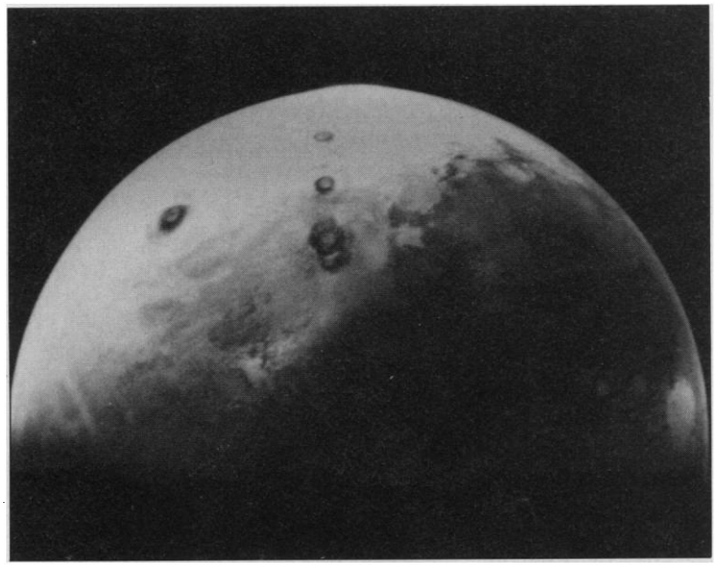
All About Mars

Mars. HUGH H. KIEFFER, BRUCE M. JAKOSKY, CONWAY W. SNYDER, and MILDRED S. MATTHEWS, Eds. University of Arizona Press, Tucson, 1992. xviii, 1498 pp., illus., + maps. $65. Space Science Series.

"It is not easy to remember, now a quarter-century after Mariner 4, how little we once knew about the planet Mars and how much of what we thought we knew was illusion," C. W. Snyder and V. I. Moroz aptly comment in their contribution to this work. Interest in Mars is of long standing, having been fueled in the early part of this century by the crusades of Percival Lowell, whose careful observations and fanciful interpretations fired the public's imagination with images of a planet undergoing gradual desiccation yet still supporting a technologically advanced race struggling to survive. Though Lowell's theories were discredited well before the age of space exploration to whose results Snyder and Moroz refer, the planet continues to fascinate and stir the imagination of scientists and the public alike.

Mars is a crucial object in comparative planetology. It resides at a critical point in the continuum of planetary bodies and processes; it lies between the small, atmosphereless, geologically quiet Moon and Mercury and the relatively large and restless Earth and Venus. Prior to the detailed exploration of Mars with spacecraft our knowledge of it was limited to telescopic observations of size, mass, surface markings, and gross atmospheric properties. The highly successful Mariner 9 and Viking missions uncovered a wonderfully complex and perplexing planet, forever changing our view of Mars. As is detailed in this volume, the surface includes ancient (approximately 4 billion years old), heavily cratered terrain like the lunar highlands, as well as very young volcanoes of extraordinary size. A whole host of channels, from small valley networks to vast outflow troughs up to several thousand kilometers in length, indicate the tremendous force of water in shaping the surface, although water is no longer stable as a liquid on the surface. The carbon dioxide atmosphere is very thin, but it supports a complex climatological system involving weather systems, seasons, water and carbon dioxide ice caps, and planet-encircling dust storms. How do we make sense of all the wonders Mars presents?

The editors of *Mars* have sought to facilitate this by assembling, with 114 collaborating authors, a synthesis of the subject. The result is a colossal book containing 38 chapters and divided into sections on solid-body geophysics, bedrock geology and geological units, surface properties and processes, current atmospheres, biology, and satellites of Mars. All of the chapters are thorough, generally providing a short historical perspective, carefully noting all proposed theories invoked to explain observations, elaborating on the favored model or interpretation, and concluding with a look toward the future.



Mars as photographed at a distance of 560,000 kilometers by Viking 1, 7 June 1987. The Tharsis Mountains, a row of three volcanoes standing about 20 kilometers above the surrounding plain, are visible in the photograph, with Olympus Mons, Mars's largest volcano, toward the top. The circular feature near the bottom of the disk is the impact basin Argyre. North is toward the upper right corner of the photograph. [National Aeronautics and Space Administration]

Because the book is essentially a compilation of reviews, it does not break much new ground. Yet the book as a whole provides a pleasingly integrated perspective of all the major planetary components.

Several themes bind the chapters together. Especially interesting are the ubiquitous fine-grained dust and soil that give Mars its characteristic bright ocher red color. Banin, Clark, and Wänke examine the evidence for the chemistry and mineralogy of the surface, concluding, "With limited decisive information at hand, we may speculatively suggest that the fine soil on Mars is likely to be a multicomponent mixture of weathered and nonweathered minerals." Dust is the result of alteration of the crust; Gooding, Arvidson, and Zolotov explore possible mechanisms of alteration and weathering. Though the precise pathways cannot be determined, predicted reaction rates under current conditions are low, so the majority of this material was formed in an earlier epoch. Christensen and Moore consider the Martian surface layer and find that dust and soils exist in several coherent forms, apparently related to changing environmental conditions. It is interesting to note that the two Viking spacecraft landed on an uncommon type of surface. Some of the altered material is highly mobile, as is documented in the chapters by Greeley *et al.* and Kahn *et al.*, and contributes to the radiative and dynamic properties of the Martian atmosphere (Zurek *et al.*, Kieffer and Zent). As is discussed by Thomas *et al.*, dust and sediment also become trapped in the polar deposits, giving rise to many exciting possibilities for the study of climate change. Altered dust, then, can be considered a defining characteristic of Mars, although the precise mineralogy of the starting and final products, alteration pathways, and fundamental physical properties remains largely conjectural and model-dependent.

In a book of this scope there will inevitably be issues to quibble with. For example, in many chapters the surface layer of Mars is described as homogenized through continuous eolian activity and global dust storms. However, continuing spacecraft and telescopic observations give clear evidence of variations at several length scales and in association with distinct surface units. Moreover, the role of the atmosphere in the formation of craters and their ejecta is given only passing reference in two chapters.

These minor flaws notwithstanding, the editors of *Mars* have put together a well-balanced and thoughtful collection that acknowledges the existence of many unresolved questions concerning the formation and evolution of the planet. The reference list alone is an astonishing accomplishment and a valuable resource in its own right. A few chapters, for example, those on gravity and topography, present the current state of knowledge well but will soon become obsolete. With the U.S. Mars Observer and MESUR and the Russian Mars 94 and 96 missions we are poised for a new decade of discovery. Equipped with this important source book of current knowledge, I am looking forward to continuing evolution—and revolution—in our understanding of Mars.

John F. Mustard
Department of Geological Sciences,
Brown University,
Providence, RI 02912

■

Messier 31

The Andromeda Galaxy. PAUL HODGE. Kluwer, Norwell, MA, 1992. x, 358 pp., illus. $79. Astrophysics and Space Science Library, vol. 176.

Many fields of knowledge, biology for example, have been opened by surveys and morphological classification. In others, ancient Egyptian hieroglyphics for example, the detailed study of a single object provides the basis for a major fraction of future work. The Rosetta Stone of extragalactic astronomy is the Andromeda Galaxy. Andromeda, a.k.a. Messier 31 and NGC 224, is the most luminous of the three galaxies (other than our own Milky Way) visible to the naked eye, and the only one visible from the Northern Hemisphere. Andromeda is also nearly a duplicate of our own galaxy. Whereas our own galaxy is difficult to study as a whole because the solar system is deeply embedded in its gas and dust, Andromeda is arrayed before us in the full glory of a giant spiral. If the Milky Way is the *Queen Mary* of galaxies, Andromeda is the *QE II*.

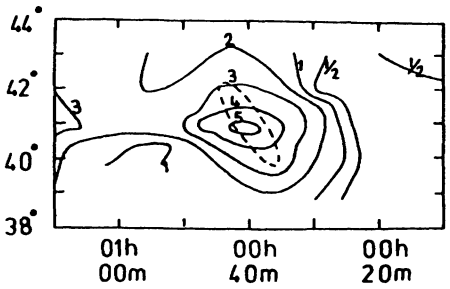
In *The Andromeda Galaxy* Paul Hodge presents a summary of almost all the work done on Andromeda since the beginning of written history. The first recorded mention of the nebula was made in the 10th century by al-Sufi. Although the nebula was observed and mentioned by numerous astronomers in the intervening years, serious work on it didn't begin until near the end of the 19th century. This attention was due to two events, the development of photography to record images through telescopes and the eruption of S Andromeda or SN1885a, the first extragalactic supernova observed by humankind. S Andromeda fueled both sides of the debate on the galactic or extragalactic nature of the nebulae. This debate finally was decided conclusively by Hubble's discovery of extragalactic Cepheids, also in the Andromeda galaxy, in the early 1920s.

Hodge collects and reviews work on Andromeda's dynamics, gas and dust content, stellar populations, and radio and x-ray observations. He is at his best describing the work on stellar populations in Andromeda, to which he has made many fundamental contributions. Particularly useful is the review of his own "population box" description of a galaxy's stellar content, which is the first quantitative conceptual attempt to view the stellar content of a galaxy as more than a one-parameter family.

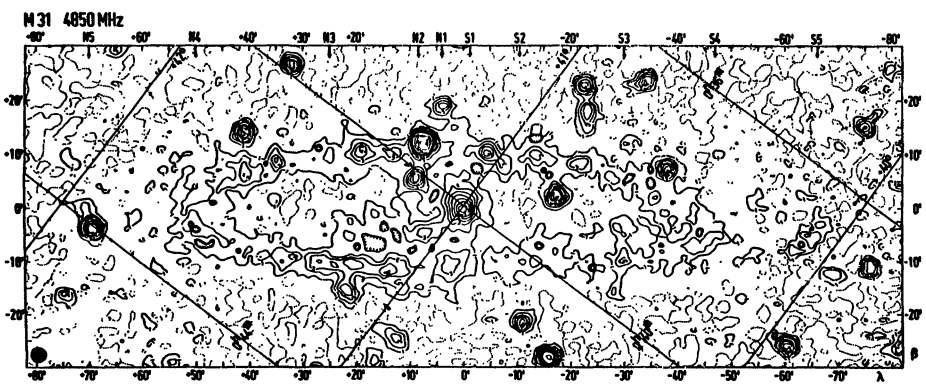
This book is an excellent reference for the serious student of galaxies. Every classic paper on Andromeda is cited, and all the important results are well described and summarized. Hodge takes particular pains to compare and contrast Andromeda with the Milky Way. However, in covering all the observational bases, he spends little time on the deeper astrophysical implications of the observations—the importance of Andromeda and its stellar constituents as one of the first rungs of the extragalactic distance ladder, the importance of the measurement of its neutral hydrogen rotation curve and halo of globular clusters in the dark-matter–missing-mass debate. If the reader is interested in a description of the detailed physical processes that describe a galaxy, especially its internal kinematics and dynamics, a better book would be *The Milky Way as a Galaxy*, edited by Buser and King (University Science Books), which is, in many ways, complementary to *The Andromeda Galaxy*.

This is not a book for the general reader. The presentation is very dry and only a little of the author's own spirit and incisive interpretation is in it. There are several minor references given in the text but missing from the reference list. On the other hand, I'm sure glad I now have the book on *my* reference shelf.

John Huchra
Harvard-Smithsonian Center for Astrophysics,
Cambridge, MA 02138



"The first radio continuum map of M31," made by R. Hanbury Brown and C. Hazard in 1950. M31 "was the first object that Hanbury Brown and Hazard turned to after getting the Jodrell Bank 218-foot transit telescope in final form for observing. . . . It took them 90 nights, working during the radio-quiet time around midnight, to map out the radio radiation" shown here. [Reproduced in *The Andromeda Galaxy* from W. Sullivan, Ed., *The Early Years of Radio Astronomy* (Cambridge University Press, 1984)]



"Contour map of M31 at 4850 MHz, clearly showing the 10 kpc ring structure. Arrows indicate positions of Baade's arms N5 to S5." [From *The Andromeda Galaxy*, E. Berkhuijsen *et al.*, *Astron. Astrophys.* **117**, 141 (1983)]

■

Southerly Enterprises

A History of Antarctic Science. G. E. FOGG. Cambridge University Press, New York, 1992. xxii, 483 pp., illus. $89.95. Studies in Polar Research.

The canvas is vast—a continent of 13 million square kilometers averaging 1500 meters above sea level and covered over much of its area by more than a kilometer of ice and snow. Below its frozen surface the land is depressed hundreds of meters; where