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.

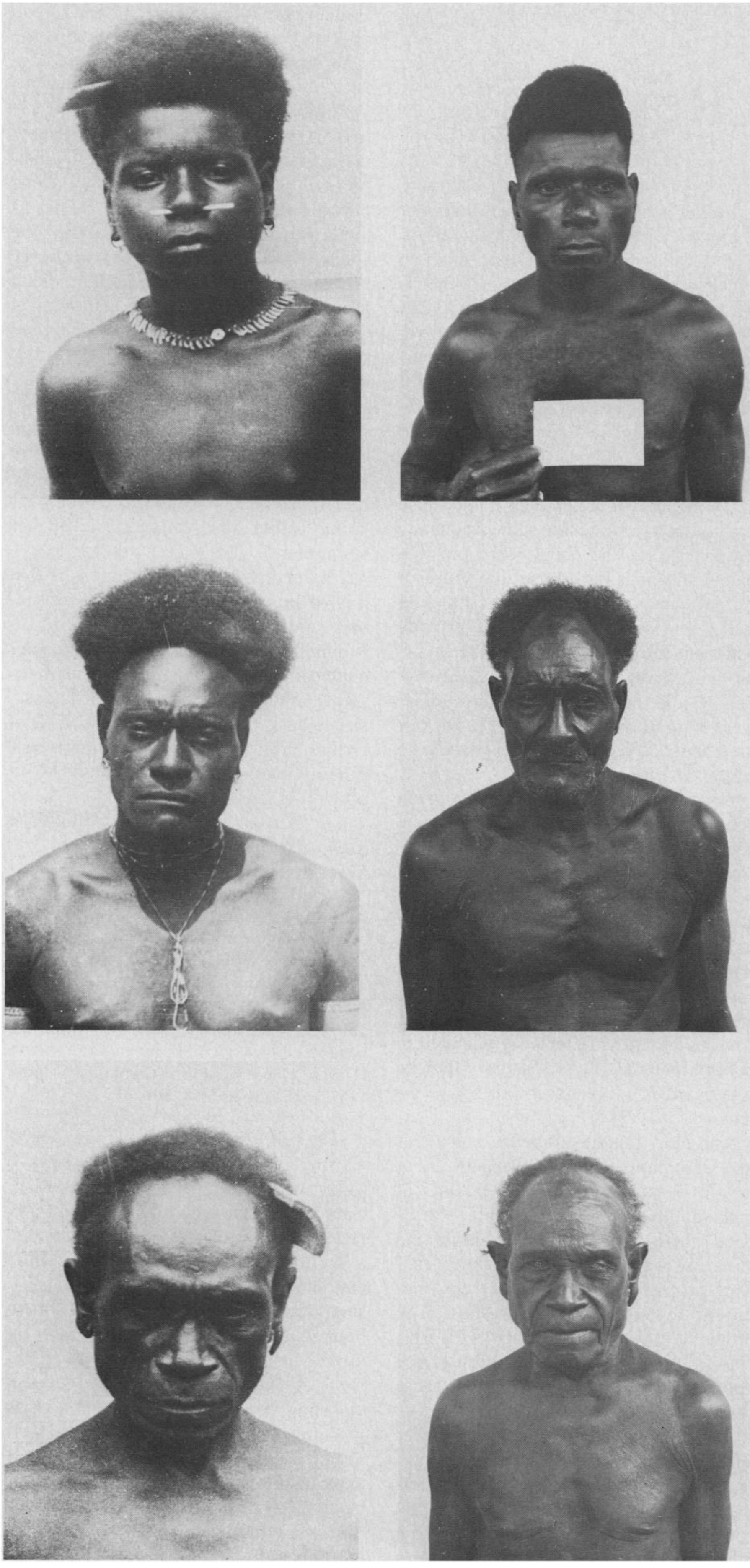
The incredible part of the story is that it is virtually certain that a series of second- and third-generation spacecraft to Jupiter will restructure and build further on the evidence so beautifully brought together in this book. The book provides a strong basis for measuring the success of further missions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

JAMES W. WARWICK
Radio-Astronomy Observatory, University of Colorado, Boulder

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-



Three Bougainville Islanders, photographed in 1938–39 (left) by Douglas Oliver and again in 1967 (right) by Jonathan Friedlaender. [From *Patterns of Human Variation*]

tance models, characterized them as "biologically irrelevant." It is from this milieu of self-doubt and reevaluation of the basic tenets of population genetics that Friedlaender's book emerges.

Friedlaender focuses upon the genetic and morphological variation observed in 18 Bougainville Island villages. The data described in this volume were collected during two field studies, an extensive seven-month study in 1966–67 and a two-month survey in 1970 to fill in lacunae in the genealogical data on the northeast Siwai. The data set consists of blood specimens from 2008 individuals, 13 anthropometric measurements from 526 subjects, and 1372 hand and palm prints. The 18 villages, located primarily along the west coast and in the central and southeastern regions of the island, vary in size from 78 to 289 persons. Demographic and genealogical data were collected through interviews and analyses of church records. With the church records incomplete and with government census materials available only for 1965, Friedlaender must be commended for piecing together a coherent demographic picture. In addition, he had access to Douglas Oliver's genealogical and anthropometric data gathered in 1938–39 and to dental casts collected and analyzed by Bailit and Rapoport.

According to Friedlaender, particular villages were selected for study because they belonged to different language groups while residing in close geographic proximity. This is a reasonable experimental design for determining the relative roles of language and geographic distance in the distribution of alleles and in the genetic microdifferentiation of villages. However, Bougainville Island may not be the best possible choice for the study of divergence because of the considerable demographic disruption during World War II. Gene flow into the Bougainville population must have occurred during the Japanese occupation, particularly since a garrison of some 65,000 troops was stationed there during the war years.

One interesting result of the study is Friedlaender's conclusion that interpopulation variability in Bougainville is based, in part, upon language and geographic relationships. This finding contradicts Spuhler's conclusion (*3*) that linguistic diversification, as measured by glottochronology, is of no value in the interpretation of gene frequency distributions in Amerindian groupings. Although a low negative correlation was demonstrated between genetic distance and linguistic affinity, a significant positive correlation was found by Spuhler between genetic and geographic distance. It is difficult to determine whether the lack of fit between genetic and linguistic patterns of divergence was due to the methodological foibles of glottochronology or whether a comparison of tribal divergence spanning thousands of years and miles produces too much static. The relationship between linguistic and genetic divergence may be observable only for small populations, such as Bougainville or the Yanomama (*4*), that are intimately bound to the land and have little migration.

Friedlaender employs a method, developed by Gower, for measuring the fit between two arrays by the squaring of the summed deviations to produce a statistic called R^2. This statistic indicates that anthropometrics and linguistics give the best fit while dermatoglyphics, male and female, are furthest removed from the pattern of variation observed in the other systems. Friedlaender interprets these results to mean that dermatoglyphic patterns differ little among villages, while varying enormously on the individual level. He is probably correct in that polygenic systems (which experience little environmental influence) tend to be more "conservative" evolutionarily and there has been insufficient time for the villages to diverge significantly. However, if this is the case, why do the dermatoglyphic patterns of the males and females differ so markedly even though they represent a subdivision of the same gene pool?

Although some dermatoglyphic traits exhibit high heritabilities in certain populations, divergences based upon these traits are often at odds with the historical, demographic, and blood-genetic evidence. One of the contributing factors to the lack of fit between dermatoglyphic traits and other genetic variation may be the definition of the traits or units. For example, the number of ridges on a given finger is determined by counting ridges intersected by a line drawn from the triradius to the center of the pattern. If a finger lacks a triradius, that is has an arch, the ridge count is designated 0. The total ridge count (TRC), computed for the individual by the summation of all ridges on all fingers, is commonly employed as a single polygenic trait. This traditional method of ridge counting, used in Friedlaender's study, results in highly distorted variances, which may in turn influence the multivariate measures of divergence. In addition, TRC is not a continuous variable that is normally distributed, but a quasi-discrete variable. However, Friedlaender cannot be criticized for the use of this dermatoglyphic trait, since it has been employed by anthropologists and geneticists in many other studies. In the multivariate statistical analyses of the dermatoglyphic traits, Friedlaender correctly tested for the equality of variance-covariance matrices for individual groups. He found that the H_1 tests were highly significant, prompting him to warn that "it is questionable whether discriminant analysis, or any multivariate technique assuming normality of dispersions, is appropriate." He then proceeds to perform the discriminant function analysis of dermatoglyphics, thus ignoring his own warning. This step may be justifiable, however, since many multivariate techniques are sufficiently "robust" to withstand moderate violations of the normality-of-dispersions assumption.

In two recent publications (*5, 6*) factor and principal components analyses of dermatoglyphic traits suggest that fields, analogous to Butler's dental fields, may exist in finger and palmar configurations. Crawford and associates (*5*) demonstrate that in all the populations contained in their sample certain highly intercorrelated "traits" emerge as likely dermatoglyphic units. To date, these "traits" have been found in Amerindian, European, and African populations and appear to be promising substitutes for the traditional methods of dermatoglyphic analyses.

One of the unique features of this volume is the examination of the secular trend among the men of northeast Siwai, made possible by comparisons between the anthropometric data collected by Oliver in 1939 and Friedlaender's surveys in 1967 and 1970. As expected, there is an increase in stature and weight in the samples from 1939 to 1967. Longitudinally, an unexpected decrease in weight was found in men weighed in 1938 and then reweighed three decades later. In industrial populations, by contrast, there is an increase in weight during the latter years of adulthood. It would have been particularly informative to determine, through factor analysis, if the Siwai became bigger all over or whether certain dimensions or traits were disproportionately affected.

Despite the criticisms and the Monday morning quarterbacking this volume is pioneering and provides a solid foundation for others to build on. However, the relationships of various facets of the genome and the environment can better be understood in future studies in populations with better historical reconstruction and greater demographic stability than are found in Bougainville. It is the absence of this historical perspective that limits Friedlaender's analysis. Ward (*7*) recently concluded in an overview of a similar study:

> Only by understanding how the complex of historical factors interact to influence the distribution of genetic and morphological attributes in populations such as this will we ever understand the diversity of our genetic heritage.

M. H. CRAWFORD
Laboratory of Biological Anthropology, University of Kansas, Lawrence

References

1. R. C. Lewontin, *The Genetic Basis of Evolutionary Change* (Columbia Univ. Press, New York, 1974); H. Harpending, *Annu. Rev. Anthropol.* **3**, 229 (1974).
2. J. Felsenstein, *Am. Nat.* **109**, 359 (1975).
3. J. N. Spuhler, in *The Assessment of Population Affinities in Man*, J. S. Weiner and J. Huizinga, Eds. (Clarendon, Oxford, 1972), p. 87.
4. R. S. Spielman, E. C. Migliazza, J. V. Neel, *Science* **184**, 637 (1974).
5. M. H. Crawford, P. M. Lin, G. Thippeswamy, in "The Tlaxcaltecans: Prehistory, Demography, Morphology and Genetics," M. H. Crawford, Ed., *Univ. Kans. Publ. Anthropol. 7* (1976), p. 120.
6. D. F. Roberts and E. Coope, *Hum. Biol.* **47**, 169 (1975).
7. R. Ward, in "The Tlaxcaltecans: Prehistory, Demography, Morphology and Genetics," M. H. Crawford, Ed., *Univ. Kans. Publ. Anthropol. 7* (1976), p. 176.

Alchemy in China

Science and Civilisation in China. Vol. 5, Chemistry and Chemical Technology. Part 3, Spagyrical Discovery and Invention: Historical Survey, from Cinnabar Elixirs to Synthetic Insulin. JOSEPH NEEDHAM, with the collaboration of Ho Ping-Yü and Lu Gwei-Djen. Cambridge University Press, New York, 1976. xxxvi, 482 pp., illus. + plates. $42.

Historians of alchemy have long recognized the decisive Chinese influence which turned the attention first of Islamic and later of Christian alchemists from metallic transmutation to a quest for a drug to confer longevity and cure all diseases. Why that quest should first have begun in China became much clearer in part 2 of Joseph Needham's account of Chinese chemistry and chemical technology. A question seldom asked in specialist histories of alchemy and chemistry arose almost naturally in a study of Chinese science as an aspect of Chinese civilization. It was answered in terms of the distinctive conceptions of death and the afterlife in Chinese culture.

In addition to making use of the term *macrobiotics* to refer to the search for a "drug of deathlessness," Needham introduced a new vocabulary to ease the mental discomfort of travel through the fantastic landscape of alchemy: *aurifiction* for artisan gilding or gold-faking and *aurifaction* for alleged transmutation.