Harold Johnson at Lowell Observatory: The Age of Photoelectric Astronomy Begins

By Wes Lockwood

In his brief seven-year tenure at Lowell Observatory, 1952-1959, Harold Lester Johnson, a brilliant pioneer of astronomical photoelectric photometry, made a lasting impact on Lowell Observatory. Almost single-handedly, with the benign consent of Observatory Trustee Roger Lowell Putnam but only begrudging support from the Observatory's senior staff, he brought Lowell to the frontier of observational stellar astrophysics. His prodigious output, devoted to precise measurements of stars in open and globular clusters and to the construction of the innovative instruments needed for his work, revived the almost defunct *Lowell Observatory Bulletin* series and filled many pages of America's pre-eminent astronomical publication, *The Astrophysical Journal*.

To begin this story, let's back up 60 years to a time when photography was the reigning tool of astronomy and Lowell Observatory was just beginning to awaken from the long slumber induced by the Great Depression and World War II. Freed from wartime military research duties, American astronomers resumed their customary activities with new electronic tools. The most important of these was the photomultiplier tube, a special type of light-sensitive vacuum tube that releases a measurable stream of electrons when exposed to faint starlight. For the first time ever, astronomers could meter the brightness of stellar objects with a level of precision unachievable with old-fashioned photographic plates.

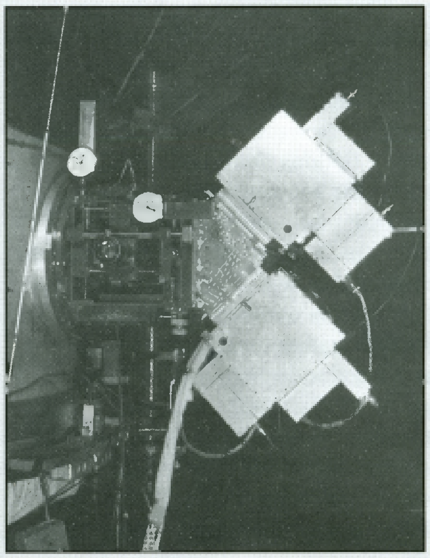
Lowell was an early beneficiary of this new technology in 1948 when the Observatory hired a fresh Berkeley Ph.D., Harold Johnson, and agreed to begin accepting federal research funds. Johnson arrived with impeccable credentials including a glowing letter of recommendation from Gerald Kron of Lick Observatory (later director of the U.S. Naval Observatory Flagstaff Station), who deemed him "...one of the two or three top ranking students of Astronomy in the country at the present time..." His first months were inauspicious: Henry Giclas recalls Stanley Sykes, the Observatory's elderly instrument maker, saying to Johnson, who was giving him a hard time about some shop work, "Young man, I was at least twice as old as you are before I thought I knew everything."

Johnson was assigned to Lowell's Project on Planetary Atmospheres, initially funded by the U.S. Weather Bureau, but he soon decamped for Madison, Wisconsin, a move he almost immediately regretted. In several letters to Director V. M. Slipher and the Trustee, Johnson apologized for his hasty departure from Lowell. In the meantime he moved to the University of Chicago and Yerkes Observatory where he continued to perfect his expertise with photoelectric instrumentation and technique.

In 1952, the death of Lowell astronomer Carl Lampland created a vacancy, allowing Johnson to return to the Observatory. He found conditions more to his liking, although he continued to chafe under the Observatory's aging leadership and archaic facilities, venting his irritation in frank, often handwritten, letters to the Trustee. Despite his frustrations, Johnson continued his photometric research under Flagstaff's clear dark skies, in his view the best in North America.

As Kron had forecast earlier, Johnson had by then become prominent in this new field, working with W. W. Morgan to formalize a new photometric system, which used colored glass filters for photoelectric stellar brightness and color measurements. The "*UBV*" photometric system, which is still in use today, measures ultraviolet, blue, and visual parts of starlight. Their efforts resulted in a classification scheme for stars based on their colors, and the creation of color-magnitude diagrams for nearby open star clusters. This in turn led to the determination of cluster distances, and to the ages and evolutionary states of the stars within them.

A National Science Foundation Conference on Photoelectric Photometry was held in Flagstaff in 1953 at the invitation of the Observatory's new director, Albert Wilson. This meeting put Lowell's young superstar dead center on the map of groundbreaking photometric work. Formal recognition of his accomplishments came in 1956 when he won the prestigious Helen B. Warner prize, awarded annually by the American Astronomical Society for outstanding work by an astronomer under the age of 35.



(Figure 1)
Johnson's photometer in 1958 shown mounted on Lowell's 42-inch Clark reflector. The light beam enters from the left and is then split into two parts by a silvered prism, one to measure the sky and one to measure the star.
The photomultiplier tubes are mounted inside the two rectangular boxes on the right. The two round dials are connected to a movable eyepiece that allows the observer to guide the telescope on a visible star while measuring the target star, which might be too faint to see by eye.

The principal recommendation of this conference had been to make plans for a national photometric telescope somewhere in the Southwest. Lowell Observatory lobbied hard for a location at Slate Mountain northwest of Flagstaff. Ultimately, despite skimpy seeing data from several locations, Tucson won the somewhat rigged competition with a site on Kitt Peak, 56 miles southwest of Tucson. (Ironically, Slate Mountain remains quite dark today while Kitt Peak is seriously threatened with growing light pollution.)

In 1953, a new 21-inch telescope devoted to photoelectric photometry was assembled on Mars Hill, making its debut in the press with the headline "Lowell's New Telescope to Train on Sun's Light." The headline referred to Lowell's program, funded by the Air Force and directed by Johnson, to study solar variability in the reflected light from the planets Uranus and Neptune. The telescope itself was the usual homegrown Lowell product, assembled from scrounged parts, including as its tube a length of 24-inch diameter steel gas pipe from the El Paso Natural Gas Company. This workhorse remains in use today, devoted solely to photoelectric photometry (see *The Lowell Observer*, Fall 2004).

One goal of early photoelectric astronomy was to measure the faint stars in open and globular clusters, barely reachable by photographic techniques. Johnson recognized early on that the limiting factor in such measurements, where the star might only be a few percent brighter than the patch of sky around it, was the minute-to-minute fluctuations of the natural sky brightness caused by airglow in the Earth's atmosphere. His solution was elegant and simple—he built a dual-beam photometer that measured a star and the sky nearby simultaneously (Figure 1).

The performance of this instrument was remarkable, besting the sensitivity of a photometer mounted at the prime focus of Mount Palomar's 200-inch telescope by a huge factor. As acting Lowell director E. C. Slipher said in an article published in the *Arizona Republic* "…this is the first of its kind developed anywhere. Dr. Johnson has succeeded in measuring stars of photographic magnitude 22.6, and those are mighty faint stars."

By the mid-1950s Lowell Observatory was actively pursuing a partnership that would bring a large telescope to a dark sky site near Flagstaff. One such proposal involved moving Harvard College Observatory's 61-inch reflector, built in the 1930s. Johnson, in correspondence with the Trustee in December 1956, strongly opposed this proposition, knowing the telescope was in poor repair. He wrote that "...old telescopes should stay where they are," and that such a move would be "...the first step in making the Lowell Observatory the Flagstaff Station of the Harvard College Observatory."

Soon, another opportunity arose concerning the Perkins Observatory 69-inch telescope and its possible relocation to Flagstaff from Ohio. By late 1957 Johnson had identified four possible sites for the telescope: Woody Mountain, Anderson Mesa, Padre Butte east of Flagstaff, and A-1 Mountain, just a mile or so west of Mars Hill. He wrote to John S. Hall, Lowell's future director, saying, "We here have felt that the Anderson Mesa site (which is on the edge of Anderson Mesa overlooking Lake Mary about one mile this way from the upper dam) is the best bet." The telescope was finally moved to this location in 1961.

Johnson's final project at Lowell, completed only after he had departed for McDonald Observatory in 1959, was a joint effort with Arthur Hoag of the U.S. Naval Observatory Flagstaff Station to determine the magnitudes and colors of thousands of stars in 70 open star clusters. Hoag, using the Navy's 40-inch Ritchey-Chrétien reflector, would obtain the photographic images, each containing dozens to hundreds of stars. Johnson, working at Lowell with the 21- and 42-inch reflectors, would measure a couple dozen photometric calibration stars in each cluster.

(Fig. 2) Harold Johnson shown working on a photometer of his own design at the Catalina Observatory of the Lunar and Planetary Laboratory a few years after he left the Lowell Observatory. *(Photo by Jan Miller, Courtesy Sky & Telescope photo archives)*

The analysis of so many photoelectric measurements was a daunting task in the days before computers were common. Johnson solved the problem locally by brute force and genius, designing and building a special purpose analog computer. The operator read the recorded strip chart data directly, setting dials to specify certain constants. A few seconds later whirring motors and mechanical counters coughed up the answers. Remains of this computer, two large black cabinets each about two feet square, are still on Mars Hill, awaiting their turn perhaps as an exhibit to display the do-it-yourself ingenuity of a bygone era.

John Hall arrived to take up the directorship of Lowell Observatory in 1958. A year later Johnson moved on, joining Gerard Kuiper at the University of Texas and accepting a position as Professor of Astronomy. In 1962, again following Kuiper, he moved to the newly formed Lunar and Planetary Laboratory at the University of Arizona (Figure 2). Johnson died in 1980 in Mexico City, at age 59.

Once, every Lowell telescope had a photometer. Now, two survive here while at most observatories photoelectric work is history. But the photomultiplier tube still measures starlight far more precisely than the more commonly used charge coupled devices (CCDs). That's why Dave Schleicher and I continue to use them for our photometric work on the 21-inch telescope on Mars Hill and at the larger telescopes on Anderson Mesa.

This profile of Harold Johnson has been fleshed out from the official record using dozens of letters in the Lowell archives between Johnson, V. M. Slipher, Roger Lowell Putnam, Henry Giclas, and John Hall. In them, Johnson gave free vent to his concerns and frustration on behalf of the advancement of the Lowell Observatory. Harold Johnson's son, August Johnson, added a number of details during recent visits to Flagstaff.