BOOK REVIEWS

The Era Before NASA

Solar System Astronomy in America. Communities, Patronage, and Interdisciplinary Science, 1920–1960. RONALD E. DOEL. Cambridge University Press, New York, 1996. xiv, 280 pp. + plates. $59.95 or £40.

In 1956 Harvard's Fred L. Whipple, who chaired the International Astronomical Union's commission on meteorites, complained in the opening volume of a new astrophysical series that the solar system was a "neglected" field of study. In the same venue Chicago's Gerard P. Kuiper, who had just finished two terms as chair of the IAU's commission for the physical study of the planets, bemoaned the virtual "abandonment of planetary studies" since the early 20th century. Such laments swelled into a dirge as NASA and military space agencies made ready during the next decade for increasingly ambitious missions beyond the Earth's atmosphere. Since then most astronomers and historians of astronomy have believed that the half-century of solar system research prior to the space age was almost barren. In justifying this belief, they invoke not only the complaints of Whipple, Kuiper, and others but also the disrepute that claims for life on Mars brought on the field at the century's beginning, the fundamental ways in which understanding of the stars and galaxies advanced between 1910 and 1960, and the rapidity with which earlier knowledge of the solar system came to be seen as meager and unreliable after Sputnik.

Ronald Doel's superb book challenges the thesis that American scientists neglected the solar system in the four decades preceding NASA's founding. Drawing on the archival records of more than 50 scientists and their patrons, on dozens of interviews conducted by himself and other historians, and on a vast array of contemporary articles, chapters, and monographs, he traces research in North America between 1920 and 1960 on the formation, evolution, and constitution of the planets, moons, asteroids, comets, and meteors. His narrative establishes that this field was ever more dynamic. It also establishes the field's growing fecundity by describing, inter alia, the identification of methane and ammonia in Jupiter's atmosphere, the demonstration of the interplanetary origin of meteors, the determination of the age of Earth and meteorites as about 4.5 billion years, the construction of a strong case for recurring large-body impacts on the Earth and the moon, and the proposal of the dirty-snowball model of comets.

Doel attributes much of this vitality to the increasing interdisciplinarity of American solar system studies during the four decades. Indeed, 22% of the nine scientists most frequently mentioned in his book and 33% of the next 18 entered into their research on the solar system with backgrounds in geology, chemistry, or meteorology. Doel examines why, how, and with what success astronomers worked with such outsiders in their mutual attempts to enlarge knowledge of the planets and lesser bodies in the sun's family. He pays due heed to the protagonists' backgrounds, tools, standards, and agendas, to their relations with patrons and gate-keepers, to their more or less transient venues for exchanging information, and to their styles of cooperating and competing. While masterly, his accounts of their undertakings are generally so succinct that the reader only catches occasional glimpses of the protagonists' strategies for dealing with the obstacles to interdisciplinary research. By contrast, his narration of Kuiper's collaboration with the physical chemist Harold C. Urey in theorizing about the solar system's condensation out of a primeval gas nebula is a satisfyingly rich portrayal of an interdisciplinary project. His analysis illuminates not only the origins of their partnership in 1949–50 and its early fruits but also the differing disciplinary commitments that rent it asunder a few years later.

"Samuel Boothroyd (left) and Vesto M. Slipher (right) at a station of the Harvard Arizona Meteor Expedition, 1932. The largest meteor expedition then undertaken in North America, the project reflected the hopes of Harlow Shapley to employ meteors to study the interstellar medium and stellar spectra." [From *Solar System Astronomy in America*; Lowell Observatory photograph]

But if American scientists were indeed active in solar system research in the four decades before Sputnik, why the plaints from 1956 on about the field's neglect and abandonment? Doel convincingly argues that this grumbling was inspired by changes in patronage for American astronomy. From 1920 to about 1955, much support for astronomical personnel and facilities had been for the entire discipline rather than specific fields. Throughout this period, accordingly, many astronomers used their resulting autonomy to work in two or more fields at once or to switch from one field to another as they discerned appealing opportunities. Even the rather substantial postwar moneys that military patrons provided for upper-atmosphere and solar system studies that might prove to be of operational value did not change this general pattern. Then in the mid-1950s the National Science Foundation entered the scene. Soon NSF's managers and panels in effect decided against funding much ongoing solar system research when they adopted a policy of not supporting projects that already enjoyed military patronage. NSF also decided against giving leading solar system astronomers any real role in the planning process for a new national observatory in the American Southwest. More than anything else, Doel shows, it was NSF's actions that led Whipple and Kuiper to begin complaining about the treatment of their field. Understandably, their dismay at being marginalized affected their reading of the field's history earlier in the century.

Besides offering a carefully crafted and unusually original history of solar system research between 1920 and 1960, Doel reflects on its broader significance for our

understanding of the transformation of American science during the mid-20th century. In particular, he discusses how dramatic increases in patronage for science profoundly altered both the social organization of disciplines and the conduct of interdisciplinary research in the postwar period. Those who, like myself and, I suspect, Doel, see much that is admirable in little science with its transient interdisciplinary collaborations will marvel at the dispassionate acuity of his analysis of the transition to Big Science with its intense specialization and institutionalized multidisciplinary teams.

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Bats and Their Brains

Comparative Neurobiology in Chiroptera. GEORG BARON, HEINZ STEPHAN, and HEIKO D. FRAHM. Birkhäuser Boston, Cambridge, MA, 1996. In three volumes. Vol. 1, Macromorphology, Brain Structures, Tables and Atlases. Vol. 2, Brain Characteristics in Taxonomic Units. Vol. 3, Brain Characteristics in Functional Systems, Ecoethological Adaptation, Adaptive Radiation and Evolution. x, 1596 pp., illus. $285.

The ability of bats (Chiroptera) to fly and to orient by echolocation gives them unparalleled mobility at night, and they have exploited the opportunities this opens to them by radiating into many different nocturnal niches. The order Chiroptera consists of two suborders, 17 or 18 families, and over 900 species with a complex geographic distribution that reflects an evolutionary process heavily dependent on differentiation of patterns of behavior, thus making the brain and nervous system key sites for phylogenetic comparison. The flight of bats, their use of biosonar, often in conjunction with vision and passive hearing, for orientation, their diversity of social organization and communication, and their surprising diversity in all sorts of physiology (vampire bats are flying kidneys) combine to make them a living laboratory for illustrating the adaptability of the nervous system.

This three-volume work is at once an immensely valuable source book on the neurobiology and behavior of bats and a major conceptual contribution to comparative neuroscience through systematic examination of hypotheses concerning their adaptive radiation. The first volume examines structures and fiber connections in the brain, with material ranging from gross neuroanatomy to cytoarchitecture. This volume includes a vast data set—tabulations of morphological features of the brain in different groups of bats and an atlas of the brain in two species (*Rousettus amplexicaudatus*, *Myotis montivagus*). The breadth and depth of the review of literature underlying the data set and its cross-indexing by brain structure and taxonomic unit make this volume a monumental descriptive contribution, but it also deals

The common long-eared bat *Plecotus auritus* (Linné, 1758). [From the cover of *Comparative Neurobiology in Chiroptera*, vol. 3]

effectively with using the data to answer questions about brain size (encephalization) in relation to phylogeny. The second volume is an ambitious compilation of every conceivable aspect of neurobiology—gross and fine neuroanatomy, neurophysiology, histology, histochemistry, and behavior—in different groups of bats. At its most detailed level, this volume essentially describes what is known about the habitat, habits, behavior, sensory capacities, and brain organization in different species of bats—and there are a lot of them. Comparisons of brain size begun in the first volume are carried in the second volume to the level of numerous specific brain structures in different families, genera, and species. The third volume is an equally ambitious examination of the same wide range of material reorganized in terms of functional neural systems. Details of sensory, motor, limbic, and neocortical systems are examined in relation to ecology, behavior, and adaptive radiation as represented by phylogenetic relations.

Taken together, these three volumes raise a wide range of different types of questions about the organization and evolution of the brain, answer many of them, and generally glean from our present knowledge a program of enquiry to answer yet more. The work exhibits a level of scholarship that I expect will not soon be equaled in neuroscience, and I hope that neuroscientists working with the "mainstream" animals—chiefly primates, cats, and rats—will discover the surprises these authors have handed to them in one source.

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Books Received

Applied Population Ecology. A Supply-Demand Approach. Andrew Paul Gutierrez. Wiley, New York, 1996. xviii, 300 pp., illus. $69.95.

Archaeological Chemistry. A. Mark Pollard and Carl Heron. Royal Society of Chemistry, Letchworth, Herts, UK, 1996 (U.S. distributor, CRC, Boca Raton, FL). xvi, 375 pp., illus. Paper, $39 or £322.50.

Archaeology. Theories Method and Practice. Colin Renfrew and Paul Bahn. 2nd ed. Thames and Hudson, New York, 1996 (distributor, Norton, New York). 608 pp., illus. $45.

"Brain Drain" from Russia. Problems, Prospects, Ways of Regulation. Stanislav Simanovsky, Margarita P. Strepetova, and Yuriy G. Naido. Nova, Commack, NY, 1995. xv, 209 pp. $59.

Breakthrough. The Race to Find the Breast Cancer Gene. Kevin Davies and Michael White. Wiley, New York, 1996. x, 310 pp. $24.

Cellular Biophysics. Thomas Fischer Weiss. MIT Press, Cambridge, MA, 1996. 2 vols. Vol. 1, Transport. xxxvi, 693 pp., illus. $50. Vol. 2, Electrical Properties, xxxii, 557 pp., illus. $45. The set, $85.

Chemical Ecology. The Chemistry of Biotic Interaction. Thomas Eisner and Jerrold Meinwald. National Academy Press, Washington, DC, 1996. x, 214 pp., illus., + plates. $49.95.

Convection and Substorms. Paradigms of Magnetospheric Phenomenology. Charles F. Kennel. Oxford University Press, New York, 1996. xx, 408 pp., illus. $65. International Series on Astronomy and Astrophysics.

Development of the Cerebral Cortex. Gregory Bock and Gail Cardew, Eds. Wiley, New York, 1995. viii, 337 pp., illus. $79.95. Ciba Foundation Symposium, 193. From a symposium, London, Nov.-Dec. 1994.

DNA Vaccines. A New Era in Vaccinology. Margaret A. Liu, Maurice R. Hilleman, and Reinhard Kurth, Eds. New York Academy of Sciences, New York, 1995. xiv, 294 pp., illus. $95. Annals, vol. 772.

Engines of the Mind. The Evolution of the Computer from Mainframes to Microprocessors. Joel Shurkin. Norton, New York, 1996. 363 pp., illus. Paper, $13 or C$16.99. Reprint, 1984 ed.

Evolutionary Algorithms in Theory and Practice. Evolution Strategies, Evolutionary Programming, Genetic Algorithms. Thomas Bäck. Oxford University Press, New York, 1996. xiv, 314 pp., illus. $45.

Greening the College Curriculum. A Guide to Environmental Teaching in the Liberal Arts. Jonathan Collett and Stephen Karakashian, Eds. Island Press, Washington, DC, 1996. xiv, 328 pp. $40; paper, $22.

Guidebook to the Small GTPases. Marion Zerial and Lukas A. Huber, Eds. Sambrook and Tooze (Oxford University Press), New York, 1996. xx, 476 pp., illus. $65; paper, $39.95.

An Introduction to Special Relativity and Its Applications. F. N. H. Robinson. World Scientific, River Edge, NJ, 1995. xii, 183 pp., illus. $28.

Physics and Fractal Structures. Jean-François Gouyet. Springer-Verlag, New York, 1996. xiv, 234 pp., illus. $39.

The Thermodynamics of Rheology. Or Inside the Thermodynamic Black Box. Harry H. Hull. Society of Plastics Engineers, Brookfield, CT, 1995. xii, 135 pp., illus. $33.

The Universe in a Handkerchief. Lewis Carroll's Mathematical Recreations, Games, Puzzles, and Word Plays. Martin Gardner. Copernicus (Springer-Verlag), New York, 1996. x, 158 pp., illus. $19.