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Noel Swerdlow, the renowned historian of astronomy, died in Sierra Madre, California, in July 2021. In 1988, Swerdlow was elected to membership in the American Philosophical Society, the oldest learned society in the United States (founded in 1743).

A California native, Swerdlow received a BA from the University of California, Los Angeles, in 1964. Following his undergraduate degree, he went to Yale University to further his studies, with the intention of becoming a musicologist. He completed an MA in 1967 and in 1968 his PhD in medieval history, with Bernard Goldstein as his doctoral adviser. In his acknowledgments to his doctoral thesis, "Ptolemy's Theory of the Distances and Sizes of the Planets: A Study of the Scientific Foundations of Medieval Cosmology," Swerdlow also thanked Derek de Solla Price for suggesting the topic and Asger Aaboe and Gerald Toomer for their advice and help. With this work, never published in its entirety, Swerdlow launched his career as a master of the history of ancient, medieval, and early modern astronomy. He also retained his highly developed musical interests throughout his life, expressed in multiple ways: active listening, playing keyboard, and teaching.

Renowned throughout his career for his rigorous command of the technical aspects of mathematical astronomy, Swerdlow was a scholar of immense erudition. His treatment of Ptolemy's theory of distances and sizes within the medieval tradition began with a consideration of Dante's discussion of astronomy in the *canzone* of the second treatise of the *Convivio*. Dante proposed an analogical scheme relating the planets and upper sphere to the "universe of knowledge," including the liberal arts and advanced studies. Turning his attention to Dante on the diameter of Mercury, Swerdlow suggested that "one generally imagines that men of this time knew nothing of such difficult questions as the sizes of the heavenly bodies, and would be more content to invent strange numerologies or leave the matter an unresolved mystery." With his characteristic pointedness, Swerdlow asserted that "this, however, would be wrong." Explaining that men of Dante's ilk would have used Gerard of Cremona's translation of al-Farghānī, he then took the reader through a reconstruction of the latter's computation for the diameter of Mercury, which Dante's figure of 232 miles echoes. Swerdlow concluded that "there is no doubt that Dante, and any similarly educated men of his time, knew the dimensions of the heavenly bodies with equal precision" (1–5). He then turned to Maimonides's discussion of the acceptance of opinions not subject to scientific demonstration, a philosophical question relevant to treatment of the distances of planets. Swerdlow demonstrated the validity of Maimonides's argument that the centers of revolution of the planets are located above the sphere of the moon. And with this beginning—and the ensuing forays into literature

and philosophy—Swerdlow deftly demonstrated, without fanfare, his own comfort in moving across the universe of knowledge.

Swerdlow was first appointed in the Department of History at the University of Chicago, but in time moved, as tenured professor, to the Department of Astronomy and Astrophysics. While at Chicago, he also taught in the Department of Music. Upon his retirement from Chicago, he became a visiting professor at Caltech. Over the course of his career, he was a visitor at many distinguished institutions, including as a member of the School for Historical Studies of the Institute for Advanced Study in Princeton, New Jersey, in 1973–74 and again in 1985, a fellow of the American Academy in Rome in 1990, and at the Dibner Institute (three times in the 1990s) and All Souls College Oxford in 1995. He served on a number of editorial boards, including those of the Max Planck Institute for the History of Science and the journal *Archive for History of Exact Sciences*.

Swerdlow was a person of tremendous energy, known for throwing himself into things; one notable example with lasting significance is his gift to the University of Chicago, his home institution for many years. The Noel M. Swerdlow Collection, held in the university's library, includes documents collected by him related to the nonreappointment of sociology professor Marlene Dixon and the subsequent student sit-ins in 1969. The materials date from 1967 to 1971, with the bulk of the material dating from 1969.[1]

His landmark publications include "The Derivation and First Draft of Copernicus's Planetary Theory: A Translation of the Commentariolus with Commentary," *Proceedings of the American Philosophical Society* 117, no. 6 (December 31, 1973): 423–512. Here, Swerdlow explained his two very different approaches to studying Copernicus's treatise: as a historian and as an astronomer contemporary with Copernicus, seeking to understand his efforts. This combination would become something of a trademark. Building on meticulous study of manuscript sources and works by others (including Peurbach and Regiomontanus as well as the Alphonsine tables) used by Copernicus, Swerdlow suggested that what led Copernicus to his heliocentric theory was not his objections to the failure of astronomers to adhere to the principle of uniform circular motion. Rather, Swerdlow argued, heliocentrism "really has nothing to do with the principle of uniform circular motion that started Copernicus' investigations." He made the case that in the course of Copernicus's study undertaken to solve the

1 "Guide to the Noel M. Swerdlow Collection 1967–1971," University of Chicago Library, https://www.lib.uchicago.edu/e/scrc/findingaids/view.php?eadid=ICU.SPCL.SWERDLOWNM.

problem of the first anomaly (relating to the variance of planets' motion along the ecliptic), he had carried out an analysis of the second anomaly (relating to planets' apparent retrogradation and angular distance from the sun), and that his work—reconstructed by Swerdlow—led him to heliocentrism. Swerdlow commended Copernicus for "giving (correctly) as the only evidence for his assertion the equivalence of heliocentric to geocentric planetary theory and the additional sense of the heliocentric representation of the second anomaly," by theorizing that the apparent retrograde and direct motion of the planets belongs not to them but to the motion of Earth, and also fixing the order and heliocentric distances of the planets. Swerdlow saw part of his own contribution as eliminating "once and for all the belief that Copernicus carried out any sort of independent derivation of the *Commentariolus* parameters from observation," pointing to his use of published tables (425).

In 1984, Springer published *Mathematical Astronomy in Copernicus's "De Revolutionibus,"* a monumental two-volume study of the astronomer's sources and methods produced by Swerdlow and Otto Neugebauer. Neugebauer, the author of *A History of Ancient Mathematical Astronomy* (1975), gave this account of the genesis of their collaboration in the preface:

> It seemed useful to make available a modern analysis of *De revolutionibus*, and thus in 1975 I prepared for publication "Notes on Copernicus." In the meantime, however, Noel Swerdlow, also starting from Greek astronomy, not only extended his work into a deep analysis of *De revolutionibus*, but also systematically investigated its sources and predecessors (Peurbach, Regiomontanus, etc.). I was aware of these studies through his publications as well as from numerous conversations on the subject at The Institute for Advanced Study and at Brown University. It became clear to me that my own investigations lay at too superficial a level, and I therefore withdrew my manuscript and suggested to Swerdlow that he undertake a thoroughgoing revision and amplification of my "Notes." His acceptance of my proposal initiated the present publication. (vii)

Swerdlow provided a richly detailed mathematical analysis of *De revolutionibus*. In the preface, he noted that as work was continuing on the volume and it was increasing in size, "it appeared that it could well end up being more on the subject of Copernicus' mathematical astronomy than anyone cares to know" (viii). The conferring of the Pfizer Award in 1985, bestowed by the History of Science Society in recognition of an outstanding book dealing with the history of science, demonstrated that Swerdlow was—in this instance—wrong. Their close collaboration

richly informed Swerdlow's biographical memoir of Neugebauer (also a member of the American Philosophical Society).[2]

In *The Babylonian Theory of the Planets* (Princeton University Press, 1998), Swerdlow turned to the origins and development of the Babylonian planetary theory of the late Babylonian mathematical astronomical tables and addressed the question of the derivation of the tables' parameters. There, he proposed that not only were those parameters, viz. synodic arc ($\Delta\lambda$), synodic time ($\Delta\tau$), and their period relations, derivable from the dates of each planet's appearances and disappearances, but the dates had primacy over the locations of planetary phenomena. The thesis was moreover grounded in the historical connections Swerdlow drew between the ominous phenomena of early celestial divination and observation on the one hand and mathematical astronomy on the other. He argued that planetary synodic time and arc were rooted in the observation of appearances and disappearances of planets as omens going back to the seventh century BCE, and that the correspondence of synodic time and arc was realized as a result of the systematic recording of both dates and positions in the Babylonian Diaries archive from the seventh to the first centuries BCE. The focus on the derivation of parameters gave Swerdlow's reconstruction of the trajectory from the earliest interest in ominous phenomena to the establishment of systematic recorded observation of phenomena and ultimately to the mathematical prediction of the synodic dates and positions of the planets a continuity not previously explained in those terms.

In addition to the varied and technical analyses of mathematical astronomy from Babylonian antiquity to the Renaissance, Swerdlow made original contributions to the historiography of the exact sciences, as exemplified in his "Montucla's Legacy: The History of the Exact Sciences," in the *Journal of the History of Ideas* (1993), and "An Essay on Thomas Kuhn's First Scientific Revolution, 'The Copernican Revolution,'" in *Proceedings of the American Philosophical Society* (2004). In "Montucla's Legacy," he was above all interested in conveying what he saw as the importance to and even indispensable place of the history of the exact sciences in the history of science in general, and he lamented the loss of expertise and training in the content of the sciences. "An Essay on Thomas Kuhn's First Scientific Revolution" tells of the early days of history of science as a discipline in the American university system and Kuhn's role in it with the publication of *The Copernican Revolution* (1957). As in the essay on Montucla, Swerdlow, via Kuhn's approach to the meaning of the "Copernican Revolution," addressed

2 N. M. Swerdlow, *Otto E. Neugebauer 1899–1990: A Biographical Memoir* (Washington, DC: National Academies Press for the National Academy of Sciences, 1998).

what to him were the vital questions of what the history of science should be about and what the nature of science itself was.

In 1988, the MacArthur Foundation awarded Swerdlow a fellowship, recognizing his technical analyses of the works of Ptolemy and Copernicus, which led to a greater understanding of the development of astronomy. Swerdlow was elected a corresponding member of the International Academy of the History of Science/Académie Internationale d'Histoire des Sciences in 1991 and a *membre effectif* (full member) in 2005.

Swerdlow's students include Anthony Grafton, Francesca Rochberg, Bruce Stephenson, Andrea Murschel, and Florence Hsia, whose work followed his example of close attention to challenging details. Many others attest to his immense influence on their research and careers. Swerdlow was a generous and patient mentor, supportive of researchers whose own interests veered outside of his own. His advice was invaluable, even though he acknowledged that he did not always follow his own dicta. Regarding the correction of proofs, he warned against the temptation to make nonessential corrections, to avoid the possibility of the introduction of even more errors. On the writing of book reviews, he stressed that one should take care that the published review could be read by the mother of the book's author without embarrassment. Swerdlow always enjoyed a few well-chosen witticisms in an index (as an example, look for "coals" in *Mathematical Astronomy*).

For decades, while publishing many articles and reviews, Swerdlow continued his study of astronomy during the Renaissance, focusing on the work of Kepler, Regiomontanus, Copernicus, Tycho Brahe, and Galileo, sharing what was his last major work with colleagues as it developed. The completed volume has been edited by Jed Buchwald and Anthony Grafton and will be published by Springer in the series Sources and Studies in the History of Mathematics and Physical Sciences. A list of Swerdlow's publications, compiled by Stefano Gattei, will be included in this volume, listing (in addition to his two books previously mentioned) four edited volumes, some sixty-seven scholarly articles in journals or collected volumes, some fifty-three reviews or essay-reviews, four encyclopedia entries, and five occasional notes.

In May 2023, a memorial conference was held at Caltech; the papers presented there in memory of Noel Swerdlow will be published in a volume being edited by Francesca Rochberg, *Studies in Premodern Sciences in Memory of Noel M. Swerdlow: Antiquity to the Renaissance*. The conference focused on the ancient, medieval, and early modern sciences of the heavens, with particular attention to some of the themes of interest to Swerdlow throughout his scholarly career. Thirteen contributions

spanned the entire scope of premodern astronomical sciences, including Babylonian astronomy and astrology, Greek and Greco-Roman astronomy, astrology, cosmology and harmonics, medieval European and Arabic astronomy, and Indian and Chinese traditions.

Swerdlow's work as a historian of astronomy began with his doctoral thesis on Ptolemy's cosmology, a topic that underlay much of his work and influence. In a posthumous publication, Swerdlow shared his final pronouncement on the subject, quoted here as it conveys the spirit of so much of his thinking, which he articulated so forcefully:

> The purpose of this essay is to show that there was one person, perhaps only one, who developed a rigorously scientific cosmology nearly two thousand years ago. . . . By cosmology I mean a description of the universe as a whole and of the arrangement of its principal parts. But by scientific cosmology, I mean something more. For a cosmology to be considered scientific, three criteria must be met: it must be quantitative, physical, and empirical. Quantitative means that it must assign some scale of distances and sizes to its parts. Physical means that it must rest upon some kind of physical or mechanical principles, causes, for the ordering and motion of its parts. Finally, empirical means that it must either be derived from observation or, if derived theoretically, as from physical or mechanical principles, it must be confirmed by observation. I set out these criteria, which may not be exclusive or exhaustive but are surely within reason, in order to define our subject and exclude mythological or theological cosmologies, which generally meet none of the criteria, and philosophical cosmologies, as those of Plato, Aristotle, and Descartes, which may meet one or two in some way, although not rigorously, but surely do not meet all three. I am not concerned with whether the cosmology or the criteria upon which it is based are correct. Compared to our present understanding, the scale may be off by orders of magnitude, the physics may be entirely mistaken, and the observations may be inaccurate. But if all three are present I would call the cosmology scientific, and if not I would not call the cosmology scientific.[3]

Swerdlow's assessment of Ptolemy's scientific cosmology was published by philosophers of science, testimony to the enormous reach of his own rigorous thinking. His work continues to inform our understanding of what is scientific.

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3 "Ptolemy's Scientific Cosmology," in *Theory, Evidence, Data: Themes from George E. Smith*, ed. Marius Stan and Christopher Smeenk, Boston Studies in the Philosophy and History of Science, vol. 343 (Cham, Switzerland: Springer, 2023), 327.

The authors of this eloge both benefited profoundly from Swerdlow's mentorship and friendship.

Elected to the American Philosophical Society in 1988

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