BOOK REVIEWS

A Rise to Distinction

American Astronomy. Community, Careers, and Power, 1859–1940. JOHN LANKFORD, with Ricky L. Slavings. University of Chicago Press, Chicago, 1997. xxvi, 447 pp., illus. $65 or £51.95. ISBN 0-226-46886-0.

In 1864 James Melville Gilliss, superintendent of the U.S. Naval Observatory, lamented that America had "done so little to redeem the noble promises implicitly made to astronomers of the old world." Yet by the beginning of World War I, U.S. astronomy had achieved world-class status, particularly in observational research. Even before the turn of the century, astronomy was rapidly emerging as one of America's leading scientific disciplines. The founding of the Astronomical and Astrophysical Society of America (later the American Astronomical Society) in 1889 was followed by the launching of the *Astrophysical Journal* in 1895, which joined the already vigorous *Astronomical Journal*; within two decades the world's largest reflecting telescope was under construction atop Mount Wilson in California. In the decades following the Civil War American astronomy had clearly experienced profound changes. But what factors best account for this transformation? In contrast to Europe, whose research facilities and programs had long dominated this discipline, what was "American" about American astronomy?

John Lankford's important volume, over ten years in the making, provides insightful answers to this question. A senior historian of astronomy well versed in quantitative methods and sociological analysis, Lankford has produced an original portrait of the American astronomical community from 1859 (when the field of experimental spectroscopy took root) to the eve of World War II (when the American Astronomical Society still met as a single body, without concurrent sessions), a watershed event that helped launch the modern era of U.S. astronomy. Lankford casts a wide net: he is concerned not only with the careers of elite astronomers who dominated U.S. astronomy in this period, including Simon Newcomb, George Ellery Hale, and Henry Norris Russell, but also its burgeoning rank-and-file members and its significant component of women astronomers. What makes Lankford's volume particularly valuable is his innovative methodological approach. In addition to thorough archival research, Lankford has produced a collective biography of over 1200 astronomers active between 1859 and 1940, yielding rich and previously unavailable details about family background, training, research topics, publications, first positions, and later career moves. His book provides a finely nuanced picture of how this scientific community grew and matured. Rather than offering a narrative of discovery, Lankford employs his meticulous survey of American astronomers to probe such themes as the evolution of scientific careers, the nature of power, career management, and the reward system.

Lankford's study illuminates several significant transformations within American astronomy. One is the rise of astrophysics, whose advocates challenged leaders of astrometry and celestial mechanics for hegemony in the U.S. astronomical community in the 1890s. Lankford clearly shows that the conflicts between these groups involved more than simple disagreements over instrumentation and research agendas. Astrometry enjoyed the support of government patrons such as the U.S. Naval Observatory, but astrophysicists required funding from private sources. This distinction would have important consequences for the development of American astronomy. While leaders of the "old" astronomy argued that calculating the motions of celestial bodies was a distinguished activity that would yield clear benefits to future generations, practitioners of the "new" astronomy sought to legitimate themselves to potential private patrons by borrowing the tools (and stature) of physicists and by emphasizing the exciting new discoveries that would come from astrophysics. As Lankford argues, these differences were not merely intellectual or professional, but social and cultural as well: Hale and other promoters of the new astronomy were dynamic, almost flamboyant characters who also needed to be effective fundraisers and administrators of their institutions. The rise of astrophysics involved significant shifts in patronage, leadership styles, and the social identity of astronomers, all with important consequences for the future growth of U.S. astronomical institutions.

Perhaps the most distinctive aspect of American astronomy in this period involved a fundamental reorganization of research programs within major observatories. Spurred by the application of photography to astrometry and astrophysics (in 1890 Harvard telescopes produced 9000 plates alone), observatory directors, aware of their need to fund expensive instrumentation and to secure maximum research output at minimal cost, began adapting the factory system to the production of scientific knowledge. At Harvard and eventually other research centers, large numbers of unskilled and semi-skilled workers, especially women, were recruited to reduce and analyze an ever-increasing volume of observational data. Reflecting the separate spheres doctrine that permeated American culture, the roles of men and women astronomers were sharply prescribed: male astronomers observed at the telescope and published results, while most female astronomers measured, classified, and reduced newly collected data. Although other historians of science have begun to illuminate the important and previously invisible contributions of women to American science following the Civil War era, Lankford vividly details how women were excluded from the power structure of American astronomy. It is here that his collective biography is especially effective in countering long-standing assumptions about the makeup and practice of American astronomy. Fully 43 percent of the American astronomical community between 1900 and 1940 were women. And contrary to the perception that most women astronomers taught at women's colleges, Lankford's compilation shows that nearly 80 percent of women involved in astrophysics, and 88 percent of those in astrometry, were involved in research full-time during these years.

What, then, made American astronomy different from (and increasingly more successful than) its European counterparts? One factor was certainly the high esteem accorded to astronomy within American culture: astronomical research became a favorite subject of newspaper reporters by the 1890s, and astronomy's transcendent spiritual values inspired James Lick, Andrew Carnegie, and other wealthy captains of American industry to endow new world-class telescopes. But Lankford convincingly argues that other factors were equally important. Institutional diversity, cognitive pluralism (the inerplay between the old and new astronomy), the perfection of assembly-line techniques for the production of scientific knowledge, and the incorporation of women into this community synergistically created a distinct style of astronomy in America. Equally significant was American non-participation in the European-based *Carte du Ciel* project, a turn-of-the-century international astrometric program involving 24 observatories that sought to produce 88,000 survey plates to exacting standards. In his provocative concluding

chapter, Lankford shows that European and British determination to complete the *Carte du Ciel* froze instrumentation and research design just when astronomical photography was developing exponentially; Oxford University alone invested decades and £20,000 (the equivalent of $15 million in 1990) in this effort. Astronomers at the U.S. Naval Observatory as well as the Dudley, Allegheny, Yale, and University of Virginia observatories did make fundamental contributions to astrometry, but their programs never dominated American astronomy. By eschewing this encumbering international project, U.S. astronomers gained by default.

Besides offering a highly original analysis of the American astronomical community, Lankford addresses contemporary efforts to understand the nature of the scientific enterprise, reminding sociologists of science that an individual's movement through hierarchically ordered reward systems is rarely as linear as often assumed and historians that quantitative approaches deserve renewed consideration. Above all, Lankford's study demonstrates that scientific careers are not determined by merit alone. Scientific communities are embedded in, and shaped by, their surrounding cultural contexts.

Ronald E. Doel
Lamont-Doherty Earth Observatory
Oral History Project,
Columbia University Oral
History Research Office,
New York, NY 10027, USA

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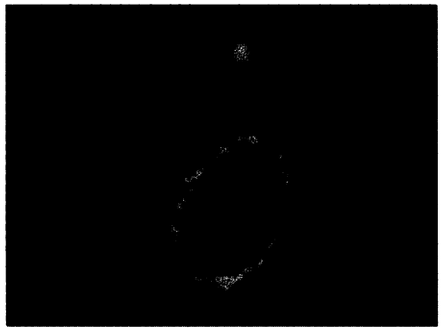
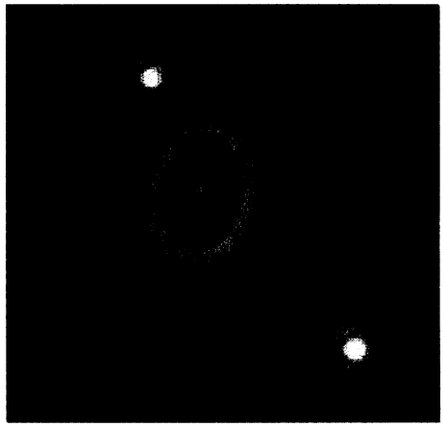
Tales of Neutrinos

Shadow of a Star. The Neutrino Story of Supernova 1987A. ALFRED K. MANN. Freeman, New York, 1997. xiv, 210 pp., illus., + plates. $22.95. ISBN 0-7167-3097-9.

The detection of neutrinos from Supernova 1987A was truly a landmark event in experimental nuclear astrophysics and a high point in the general astronomy of the last half of the 20th century. A great deal has been published about the explosion of the star Sanduleak 202, and scores of journal articles have been written for each of the 20 detected neutrinos. Yet tales of the general scientific activity relating to the observation of these neutrinos are relatively scarce. In this little book, Alfred Mann has given an insider's view of the building and operation of the detector that became the focus of attention in the aftermath of SN 1987A. Being personally involved in the Kamiokande neutrino telescope collaboration, he is intimately familiar with its details, and



"A glowing gaseous ring seen around the tightly packed remnant of SN 1987A in August 1990, which appears as the red blob near the center of the ring. [The blue star is not associated with SN 1987A.] The photograph was taken with the European Space Agency Faint Object Camera and the Hubble Space Telescope." [From *Shadow of a Star*; courtesy NASA]



"Structure of three glowing gas rings seen around the remnant of SN 1987A in February 1994. The yellow orange ring is the plane containing the supernova, with the two larger rings in front and behind that plane. The photograph was taken with the Wide Field Planetary Camera 2 and the Hubble Space Telescope." [From *Shadow of a Star*; courtesy of NASA and Christopher Burrows]

he successfully conveys the excitement of the first discovery of neutrinos from an extrasolar source.

The book is roughly divided into four parts: a general introduction to neutrinos and their significance to astrophysics, the construction and operation of neutrino detectors, the detection of the neutrinos from SN 1987A, and the scientific consequences of this discovery. It is written at a level appropriate for an educated nonscientist, yet contains enough detail that both astronomers and physicists can appreciate both the difficulties and the significance of the neutrino detections. The author's own personal reflections of the drama and the anxiety he felt in the period between the supernova's optical discovery and the subsequent announcement of the neutrino counterpart by the Kamiokande collaboration are particularly eloquent.

The author has a good intuition about what aspects of particle physics, astrophysics, and cosmology are necessary to tell his story. Nevertheless, there are a few lapses—such as his statements that a closed universe is doomed to expand and contract endlessly and that neutrino emission from a newly formed neutron star is necessary to allow it to achieve stability instead of boiling off neutrons and thus "burning up." More curious is the alternative he gives to a neutron star remnant forming in SN 1987A. He correctly points out that a black hole could now exist at SN 1987A's center, since little evidence of a pulsar, a magnetized rotating neutron star, has been found there to date. However, in proposing that a black hole could have formed because Sanduleak 202 overshot the stable neutron star state, he ironically ignores the neutrino evidence that is the kernel of his book. If a black hole is now present, its formation likely followed the demise of a metastable protoneutron star. The 12-second burst of neutrinos that Kamiokande detected would have occurred only if a neutron star had, at least briefly, existed as the remnant of Sanduleak 202's core.

James M. Lattimer
Department of Earth and Space Sciences,
State University of New York,
Stony Brook, NY 11794–2100, USA

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Other Books Received

Adversaries and Authorities. Investigations into Ancient Greek and Chinese Science. G. E. R. Lloyd. Cambridge University Press, New York, 1996. xviii, 250 pp. $54.95, ISBN 0-521-55331-8; paper, $19.95, ISBN 0-521-55695-3. Ideas in Context.

Biology and Evolution of the Gnetales. University of Chicago Press, Chicago, 1996. ii, 125 pp., illus. Paper, individuals, $11; institutions, $33.65. *International Journal of Plant Sciences*, vol. 157, no. 6 (Nov. 1996), Supplement. From a symposium, 1995.

Classical Field Theory. Electromagnetism and Gravitation. Francis E. Low. Wiley, New York, 1997. xii, 427 pp., illus. $59.95. ISBN 0-471-59551-9.

Development and Progress in Sediment Quality Assessment. Rationale, Challenges, Techniques and Strategies. M. Munawar and G. Dave, Eds. SPB Academic, Amsterdam, 1997. xvi, 255 pp., illus. $93.75 or Dfl. 150. ISBN 90-5103-133-5. Ecovision World Monograph. From a symposium, Göteborg, Sweden, Aug. 1994.

Electronic Structure and Properties of Non-Transition Element Compunds. D. V. Korolkov. Nova, Commack, NY, 1996. xii, 431 pp., illus. $97. ISBN 1-56072-410-2.

An Introduction to Parallel Computational Fluid Dynamics. Sauro Succi and Francesco Papetti. Nova, Commack, NY, 1996. xiv, 236 pp., illus. $79. ISBN 1-56072354-8.

The Manson Impact Structure, Iowa. Anatomy of an Impact Crater. Christian Koeberl and Raymond R. Anderson, Eds. Geological Society of America, Boulder, CO, 1996. vi, 468 pp., illus. Paper, $99.50. ISBN 0-8137-2302-7. Special Paper 302.