Book Reviews

A Worthy Planet

Jupiter. Studies of the Interior, Atmosphere, Magnetosphere and Satellites. TOM GEHRELS, Ed. With the assistance of Mildred Shapley Matthews. University of Arizona Press, Tucson, 1976. x, 1254 pp., illus. $38.50

There was probably no better time to put together a full discussion of Jupiter than now, following the first two spacecraft flybys of Jupiter in December 1973 and 1974 and well before the next ones, to occur in 1979. For many years Jupiter was a prime subject of interest only to a few astronomers and geophysicists. The data obtained in situ promise to convert Jupiter physics into a "hard" discipline. Paradoxically, the relating of Jupiter to other objects in the cosmos may lag as astronomers pay less attention to it and space scientists more.

This volume records the changing of the guard; many of the contributors had not been devoted to Jupiter studies until the Pioneer 10 flyby of December 1973, and some notables with much longer credentials as Jupiter scientists are not particularly involved in the treatment of the new (spacecraft) data. Astronomers play according to soccer rules: it's a foul when you lay hands on the ball. A similar phenomenon has marked studies of the moon and Mars.

Jupiter is not therefore less important as an astronomical object; it is still worthy of its place in the galaxy, and remains the best model for the planetary structures that must exist throughout the universe. Substellar in size yet with chemical abundances resembling those found in stars, surrounded by a magnificent satellite system that itself has for centuries served as a conceptual prototype of the solar system, Jupiter seems to become more interesting with each passing year.

This volume documents this case up to about 1975. Even those who do not use it in their classes will certainly want to use it to prepare their lectures and guide their researches. The editor was aggressive in seeking out authors, and if they responded richly it was in no small way a credit to his judgment about who could do a good job and what was worth putting down to describe our current knowledge of this wonderful planet.

Jupiter is now known to be a source of energetic particles that reach the earth. For decades its radio emissions—both synchrotron emissions at decimetric wavelengths and coherent plasma radiations at decametric and kilometric wavelengths—have been enigmas, only partially penetrated by spacecraft data. But the larger lesson to astronomy is to be derived from such phenomena. This cold object, visible only in reflected sunlight but emitting radio waves more intense by many orders of magnitude than those emitted by the sun in the same frequency range, inverts the usual situation of a planet around a star. As a radio source it overwhelms its star, and furthermore its radio emissions in themselves provide sufficient information to describe its orbit. Of course, at stellar distances its signals would be enormously—by 10^{11}—weaker than they are at the earth, but there would likely be no star signals to be confused with them.

And the lessons Jupiter has to teach about how electrons and protons can be accelerated remain to be fully understood. The sun itself produces this sort of acceleration during flares and perhaps at other times; some other objects in the universe also do—namely quasars, the interstellar medium, and probably pulsars. Yet it is as sure as anything can be that we'll never investigate those sources in situ. Jupiter's significance in nonthermal astrophysics is larger than its significance as a planet in our solar system.

And more remains to be learned about its essential magnetism. Strangely asymmetric in radio polarization records at high and low frequencies, Jupiter's magnetic field shows complex multipole structure at $1.6R_J$ (Pioneer 11) the extrapolation of which to the surface does not appear to explain the radio data. The problem may well be that $1.6R_J$ isn't close enough for the observation of the fine field structure that determines radio geometry.

The same might be the case with respect to gravitational data. Jupiter's interior is a mystery within a mystery, and the closer a spacecraft orbits, especially in polar passages, the more sensitive a record it can provide bearing on Jupiter's internal mass distribution. No better object than Jupiter is likely ever to be available for resolution of internal structure in relation to equations of state, or to the generation of magnetism in cosmic bodies.

But these are points of special interest to this reviewer. I would like also to mention casually, as though they were unimportant, phemonena such as the strong outward density gradient that exists, as in the planetary system itself, among the Galilean satellites; the extraordinary presence of a sputtered sodium cloud around Io; the frost-covered surfaces of Ganymede and Callisto; the energetic particle sinks and sources at the satellites; the gross magnetosphere of Jupiter, subtending degrees on our sky and bigger, if we could see it, than even the sun and the moon; and the cloud structure visible on Jupiter's surface, as fine as the best space observations and strongly inviting further observation at still higher resolution.

The incredible part of the story is that it is virtually certain that a series of second- and third-generation spacecraft to Jupiter will restructure and build further on the evidence so beautifully brought together in this book. The book provides a strong basis for measuring the success of further missions and should attract a new generation of scientists to the study of Jupiter.

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Human Population Study

Patterns of Human Variation. The Demography, Genetics, and Phenetics of Bougainville Islanders. JONATHAN SCOTT FRIEDLAENDER. Harvard University Press, Cambridge, Mass., 1975. xxx, 252 pp., illus. $18.50.

Many of the formal population genetics models of evolutionary process in use today were developed by the biostatisticians, biometricians, and plant and animal geneticists of the 1930's and 1940's. Although these genetic models are often mathematically elegant, simplifying assumptions preclude their application to human aggregates. The decades that followed their development saw the refinement of many of them and produced a closer approximation of the complexities of human population structure. However, recent reappraisals of the models used in population genetics (*1*, *2*) have been highly critical of some of the underlying assumptions applied to human groupings. For example, Felsenstein (*2*), after examining the contradictory underlying assumptions of isolation-by-dis-