

named spaces (which are connected with "positive" operators). The presentation is particularly adapted as an exact and clarifying foundation for the Hilbert-space techniques so common and necessary in present-day theoretical physics. The chapter on approximate solution of functional equations deserves special mention as providing an elegant, concise, and illuminating treatment of general approximate methods in the solution of integral and differential equations.

All in all, this book will repay the attention of any mathematically inclined physicist or engineer.

The Universe and Its Origin. H. Messel and S. T. Butler, eds. 147 pp. St. Martin's Press, New York, 1964. \$3.75.
Reviewed by J. Allen Hynek, Northwestern University.

"When we see the Moon from close up it will be mostly very gentle slopes that we shall see and none, or extremely little, of the jagged steep mountains that have been the usual artist's conception of the lunar surface." So Tom Gold closes his chapter on the Moon in this pre-Ranger VII book which consists of lectures on cosmology, stellar evolution, and the origin of the solar system, prepared expressly for secondary-school science teachers in Australia.

Gold's prediction seems to have been strikingly confirmed by the epoch-making flight of Ranger VII, at least for the very limited region of the Moon examined. The jagged moon-scape so ubiquitously pictured by science-fiction artists seems conspicuously absent.

It seems clear that erosion has been active on the moon to produce the Ranger-observed landscape but obviously not by the weathering processes so familiar on earth. Gold suggests an erosion that is possible only in a vacuum which permits bombardment by charged particles, hard radiation, and micrometeorites. "Vacuum erosion" (it might be called) is the mechanism that Gold feels has produced the surface texture of the moon.

The moon is perhaps our Rosetta Stone for an understanding of the origin of the solar system. There is strong reason to believe that "it was

there in the beginning," and because the ravages of time have been much less on the moon than on the earth, detailed inspection of the Moon might be to astronomy what the opening of an age-old undisturbed tomb is to archaeology.

Origins is the theme of the entire small volume. The other contributors, George Gamow, Bart Bok, and C.B.A. McCusker, are concerned with the origin of the universe, of stars, and of cosmic radiation, respectively. Gamow also concerns himself briefly with the origin of life on earth.

Although the editors warn that the subjects treated by the authors "do not necessarily integrate with one another," in matter of fact, they do quite well. The problems of the origins of just about everything celestial, from the chemical elements which are in the stars to the stars themselves and to the galaxy, are outlined and treated in a coherent and in an as up-to-date manner as is possible in this rapidly growing field. What may particularly strike the American reader of this Australian volume, however, is the comment by the editors that the chapters were "written to cater for secondary school teachers". If so, then we must gather that secondary education in the sciences—and the education of the secondary science teacher—is more advanced in Australia than it is here.

Gamow leads off, and in five brief chapters reviews the distance and time scale of the universe, discusses the pros and cons of the evolutionary and steady-state theories, coming out strongly (as might be expected) for the evolutionary theory, and treats then of the origin of galaxies, stars, planets, and life. He gives a good account of the evolution of the cosmic distance scale, and extends the discussion to the curvature of space, the age of the earth, of the moon, of the stars, and of the galaxy. The editors failed to catch some simple but outlandish errors: the Hubble constant is given as 23 hours/sec/light year; obviously a million light years is meant. This would be a dynamic and cataclysmic universe indeed, if that figure were true! In addition, Gamow gives us a truly gigantic universe: the distance of the Corona Borealis cluster

of galaxies is stated as 800 billion light years, a figure over-generous by more than two orders of magnitude. He gives the present rate of recession of the moon from the earth as 10 cm per lunation. At that rate, the earth and moon must have been close together a matter of 300 million years ago, and not 5 billion years, as he states.

Despite these slips, the chapters adequately present the over-all picture, always interestingly written. Gamow's section is by far the most quantitative—and if allowance is made for the obvious errors, the reader will learn much more than a secondary science teacher is expected to know in this country.

The other three sections are much more descriptive in nature, but at no sacrifice of accuracy of concept. Bok gives a fine and entirely adequate account of stellar evolution and the role this plays in the origin of elements.

Gold gives a fine presentation of the modern cold accretion hypothesis of the origin of the solar system, a hypothesis which appears to fit the facts much better than any previous theory. Finally McCusker, in the shortest section of the book, summarizes our present knowledge of the origin of cosmic radiation.

The book can be highly recommended as a good overview of the present picture of cosmic origins.

Elements of Astromechanics. By Peter van de Kamp. 140 pp. W. H. Freeman, San Francisco, 1964. Cloth \$4.00, paper \$2.00.
Reviewed by E. J. Opik, University of Maryland and Armagh Observatory.

The author is known for his outstanding investigations of double stars, crowned by the discovery of the truly planetary-size dark companion of Barnard's star.

The booklet is dedicated to an elementary two-dimensional presentation of the Newtonian two-body problem, except for a digression into double-star orbits and the perspective effects of stellar proper motions. Neither the elements of planetary orbits, nor the calculation of the positions of planets in space or on the celestial sphere are mentioned. The numerical applications, very limited in scope, refer to