pages, will be of interest to physicists and engineers in many other projects. The beam intensity is high, and the large beam power must be absorbed; problems arise, not only of thermal heating but also of radioactivity. These problems, faced for the first time at SLAC, will be important for other accelerators.

The development of high-power klystrons has been almost entirely a result of the Stanford linear accelerator program started by Hansen. The section of this book on klystrons will, therefore, be of especial interest to many persons. In reading this section, I recognized the names of many who were involved in the building of the first high-power klystrons for the Mark III accelerator, and one of the strengths of the Stanford development program became crystal clear to me: The developers of SLAC have been working on accelerators for 20 years, and their expertise is unsurpassed.

But with all the interest of this book for the technically minded, and I have mentioned only three of the many technical achievements, the book will remain primarily a book for libraries. Anyone building another SLAC will want a copy—or more probably 100 copies—but I know of no one in this position. Anyone really interested in one of the specialized topics will probably wish to compare the treatment of it here with other work in the field, and the useful parts of this work will find their way into reference books and textbooks. Nor can the book be recommended to replace Agatha Christie or Tolstoy on the bedside table. It will not, therefore, become a best seller; but all physicists who are interested in the detail and intellectual power necessary for a successful large project of any sort must dip into it from time to time. Otherwise, they may be tempted to undertake a large project with insufficient appreciation of the effort that will be required of them.

The authors must not be disappointed if this book does not become a compulsory textbook for all high-energy physics courses. Even with the limited circulation I have described, the book will have been well worthwhile.

RICHARD WILSON
Department of Physics, Harvard University, Cambridge, Massachusetts

Unanswered Questions about the Red Planet

The Book of Mars. SAMUEL GLASSTONE. National Aeronautics and Space Administration, Washington, D.C., 1968 (available from the Superintendent of Documents, Washington, D.C.). viii + 318 pp., illus. $5.25. NASA SP-179.

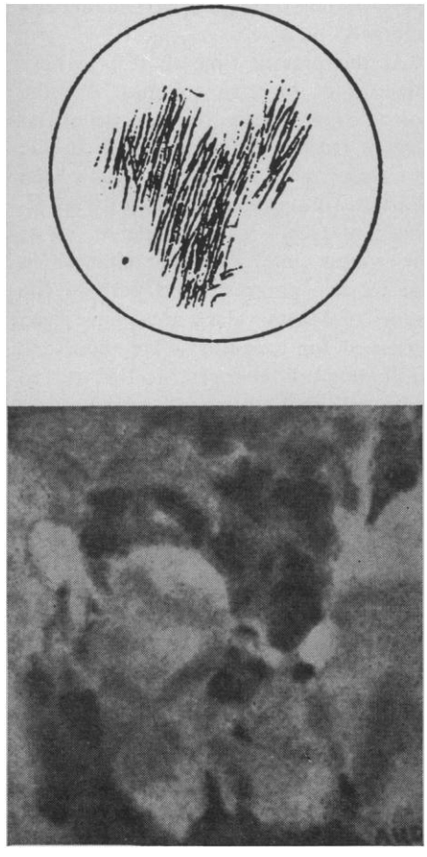
Racing toward rendezvous with Mars, in stately Keplerian choreography, are two United States Mariner class space vehicles. They will fly by the planet within a few days of 1 August 1969. Each spacecraft contains a small scientific laboratory which will examine the planet: at optical frequencies with two vidicon cameras and three-color photography (the long-focal-length system is capable of resolution down to several hundred meters); in the ultraviolet with a moderately high-resolution spectrometer; in the infrared with a two-channel radiometer and a moderate-resolution spectrometer; and at microwave frequencies with an S-band occultation experiment. Cartography, relief, cratering statistics, and information on the composition and structure of the ionosphere, neutral atmosphere, and epilith should emerge from this mission. It will be a rather thorough remote reconnaissance of the planet, and the forerunner of more ambitious unmanned ventures which will add immeasurably to our still quite sparse knowledge of the red planet.

Mars has played a variety of roles in the development of scientific thought. Because Tycho Brahe had made extensive pretelescopic observations of the apparent motions of Mars; because Tycho on his deathbed exhorted Johannes Kepler to analyze these observations; and because Mars has, except for Mercury and Pluto, the most eccentric orbit of all the planets, Kepler was able to deduce his laws of planetary motion, which in turn provided the inspiration for Newtonian mechanics. (The high orbital eccentricity implies that some years are much more favorable than others for observing and for visiting Mars; 1969 and 1971 are the most favorable years in a period of almost three decades.) The year 1877 saw both the discovery of the two small moons of Mars and the codification of the concept of the Martian canals, both events raising enigmatic issues which are with us still. The passionate and articulate writings of Percival Lowell, arguing that the canals were artifacts of a race of intelligent beings, put Mars forcefully into the public consciousness—and probably had the side effect of making planetary astronomy somewhat disreputable in the minds of many astronomers. To Lowell's writings in the first decade of this century can be traced many of the popular stereotypes about life on Mars. Since the end of the Second World War serious ground-based and space-borne investigations of Mars have blossomed. But with virtually every finding an associated enigma has emerged.

At the present time there is a very long list of Martian enigmas: Are the polar caps largely frozen water or largely frozen carbon dioxide? In the latter case, does a major fraction of the Martian atmosphere—primarily composed of CO_2—really condense out at the winter pole? Seasonal changes in the relative contrasts and perhaps the colors of Martian dark areas have been observed for a century. Are these due to biological changes on Mars, to meteorological changes, or to some other phenomenon? What is the significance of the "leopard skin" fine structure which mediates the changes in the dark areas? The outlines of Martian dark areas change erratically over the decades. Areas hundreds to thousands of miles on a side appear and disappear. What possible explanations for such behavior are there? The pattern of bright and dark areas on Mars visible at longer wavelengths becomes generally invisible in blue light. This phenomenon is usually attributed to a "blue haze." If there is such an atmospheric haze, what are its properties? Or is it possible that we are observing nothing but an intrinsic loss of surface contrast in the blue? In the latter case, how can we understand the "blue clearings," occasional recoveries of blue contrast? The angular size of Mars appears to be significantly larger in blue than in red light. The effect is apparently too large to be accounted for by high-altitude haze or cloud layers. What is it due to? The general reddish coloration of the planet is often attributed to the presence of ferric oxides. But can ferric oxides really be a major constituent of the Martian surface? And perhaps the most significant of the Martian enigmas: at what stage in its chemical evolution is Mars? There is an entire continuum of

possibilities, from a total absence of prebiological organic compounds and signs of past life, through advanced extant life forms. At the present time there is no good evidence as to where Mars lies on this continuum.

The Book of Mars is an engaging, thorough, and exceptionally clear discourse by the well-known writer of scientific textbooks and more popular works Samuel Glasstone. The book begins with an excellent historical introduction to Mars marked by intriguing reproductions of early attempts at Martian cartography. This is followed by a quite well done descriptive section on the orbital motions of the planet; here, as in the rest of the book, the discussion is semiquantitative. Glasstone proceeds in a workmanlike manner to discuss the physical environment, the Martian atmosphere, surface, clouds, and haze. With no perceptible difficulty he then successfully changes disciplinary gears and discusses modern ideas about the nature and origin of life, the formation of prebiological organic molecules, and the possibility of life on Mars. The last three chapters are concerned with the present plans for the exploration of Mars and for the avoidance of contamination by terrestrial microorganisms inadvertently delivered to the planet by spacecraft. The illustrations are generally clear and illuminating, with only the reproduction of the Mariner IV photographs being of low quality. The discussion is very up-to-date, references to works published as late as mid-1968 appearing throughout. There is a balanced discussion of a number of controversial issues, for example, the carbonaceous chondrites. There are only occasional conceptual failures, as for example on page 111 where the apparent absence of a 0.88-micron feature in the Martian reflection spectrum is used to argue against the presence of ferric oxides on the planet. There is a gentle but deft critique of the sureness with which previous conclusions, for example, about the surface pressure and about the composition of the polar caps, were enunciated. Errors in fact are extremely rare, perhaps the most serious being the implication on page 222 that the oxygen produced by green plant photosynthesis derives from carbon dioxide rather than from water. The book is graced with a knowledgeable foreword by Homer Newell, the Associate Administrator of NASA.



Early and modern drawings of Mars, showing the dark area Syrtis Major. *Top*, by Christiaan Huygens, 1659. This is the earliest known drawing of Mars that shows an identifiable surface feature. As a result of having observed this feature, Huygens was able to derive the obliquity of Mars and to calculate its period of rotation. *Bottom*, by A. Dollfus, 1948, representing the planet as viewed through a 60-centimeter refracting telescope under "perfect" seeing conditions. Under such conditions features which ordinarily appear to be continuous are resolved into disconnected fine mottling. Forthcoming spacecraft observations of Mars should improve the resolution of the planet by a factor of about 100. [Reproduced in *The Book of Mars* from C. Flammarion, *La Planète Mars*, vol. 1, and G. P. Kuiper and B. M. Middlehurst, Eds., *The Solar System*, vol. 3, respectively]

The Book of Mars is such an excellent book that it's a pity it's virtually unavailable for purchase. Thinking to use it in a freshman seminar at Cornell, we ordered the book from the Government Printing Office more than three months ago. As of this writing copies for class use still have not arrived. This is a pervasive problem concerning many documents issued by the Government Printing Office; to check into it for this review I called Carper Buckley, the Superintendent of Documents. Buckley indicated that the basic problems were congressionally imposed employee ceilings and space limitations. It seems ironical that the Government Printing Office has the facilities to produce so excellent a book but not to arrange for its distribution. At the rate at which our knowledge of Mars is improving, this book may be obsolete by the time orders for it are filled; but it is an invaluable record of our knowledge and speculation about the planet early in the era of Martian exploration.

CARL SAGAN
Laboratory for Planetary Studies,
Cornell University,
Ithaca, New York

Telescope Makers

Alvan Clark and Sons. Artists in Optics. DEBORAH JEAN WARNER. Smithsonian Institution Press, Washington, D.C., 1968 (available from the Superintendent of Documents, Washington). vi + 122 pp., illus. $1.75. U.S. National Museum Bulletin 274.

The metal dinner bell at Phillips Academy at Andover broke in 1844, and Alvan Clark, a professional portrait painter who was also a successful inventor and a superb sharpshooter, supervised his son George in putting the pieces to use to construct a telescope—their first. Thereafter, Alvan, with his two sons George Bassett Clark and Alvan Graham Clark, five times made the objectives for the largest refracting telescopes in the world; the fifth of their efforts, the Yerkes 40-inch lens, has never been surpassed. Their optical work was unexcelled anywhere in the world and was the first significant American contribution to astronomical instrument making. The secret of their success was, in addition to their incredible patience and urge to perfection, their use of local correction (figuring) to obtain the sharpest possible focus rather than mathematically true curves. This technique was better because optical glass discs were inhomogeneous. Alvan Clark and Sons undoubtedly stimulated the great flowering of astronomy in this country that began in the latter half of the 19th century and that later reached full maturity with the spectacular successes of the great reflectors on Mount Wilson and Palomar.

The Clarks became, somewhat inci-