussed to some extent, the stress being on topics of direct astronautical interest such as Coriolis force,

potential energy, mass, and gravity. Part 3 (about half the book) is concerned with typical astronautical problems: orbital theory, space navigation, orbit perturbations, propulsion dynamics. The treatment is concise but always very clear. A large number of practical illustrative examples fully worked out in the text and many qualitative or quantitative unsolved problems are given at the end of each chapter; only a few of them are provided with answers. Many good illustrations are included.

The metric system is used throughout, and this surely is a healthy feature. However, familiar data, such as escape velocities, are quoted in both metric and English units. Conversion tables for the two systems appear in an appendix.

The book can be used very conveniently as a reference work, thanks to a nomenclature index and a fairly detailed glossary of astronautical terms. Bibliographical references (up to 1960) are abundant and include a list of journals and of bibliographical compilations.

Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanac. Prepared jointly by the Nautical Almanac Offices of the United Kingdom and the United States of America. 505 pp. Her Majesty's Stationery Office, London, 1961. Distr. in US by British Information Services, New York. $7.85. *Reviewed by R. E. Street, University of Washington.*

SINCE 1960 the British *Astronomical Ephemeris* and the *American Ephemeris and Nautical Almanac* have been identical. The purpose of this *Explanatory Supplement* is to provide users of the *Ephemeris* with fuller explanations of its content, derivation, and use than can be included in the *Ephemeris* itself. It includes auxiliary tables and reference data required in the application of the data tabulated in the *Ephemeris*.

The volume is much more than a dry listing of formulae and tables. It contains a history of the development of Ephemerides in the two English-speaking countries with numerous references. There is an exhaustive discussion of coordinate systems with all of the required corrections, an excellent description of the various modern methods of measuring time with slight reference to the historical development, where ephemerides of minor bodies not in the major *Ephemeris* can be obtained, a brief but fascinating history of the calendar, and many more topics too numerous to enumerate here. The chapter on the system of astronomical constants, for example, makes it clear why these must be self-consistent rather than accurate.

This reviewer is not going to insist that it is necessary for the user of the *American Ephemeris and Nautical Almanac* to have this *Supplement*, whether he is an astronomer, astronaut, or student, as obviously we have gotten along without it for the last two years. On the other hand, those of us who have wondered how and where the tables in the *Ephemeris* came from will find