Miss Leavitt's Stars: The Untold Story of the Woman Who Discovered How to Measure the Universe, by George Johnson, Atlas Books, 10 E. 53rd Street, 35th Fl., New York, NY 10022, 2005, ISBN 0-393-05128-5, US$22.95.

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Henrietta Leavitt shows up in innumerable sidebars in modern astronomy textbooks as one of the long-ago women who made significant contributions to astronomy. Along with Annie Jump Cannon and Cecilia Payne-Gaposchkin, Leavitt represents an early generation of early female astronomers who, serving as astronomical "computers" doing meticulous and demanding work around the turn of the 20th Century, received little credit for their contributions until much later. But how much do we know about Leavitt and her life? George Johnson assembles the fragments in his scientific biography, *Miss Leavitt's Stars*.

Very little personal history exists to piece together. The scraps of information that Johnson provides (snippets of letters, an inventory of belongings from Leavitt's will, and other odds and ends) barely sketch the outlines of her character. As the author himself says about his subject, she emerges "not solid enough, perhaps, to star in her own biography but someone with a story to tell." Indeed, the larger story—of the astronomical community figuring out the surprising scale of the Universe, based in large part on Leavitt's work—emerges beautifully from Johnson's narrative. Shapley, Curtis, and Hubble take on distinct personalities (likeable or not), and the scientific debates that raged assume both personal and analytical qualities.

Leavitt's primary contribution to modern astronomy came in the establishment of the period-luminosity relation for variable stars. Through painstaking comparison of numerous photographic plates of the Magellanic Clouds, she identified thousands of

variable stars, commenting early on that, based on sixteen of the number, "It is worthy of notice that the brighter variables have the longer periods." Half a decade later, when she codified the results into a numerical relationship, the results were published under the name of her boss, the director of the Harvard Observatory, Henry Pickering. (However insulting the loss of authorship, other female astronomers fared even worse: Cecilia Payne's 1925 doctoral work, which correctly demonstrated that the Sun consisted primarily of hydrogen with some helium, was so roundly ridiculed by Henry Norris Russell that Payne was pressured to call her own result "spurious.")

After relating the origin of "Henrietta's Law," Johnson follows the falling dominoes as the implications of her observations became apparent. Harlow Shapley picked up on the period-luminosity relationship to argue that the Milky Way was much larger than commonly accepted at the time—and with a diameter of 300,000 light years, three times larger than is currently accepted, actually, because he did not know to account for interstellar reddening. All well and good, but Shapley made a further logical leap, arguing that other "spiral nebulae" must be smaller parts of the much larger structure of the Milky Way. On that count, he could not have been more wrong. In late 1923, a watershed event took place when Edwin Hubble discovered variable stars in the Andromeda Galaxy: capitalizing on Leavitt's period-luminosity relation, he estimated the distance at a million light years. From a human perspective, the Universe became much larger, practically overnight.

Leavitt's work forms one of the strongest rungs of the cosmological distance ladder, the difficult (and sometimes rickety) structure that astronomers must climb to ascertain the scale of the cosmos. Johnson provides a concise history of the era in which human comprehension of the size of the Universe began to encompass the billions of light years of modern cosmology. With new tools for describing the size and scale of the Universe becoming readily available to the planetarium community, a solid footing in the historical origins of our knowledge becomes increasingly necessary. How do we know how distant

the galaxies lie? How have we measured the extent of the Universe? Part of the answer lies in the understanding of Miss Leavitt's stars.