Fred Whipple's Empire: The Smithsonian Astrophysical Observatory, 1955–1973, by David H. DeVorkin. (Washington, D.C., Smithsonian Institution Scholarly Press, 2018). Pp. xvii + 401. ISBN 978-1-944466-18-3 (paperback), 177 × 254 mm, US$79.95 (available as a free download).

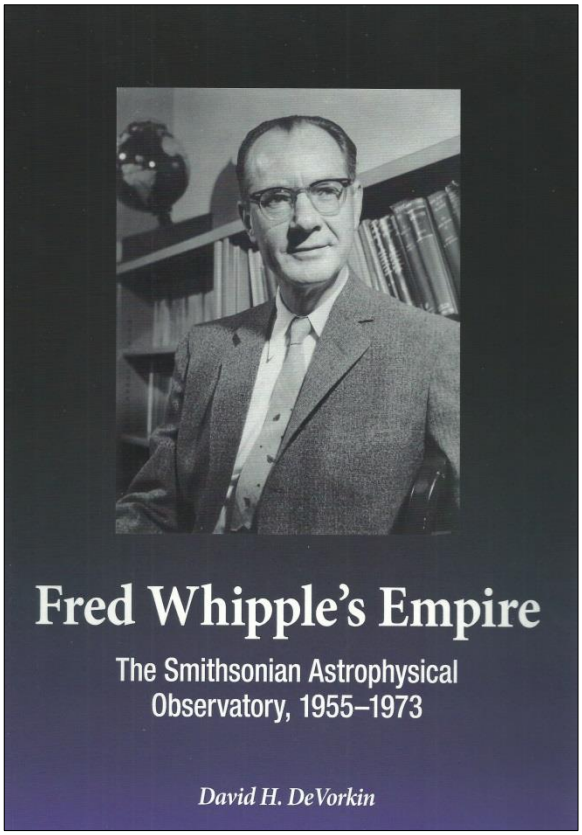
The Harvard-Smithsonian Center for Astrophysics (CfA) is one of the largest and most important institutions of its kind in the world. Yet, its complex origin, arising from the merger of two largely autonomous entities, the former Smithsonian Astrophysical Observatory (SAO) and the Harvard College Observatory (HCO), has never been told before in a work of such depth, clarity and understanding. But ironically, the individual most responsible for creating the CfA, SAO Director Fred Lawrence Whipple (1906–2004), remained opposed to the merger and was forced into retirement on its account.

DeVorkin shows how Whipple's experiences gained during WWII, in operating within a government and military command structure, were readily turned to his advantage with the advent of the Space Age and the enormous opportunities it afforded to increase his infrastructure. When Whipple was first appointed SAO Director in 1955, there were less than twelve personnel; under his leadership, this was expanded to more than 300 by 1961, a majority of whom were paid by the National Science Foundation (NSF) through congressional allocations.

Much of what Whipple accomplished during the early phases of his Directorship revealed a broadly unified, interdisciplinary approach to science, which ranged from his research on meteors and the upper atmosphere (aeronomy) to satellite tracking and geodesy. This integration was sketched out in a 1965 white paper, "The Earth as a Planet," with the Smithsonian Standard Earth being one of its notable outcomes. The progression was continued with the chemical analysis of meteorites acquired by Smithsonian scientists and the preparations made for receipt of the first returned lunar samples. DeVorkin convincingly shows how Whipple's approach repeatedly broke cognitive barriers and opened up non-traditional areas of research within the astronomical community.

DeVorkin has also identified two broad styles in Whipple's ambitious management strategies: (a) in the first case, he addressed intellectual problems through fulfillment of institution-based service functions; and (b) in the second case, he converted short-term infrastructures into permanent fixtures on the landscape (pp. 175–176). Both tasks were first accomplished on a large scale through his establishment on the Harvard campus of the satellite-tracking facilities for the International Geophysical Year (IGY) and beyond.

A similar pattern was followed in the SAO's growing presence on Mount Hopkins in Arizona. This site, whose skies rivaled those of Kitt Peak, was used to develop the Large Optical Reflector (LOR) for conducting early ground-based studies in gamma-ray astronomy. In succession, it became the locus for a state-of-the-art sixty-inch reflector employed for photometric work and, ultimately, home to the daring Multiple Mirror Telescope (MMT)—the first large-scale demonstration of combining smaller reflecting surfaces into a single instrument of considerable light-gathering power. DeVorkin's account offers compelling insights into the post-war development of large optical



reflectors and the complex negotiations (in this case, among four institutions) that were necessary to create them. The MMT brought to reality Arizona astronomer Aden Meinel's vision for such devices and offers a valuable complement to previous histories such as W. Patrick McCray's *Giant Telescopes* (2004). The MMT Observatory was later renamed the Fred Lawrence Whipple Observatory.

Along the way, there are a number of subnarratives (like the LOR) that qualify as interesting but little-told stories of American astronomy after 1950: for example, development of the Baker-Nunn cameras employed worldwide for satellite tracking operations; concurrent efforts to produce the SAO Star Atlas and Catalogue which met both military and scientific

objectives, because the same database that was applicable to space navigation would provide the internal guidance system of ICBMs—a stark reminder of the Cold War implications that lay behind 'pure' science; creation of the Smithsonian's Prairie Network that photographically aided the recovery of meteorites and offered proofs of their asteroidal origins. We are also reminded of the rise of large computing centers in the physical sciences, the likes of which underwent a kind of competition analogous to that of telescope apertures among leading research institutions.

Chapter 10, "Project Celescope," presents the most in-depth account of the difficult trials attending the design, construction and operation of this component of the Orbiting Astronomical Observatory (OAO-2). On more than one occasion, NASA threatened to pull Celescope away from the SAO and to turn the very much-delayed project over to the Goddard Space Flight Center (GSFC). Production of the UV-vidicons not only proved to be almost impossible for existing manufacturers, but their gradual degradation during the mission required the best minds of the SAO's Research and Analysis Division to salvage the Celescope data that was returned.

Along with the optical initiatives begun on Mount Hopkins, a somewhat parallel development was undertaken (again, in incremental stages) within the domain of radio astronomy. Competing with the proposed Very Large Array (VLA) was the Smithsonian's design of a 440-foot diameter fully steerable radio telescope, housed within a 550-foot diameter radome, which was to be operated by the Northeast Radio Observatory Corporation (NEROC). Here, DeVorkin shows the levels of brinksmanship that Whipple and Smithsonian Secretary S. Dillon Ripley displayed that sought to raise the SAO into a key, if not *the* key, institution that would speak for American astronomy (in the period before the decadal surveys grew to unchallenged status). Ripley himself asserted the "… right to secure direct appropriations for national facilities available to one and all." (Ripley, quoted on p. 235). But in the wake of post-Apollo governmental restructuring and fiscal tightening, especially under scrutiny from the Office of Management and Budget (OMB), Whipple's team was forced to withdraw their proposal in deference to pending allocations (stemming from the NSF) for the VLA.

It was from the OMB's examination of SAO that the first 'seeds' were sown regarding the possible merger of the Smithsonian and Harvard centers into a single, unified institution. These stirrings also came about at the time of increasing tensions between Whipple and HCO Director Leo Goldberg, whose personality and management style contrasted significantly with his predecessor, Donald H. Menzel. Goldberg (and the Harvard Observatory Corporation, HOC) voiced many complaints against Whipple, including their total exclusion from engagement with the MMT, along with the striking imbalance in teaching loads maintained by Harvard faculty but not required of SAO employees. Whipple, DeVorkin argues, fundamentally distrusted, and remained alienated from, Harvard's Astronomy Department. He felt that his autonomy as SAO Director would be threatened by over-site stemming from HOC and as a result, avoided direct involvement as much as possible. Several high-level review panels were convened to study the problem and reached near-unanimous agreement that the two institutions should be merged, with the CfA becoming the final result. Whipple, however, was not to be its leader and was thereby convinced to step down.

These difficult and sensitive issues, involving Whipple's personality and strong ambitions, are handled extremely well by DeVorkin, as are virtually all aspects of the book. They repeatedly showcase the work of a master historian operating at the peak of his craft. One of the foremost achievements of this volume is its construction of a coherent series of sub-narratives, each of which details the large number of individual projects and aspirations pursued during this period, but without losing sight of the overall 'big picture'. Indeed, no better approach seems even remotely possible.

This is an important book: it highlights the emergence of SAO as a major player within postwar U.S. astronomy and space science and its attempts "… to reshape not only patronage patterns for astronomy but also the profile of astronomical institutions …" during the Cold War era (on p. 52). These endeavors achieved tremendous success before the Smithsonian's role within the Federal structure itself was seriously challenged—an action that ultimately reined in the seemingly boundless opportunities sought by its leaders.

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Jupiter, by William Sheehan and Thomas Hockey. (London, Reaktion Books, 2018). Pp. 191. ISBN 978-1-78023-908-8 (hardcover), 175 × 225 mm, US$40.00.

Jupiter is one of a series of books on Solar System objects being published by Reaktion Books. Two other titles in the series were