British University Observatories 1772-1932, by Roger Hutchins; pp. xxiii + 533. Aldershot and Burlington: Ashgate, 2008, £65.00, $114.95.

British University Observatories 1772-1932 is a masterly, comprehensive, and well-illustrated institutional history. While historians of astronomy have traditionally focused on state and amateur observatories, Roger Hutchins convincingly argues that university observatories were essential in the development of the physical sciences broadly construed: "Establishing astronomy and especially astrophysics as an academic subject could only occur in universities" (167).

Hutchins is not interested in recent work in cultural studies of science and explicitly rejects "studies of scientific knowledge and studies of scientific practices" (PG). The book nonetheless sheds light on a context that is much broader than the author intends, touching on the history of astronomy in general, of its instruments, educational curricula, personalities, and research programs.

Hutchins argues that to be successful British university observatories had to concentrate on areas that were not covered by the state-focused Greenwich Royal Observatory. The Royal Observatory centered on improving mapping (longitude) for navigational purposes and on the determination of accurate time. Along with the prompt publication of accurate positions of the Sun, Moon, planets, and bright "fundamental" stars, its state-focused research covered global magnetic measurements (important for accurate compass readings) and meteorology (weather). While initially the task of university observatories was to teach students (professors would rarely observe) how to do meridian work, their research program soon expanded to include investigations of Newtonian gravitation, celestial mechanics, and later in the 1820s comets and double-star work, moving the center of astronomy from the solar system to distant stellar systems and extending Newtonian science to those areas. In the 1840s the use of heliometry for the measurement of stellar parallax inaugurated the possibility of measuring the distance of stars beyond the Sun, furthering the research possibilities of extra-meridian work.

In the 1850s the division of labor between the Greenwich Royal Observatory and the university and amateur observatories intensified along with a broadening rift between mathematical astronomers and practical observers. Meridian work was extremely labor-intensive, and influential university astronomers urged their community to divide and conquer. University and private observatories should abstain from the meridian astronomy of focus at the Royal Observatory in order to explore other topics: comets, occultations, sunspots, and nebulae. Scientific publications of the late 1840s (the Monthly Notices) reflected these changes by providing space for new observations, comments, and discoveries—a forum quite distinct from the positional tables published by Greenwich—that favored amateurs as well as universities.

Private and university observatories competed for large telescopes, while state observatories continued to favor meridian transit circles for precise positional measurements. The introduction of two technologies, telegraphy and photography, further changed the face of astronomy as the boundaries between astronomy, physics, and chemistry blurred, reflecting broader changes in the relation between science, industry, academia, and the modern nation-state. Some university observatories started to employ new chronographic methods and became connected to larger telegraphic networks for the distribution of time. Photographic equipment, at first mostly used by amateur astronomers, was adopted by many university observatories, aiding both cataloging work and basic research (such as on measurements of the Moon's libration). By the 1850s, with the rise of astrophysics, university observatories increasingly installed dark rooms and hired personnel with experience in physics and chemistry. Investigations of the chemical constitution of the universe, particularly of the Sun, would occupy their research for decades to come. The importance of university observatories became firmly established in the context of astrophysics: Hutchins argues, "Only the university sector could respond adequately" (168).

Hutchins convincingly shows that even the history of small university observatories is illustrative of larger disciplinary changes where we can see the incipient roots of practices that would only flourish decades later. From the 1830s to the last decade of the century, some of the smaller university observatories provided the setting for such astronomers as John Pringle Nichol to write popular books rather than research papers, inaugurating a tradition that was continued by many others in the twentieth century. Other small university observatories did what they could. In addition to basic meridian training, some observatories focused on local civic work on time and meteorology, on observations of the diameter of the Moon, eclipses of Jupiter's satellites, lunar occultations, sunspots, as well as some spectroscopic work; in the 1860s and 1870s, some focused on lunar theory or on the three body problem.

As the nineteenth century came to an end, most amateur astronomers allied themselves with university observatories because government funding was unwilling to support some of their dearest research agendas. In 1872 Warren de la Rue donated his reflector and the entire contents of his observatory to Oxford, providing an impetus for institutionalizing the role of photography in astronomy. Between 1842 and 1939 six university observatories absorbed instruments from eighteen private observatories. University observatories were an important setting where the traditional, gentlemanly academic culture (valuing pure mathematics) was brought more in line with practical concerns. Historians have recently focused on how these cultural changes appeared along with new laboratories of physics (such as of the Cavendish Laboratory) and new curricula (such as the Natural Science Tripos), but Hutchins reminds us of the centrality of the university observatories in promoting these changes. University observatories were essential in propagating the influential idea that firm scientific knowledge should be based on applied mathematics.

In the 1880s the potential of astrophysics, based mostly on spectroscopy, expanded dramatically with the availability of dry-plate photography. The need for professional, university-trained astronomers thus increased exponentially. Photometry projects were begun at various university observatories (notably at Harvard College but also at Oxford), culminating with the creation of the Carte du Ciel in 1887, a project to photograph all of the sky to obtain the position of fainter stars, more proper motions to measure parallax distances, and accurate magnitudes for the classification of stars. For these research agendas, successful university observatories allied themselves with good-climate high-altitude sites, such as the mountain-top Lick Observatory and its Santiago Station in Chile and Harvard College's Arequipa Station in Peru.

By the turn of the century, astrophysics had advanced to the point that most astronomers were involved in the spectral classification of stars, spectrophotometry, stellar measurements of temperature, color, luminosity, radial velocity, and questions of stellar evolution. These topics brought research far from classic celestial mechanics of the first decades of the century and far from the meridian work practiced at state observatories.

As the race for light grasp and aperture increased, British university observatories were soon dwarfed by the prohibitively expensive Yerkes, Lick, and Mount Wilson Observatories, and had to reorient themselves once more. The University of London's small Mill Hill Observatory began to do valuable work in stellar characteristics of color, magnitude, and parallax. The Oxford Observatory successfully turned to seismology and statistical cosmology, supporting the history of astronomy and continuing the important task of popularizing astronomy through the publication of popular astronomy books. In addition to stellar astronomy, important research questions of the 1920s, concerning solar physics and relativistic cosmology, merged seamlessly with the preexisting research culture of university observatories and kept them alive.

Hutchins's book is an essential contribution to the history of science, both when it delivers what it promises, but especially when it digresses to the history of instrumentation, practices, research agendas, and to geographies beyond Britain. A large section dedicated to the discovery of Neptune, to cite one example, illustrates new relationships between mathematical, amateur, practical, and university astronomy, but it is in fact most interesting when it departs from the institutional focus of the book.

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Queries

1. Second paragraph, highlighted sentence beginning "Hutchins is not interested in recent work in cultural studies of sciene…": Could you

please provide a page number for the quotation "studies of scientific knowledge and studies of scientific practices"?

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