

ADVANCING ASTRONOMY ON THE AMERICAN FRONTIER: THE CAREER OF FRANK HERBERT LOUD

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Abstract: Frank Herbert Loud came to Colorado Springs in 1877 to teach mathematics and became interested in astronomy after witnessing the solar eclipse of 1878. His nearly 50-year astronomical career included overseeing the building of two observatories, founding the Western Association for Stellar Photography, supporting expeditions for two solar eclipses, supplying astronomers with meteorological data for the Rocky Mountains, educating students, publishing astronomical articles and giving public lectures, and aiding and influencing two Directors of Harvard College Observatory. Despite this, Loud and the two observatories he directed have been mostly forgotten, although they were well known by contemporary astronomers. Loud and his work deserve to be remembered given the relative scarcity of astronomers and observatories in the American West (i.e. west of the Mississippi River) in the late nineteenth and early twentieth centuries.

Key words: Frank Loud, Edward Pickering, Donald Menzel, Western Association for Stellar Photography, Colorado College, Wolcott Observatory, Nob Hill Observatory, 1878 Eclipse, 1918 Eclipse

1 INTRODUCTION: FROM BOSTON TO COLORADO SPRINGS

Frank Herbert Loud (Figure 1) was born 26 January 1852 in Weymouth, Massachusetts. He graduated from Amherst College in 1873 and received an MA degree from Amherst in 1878. He later received another MA from Harvard (1899), and a PhD from Haverford College (1900).¹ Although his career was spent in Colorado (from 1877 until just before his death in 1927), Loud made frequent visits to Boston and other eastern cities. Keeping close ties to the east coast was perhaps the only way to undertake a program of sophisticated astronomical observation and instruction in the American west.

Loud taught mathematics at Amherst from 1873 to 1876 before accepting a position at Colorado College. Arriving in 1877 in Colorado Springs, Colorado, Loud was the first Head of the College's Mathematics Department. From its inception Colorado College (founded 1874) was envisioned almost as an outpost of Boston and its colleges, and soon provided western students to eastern schools. Although the founder of Colorado Springs, General William Jackson Palmer (from Pennsylvania), donated the land for the College, the rest of the early development of the school was guided by New Englanders. Colorado College was non-denominational (though 'under Christian auspices' per its charter); it was also coeducational. One of its very first Presidents was a New Hampshire Congregationalist, Edward P. Tenney, who revered Harvard and was friends with the wealthy Bostonian Henry Cutler; Cutler provided the funding for Colorado College's first building, Cutler Hall. Tenney and Cutler then borrowed \$100,000 to purchase land for the school, which property they called 'New Massachusetts'. In 1888 William F. Slocum, a Congregational minister from Massachusetts, succeeded Tenney as President and brought further financial and educational support from Boston. Even the school's buildings were designed by Boston architects (Sprague, 1987: 260–63). The connection to Boston helps explain how a young Frank Loud was lured from established Amherst to fledgling Colorado College. It further explains the connections between Loud and astronomers like Edward C. Pickering of Harvard

College Observatory and David Peck Todd (an Amherst graduate) of the United States Naval Observatory.

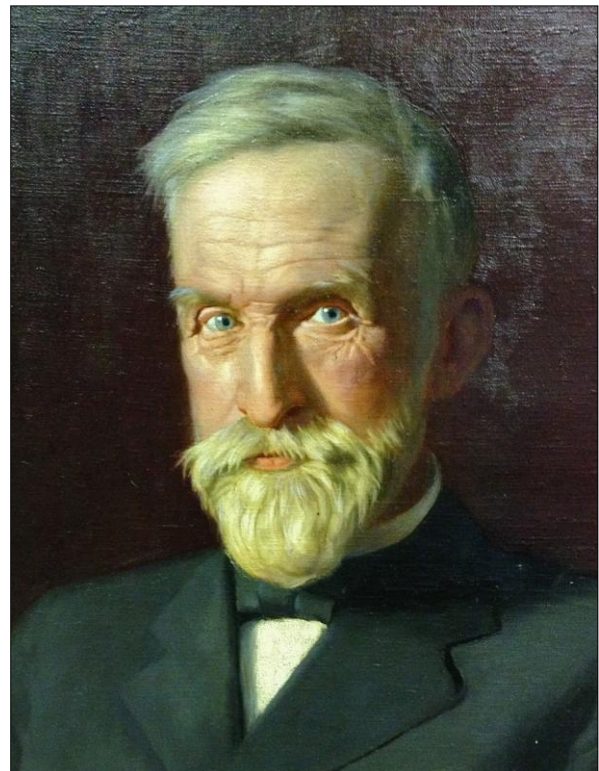


Figure 1: Frank Loud ca. 1923, oil painting by J.I. McClymont (courtesy: Colorado Springs Pioneers Museum, Starsmore Center for Local History).

Loud founded Colorado College's meteorology program. At the time the 14,115-foot (4302-m) summit of nearby Pikes Peak had the world's highest meteorological station. This resource, combined with his own daily readings, enabled him to provide meteorological data to astronomers interested in Rocky Mountain observing conditions. Loud published annual meteorological data and was on one occasion employed by the U.S. Weather Bureau. Loud's meteorology course ('Astronomy D') at Colorado College eventually attracted from 15 to 25 students and was

known for its "... value for training in habits of observation." (*Proceedings of the Third Convention of Weather Bureau Officials*, 1904: 177). In addition to teaching mathematics and meteorology Loud was Colorado College's first Librarian from 1878 to 1886; Melvil Dewey, creator of the Dewey decimal classification system, was Loud's Amherst classmate.

Loud also started the Colorado College Scientific Society in 1890 with his better-known Mathematics Department colleague, Florian Cajori. The Society published its own journal, *Colorado College Studies*, which conveyed Loud's astronomical observations and annual meteorological data for Colorado Springs. He aggressively promoted this journal by sending subscriptions to observatories as far afield as Mexico City, Havana, Toulouse, Karlsruhe, Milan, and Melbourne—helping ensure that Colorado College received reciprocal exchanges.

Thus Loud's astronomical work was enhanced by his expertise in mathematics and meteorology, and these pursuits were themselves done to advance Colorado College's instruction in the sciences. Hence Loud's various titles over the course of his tenure ranging from Professor of 'Mathematics and Metaphysics' to 'Mental Philosophy; Mathematics; and Meteorology'. By 1889 he was 'Professor of Mathematics, Astronomy and Meteorology'. Let us start at the beginning, however, with the event that sparked Loud's interest in astronomy: the total solar eclipse that passed over the Rocky Mountains on 29 July 1878, the year after Loud came to Colorado.

2 THE ECLIPSE OF 1878

The total solar eclipse of 1878, which was viewed from Wyoming through Colorado and down into Texas, was perhaps the most impressive scientific event the western states and territories had yet experienced. Renowned astronomers like Norman Lockyer, Henry Draper, Charles Young, and Samuel Langley (to name just a few) spread out along the front range of the Rocky Mountains, from Wyoming down through Colorado (including Colorado Springs). David Peck Todd observed from Texas. The arrival of Langley's party and their equipment in Colorado Springs impressed Loud; all the activity and preparation was tremendously exciting—astronomers arriving with crates full of instruments, daily time checks at the local signal office, and telegrams back and forth from eastern observatories to the top of Pikes Peak where Langley would observe the event.

To ensure his own participation Loud drew upon his Boston connections in advance. In February 1878 Loud wrote to Todd that he was now at Colorado College, "... an institution which while it has in reality an excellent prospect for the future is but just established and has no completed buildings no instruments and very little money." He emphasized, however, that the school was "... right in the track of the coming total eclipse of July 29th ..." and, in short, could Todd please advise how "... in such paucity of resources ..." he could use the eclipse "... to the very best advantage for the benefit of the college and everybody else concerned." He concluded by reminding Todd of their mutual connection to "... old Amherst ... I remember the direction of your tastes in science." (Loud, 1878a).

Todd was eager to help and provided a small loaner telescope with which Loud practiced for the eclipse by first observing a transit of Mercury on 5-6 May 1878. In return Loud supplied Todd with local meteorological data, and later his report on the transit—Loud's first official contribution to astronomical science. "But for your encouragement," he wrote Todd, "we should not have attempted the observation, which has certainly been excellent practice for us, whether useful in any other way or not." (Loud, 1878b).

As the eclipse of 29 July approached Loud endeavored to make himself a resource both for residents of Colorado Springs and visiting astronomers. Loud gave public lectures, wrote articles in the local newspaper (the Colorado Springs *Weekly Gazette*) and provided meteorological data to help predict the chances for favorable weather. He attended to the professional astronomers and their instruments as they arrived in the weeks prior to the event, and was made "... voluntary observer at Colorado Springs ..." to the U.S. Signal Service (Abbe, 1881: 29). Loud admitted he was simply an amateur and that his organization of a 'corps' of eclipse observers from Colorado College provided but "... a specimen of the degree of success ..." that was achieved by the "... grand results from the observations of actual astronomers." (Loud, 1878c). Despite his modesty his report on the eclipse was called the "... best and most complete report ... received in Washington." (Cottam, et al., 2011: 370).

As a cultural and scientific event the eclipse was a huge success (Ruskin, 2008). Loud became hooked on astronomy, and Colorado College even received its first permanent telescope, a four-foot focal length instrument. The telescope was given to the College after a group of local donors raised the funds to purchase it from the astronomers who had brought it to Colorado from Brooklyn (Ruskin, 2008: 33). Loud would later boast "I am the first to handle a telescope belonging to Colorado College ..."; presumably it was this instrument (Loud, 1901).

Within a few years Loud was actively making astronomical observations and teaching Colorado College students to do the same. During the transit of Venus of 1882 he observed as much of the four contacts of the transit as the cloudy weather allowed and reported that his students, "... with the aid of a small telescope ... and with smoked glass ..." made competent observations as well (Loud, 1882). In just a few years Loud had transformed himself into one of the most active astronomers in the Rocky Mountains region.

3 LOUD AND THE BOYDEN-FUND COLORADO EXPEDITION

In 1887 Harvard received a large bequest from the wealthy amateur astronomer Uriah Boyden, who instructed that some of the funds be used to conduct high-altitude astronomical research. The Boyden Fund gave Harvard College Observatory's Director, Edward C. Pickering, the necessary means to build a high-altitude observatory to support his photometric and other astronomical research programs. Colorado was one of the first places Pickering sent an expedition, in part because of the favorable results of the 1878 eclipse. According to Becker (2009: 490), Loud's meteorological expertise made him an ideal local

resource for Pickering. *Scientific American* publicized the Boyden-Fund Colorado expedition and Loud's role in it:

The headquarters of the expedition will be ... Colorado Springs, a town of importance ... a social center of considerable dignity. Among the institutions is the Colorado College. Professor Loud, whose department includes instruction in meteorology, has volunteered his assistance and advice in the pending enterprise, which will be of special value from his personal familiarity and exact knowledge of the region ... (Harvard's New Observatory, 1887: 9715).

Pickering and Loud shared an affinity for the mountains. Loud was an avid hiker and built cabins above Colorado Springs on the slopes of Pikes Peak (Brunk, 1989: 18), and Pickering was a founder of the Appalachian Mountain Club. In 1883 Pickering published his influential article "Mountain Observatories" in the Club's journal *Appalachia*, in which he noted:

Much attention has recently been directed to the question whether the conditions are more favorable to astronomical observations on the summit of a lofty mountain than at the level of the sea ... The question should, however, be decided ... valuable results would be obtained, even if the observations in the observatories on the mountain summit were not much better than those at a less altitude. (Pickering, 1884: 99, 106).

Loud had lobbied for Colorado as a location for high-altitude astronomy since the 1878 eclipse and knew that Pickering was nothing if not an advocate for the advancement of astronomy (Plotkin, 1978). He hoped that Pickering would become involved in Colorado, which could lead to a possible role for himself and Colorado College in Harvard's astronomical research. But from Pickering's perspective Loud's meteorological expertise was his real contribution to the project.

Becker (2009) has described Loud's work for the Boyden Fund expedition during 1887–1888, and interested readers are well advised to review her fine article. In short, Pickering relied on Loud to organize a series of volunteer meteorological stations at different points around Colorado. Loud was also asked to coordinate with the U.S. Signal Service for meteorological readings from the Pikes Peak station, which at Pickering's request remained open a year longer than originally planned (the station was slated to close). Loud had been so eager to prove himself useful to the expedition that he spent much of his free time traveling to the various sites around Colorado, keen to keep Pickering supplied with data. These efforts clearly stressed Loud's regular duties as a Professor and he confessed to Pickering (who reimbursed Loud's monthly Boyden-Fund expenses), "I am so behind my ordinary work that I have left several duties unperformed among them my monthly statement of expense for two months" (Loud, 1887). Pickering was appreciative of Loud's hard work and acknowledged him in the Annual Report of the Harvard College Observatory:

Important aid was rendered in the study of the climate of Colorado by Professor F.H. Loud, who was enabled to aid officially in this work by the courtesy of the trustees of Colorado College. With his assistance stations have been established upon Mt. Lincoln [14,286ft / 4,354m], Mt. Bross [14,172ft / 4,319m], and at various lower points. (Pickering, 1887: 9).

After reviewing over a year's worth of meteorological data, however, Pickering decided that Colorado's

climate was not suitable for the Boyden-Fund project and ended the expedition, to Loud's great disappointment. Becker describes how desperate Loud was to involve Harvard in a project that might benefit Colorado College, "... in that distant day when there can be a science-making astronomical department here." (Loud to Pickering, as quoted in Becker 2009: 491), and she also notes that when Pickering pulled out of Colorado he did so with little evident concern for Loud's own ambitions. Her conclusion ("Pickering removed funding and instruments from Colorado, closing the stations one by one") can, however, leave one with the impression that after 1888 Pickering and Loud had no further collaboration (Becker, 2009: 493). In fact, their collaboration would continue, as will be described in Section 6 below.

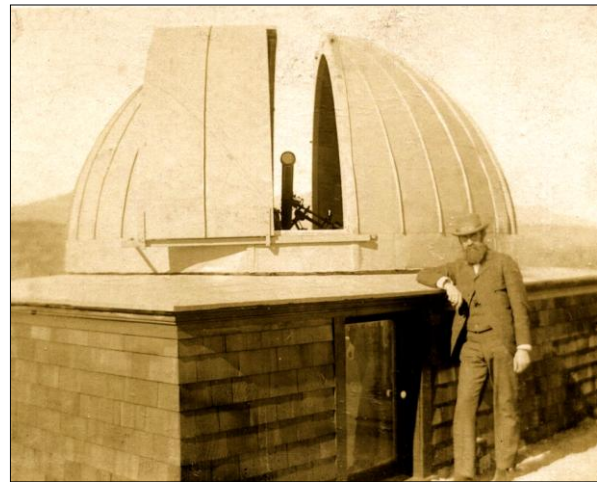


Figure 2: Frank Loud by the Wolcott Observatory dome (courtesy: Colorado College, Tutt Library, Special Collections).

4 THE WOLCOTT OBSERVATORY AND ASTRONOMY INSTRUCTION AT COLORADO COLLEGE

Since the 1880s Loud had desired a proper observatory building for Colorado College. In 1892 a four-inch equatorial telescope (by William Kahler of Washington D.C.) was donated to Colorado College by Henry R. Wolcott, a prominent Colorado citizen. Perhaps realizing that his legacy should be grander than just a telescope, in 1893 Wolcott donated \$3,000 to build an observatory to house the instrument (Stone, 1918: 626). The Wolcott Observatory (Figures 2 and 3) was completed in June 1894, with a lecture room capable of seating 50 students and a large space on the roof for open-air lectures and observing events.

Coincidentally 1894 was an exciting year for astronomy in Colorado and the American west: Colorado College got its new observatory, and the University of Denver's massive Chamberlin Observatory, which housed a much larger 20-inch Clark-Saegmuller refractor, was also completed—at a cost of around \$50,000 (Stencel, et al., 2006: 6). And that same year Percival Lowell (another astronomically-inclined Bostonian) established his observatory at Flagstaff, Arizona.

In 1901 Loud described the Colorado College Observatory and his students' coursework as follows:

It contains, besides a lecture-room and a study, a dome-room in which a telescope of 4 inches aperture and



Figure 3: The Wolcott Observatory looking west with the front range of the Rocky Mountains behind (courtesy: Colorado College, Tutt Library, Special Collections).

about 56 inches focal length is equatorially mounted, and a room on the lower floor in which are a sidereal clock and a transit instrument 21 inches long and of a little less than 2 inches aperture ... The work of the students in Astronomy is elective. Last year a class of 25 studied the descriptive branch for half a year supplementing a text book by essays written from study in the library. The next half-year, when instrumental work was the chief feature, the number was reduced to eight. Another class of one, Mr. L.R. Ingersoll,² has worked through the year on some problems of mathematical astronomy, succeeding a year's study of the calendars (Loud, 1901).

In 1906 the work of the Wolcott Observatory was further enhanced with a monetary gift from General Palmer, who had built the Denver and Rio Grande railroad and was a patron of local science. Palmer's gift enabled the purchase of a 'Palmer Library of Astronomy and Meteorology'. Books were purchased from "... the library of a European astronomer ..." and included a 1607 edition of Oronce Fine's *La Theorie des Cieux et Sept Planetes*, Carl Friedrich Gauss' *Theoria Motus Corporum Coelestium*, and works by Christian Doppler, William Herschel, Percival Lowell, and Ernest Rutherford (Loud, 1907a: 382). At a larger institution such acquisitions might not have seemed so impressive but they were a real treasure for Colorado College. And Loud (1907a: 381) was thrilled to play librarian:

The recent gift, enlarging the scope and utility of the collection previously at hand, has made apparent the necessity of a catalogue of the whole, which thus becomes the nucleus of an observatory library ...



Figure 4: Frank Loud's house ca. 1901, complete with telescope and meteorological instruments (courtesy: Colorado College, Tutt Library, Special Collections).

5 SABBATICAL LEAVE AND RETIREMENT FROM COLORADO COLLEGE

Loud was absent from Colorado from 1899 to 1900 on sabbatical leave. During that time, as noted in Section 1, he completed an M.A. at Harvard (1899) and a Ph.D. at Haverford (1900). While at Haverford he traveled to Virginia to observe the total solar eclipse of 28 May 1900 (Loud, 1906). After this sabbatical he continued to teach at Colorado College until his official retirement in 1907, during which time he was "... classed among the best Meteorologists and Astronomers in the west." (Kerr, n.d.). In the decades after Loud's retirement from Colorado College the Wolcott Observatory languished, perhaps in part due to competition from the Chamberlin Observatory telescope a mere 70 miles away in Denver. Within a few decades the Wolcott Observatory was repurposed, indicating just how integral Loud had been for astronomy at Colorado College. By 1934 the observatory fell to a variety of non-astronomical uses until it was finally razed in 1969.

During Loud's tenure his astronomical publications, though not numerous, demonstrated his competence. Among his most significant published works were observations of the 1878 and 1900 solar eclipses, observations of the transits of Mercury in 1878 and 1881 and the transit of Venus in 1882. He also published an interesting article comparing the observations of the sunspot of 1905 made at Uccle in Belgium to those made at Colorado College (Loud, 1905a). Many of his academic papers were distributed via his semi-annual bulletin of the Wolcott Observatory in *Colorado College Studies*, and he also wrote a wide variety of astronomical articles for general readers. His last astronomical publication as a Colorado College professor was probably "A suggestion toward the explanation of short-period variability", which was published in the *Astrophysical Journal* (Loud, 1907b).

Upon retirement from Colorado College Loud received an annual allowance from the Carnegie Foundation for the Advancement of Teaching, the first for a Colorado College faculty member:

[Loud] is well known throughout this country as one of its leading astronomers, and his many friends rejoice in this merited recognition of his untiring services to the cause of science. ("Among the Faculty", 1907: 75).

Loud was well-equipped to enter a productive retirement; his own house, built in 1878 just north of Colorado College, was itself a sort of private observatory, complete with a telescope and meteorological instruments (see Figure 4). Retirement also gave him more time for another project affiliated with Pickering and Harvard, the Western Association for Stellar Photography.

6 THE WESTERN ASSOCIATION FOR STELLAR PHOTOGRAPHY AND THE NOB HILL OBSERVATORY

6.1 Background

On 24 October 1904 Loud incorporated the Western Association for Stellar Photography. This Association was the administrative organization for a new observatory for stellar photography in Colorado Springs. This observatory had the support of Pickering but operated

under Loud's local management. The officers elected at that first meeting were Pickering, Loud, Herbert Howe (Director of the Chamberlin Observatory in Denver), Otis Johnson (a Colorado Springs attorney), and Edward Giddings (another Colorado Springs resident, occupation unknown). Pickering's signature was the only one of the five not present on the meeting minutes, but this is not surprising as his role in the Association was primarily that of a figurehead. This probably suited Pickering just fine; at the time he was busy advancing astronomy across the country and around the world (Plotkin, 1978). Despite his absence Pickering was elected President by the other officers. Howe was elected Vice President and Loud was elected Secretary and Treasurer (Association Documents: 10).

The groundwork for the Association had been laid by Pickering and Loud a few years earlier, probably around 1899. The Boyden Fund project had not resulted in a joint Harvard-Colorado College partnership, but Loud still believed Colorado afforded important opportunities for high-altitude astronomy, including stellar photography. Pickering agreed, and it seems certain that he and Loud discussed this when Loud was at Harvard in 1899. Allowing Loud to run a small photographic observatory in Colorado was much less of a commitment than building and maintaining a Harvard-managed facility there. Pickering knew Loud was competent enough to manage such a project, and within a few years he sent Loud the requisite equipment. Colorado College relieved Loud from teaching duties for a year in 1904 so that he could "... be made the Director of the Astronomical and Meteorological Bureau in cooperation with Harvard University." (Hershey, 1952: 158).

In 1904 Pickering again mentioned Loud in his annual report, noting that as a result of his work with the Boyden Fund expedition Harvard was

... still under great obligations to ... Loud of Colorado College for aid in many ways It has ever since seemed desirable that we might avail ourselves of his friendly aid in securing such observations as could be made to great advantage in the remarkably clear air of Colorado Springs. A plan is accordingly now being carried out which promises to give results of great value. By the aid of the Advancement of Astronomical Science Fund of 1902, a Cooke Anastigmat Lens has been sent to Professor Loud, and is now mounted and ready for work near Colorado Springs [see Figure 5]. It is expected that photographs showing the structure of the Milky Way, greatly superior to any that can be made here, will thus be obtained. (Pickering, 1904: 12).

Pickering further articulated this goal in a letter he wrote to Loud, which Loud then published as part of an article in the Colorado Springs *Gazette* entitled "Special Advantageous Conditions for Stellar Photography in Colorado". Loud wrote that:

... the superiority of Colorado's qualifications ... can not be better summarized than in a letter written by Professor E. C. Pickering ... outlining his plan which has since been carried into effect in the work in stellar photography lately begun at Nob Hill, as follows (Loud, 1905b).

Loud then quoted Pickering at length:

... in Colorado ... it is believed that results could be obtained there, which would be wholly beyond the

reach of ordinary astronomical observations. In planning astronomical work to be done in Colorado, it seems of especial importance to avail oneself of these advantages rather than to duplicate work already in progress at other observatories. A station possessing similar advantages has already been established by the Harvard college observatory at Arequipa, Peru. Much work has been done there on the southern stars, which, when extended to the northern stars at existing observatories, does not give results of equal value, on account of the haziness of the air ... It seems therefore desirable that the instrument in use at Arequipa, Peru, should be duplicated at Colorado Springs, and similar work undertaken with it, each instrument photographing a portion of the sky, which would be below the horizon of the other. (Pickering, as quoted in Loud, 1905b).

6.2 The Nob Hill Observatory

Pickering provided the Cooke lens, but Loud would have to provide the observatory. Initially the observatory was merely a 'station' but Loud had bigger plans. He had set up the camera as early as 1903 at which time it was reported he would "... spend his summer putting the new apparatus for astronomical photography into condition for the best possible service." (*Colorado School Journal*, 1903: 231). The location he chose was a rise east of Colorado Springs called Nob Hill.

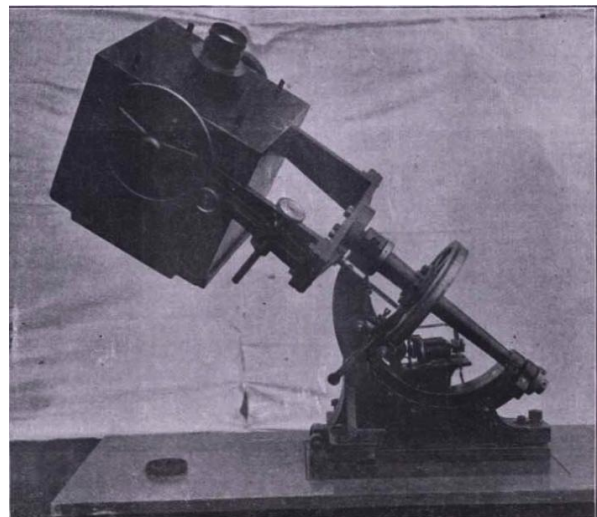


Figure 5: Nob Hill Observatory camera (courtesy: Colorado College, Tutt Library, Special Collections).

One of the purposes of the Western Association for Stellar Photography was to provide a proper observatory building for the Nob Hill camera. This required land and money and therefore a source of funding. Loud and the other local Association directors determined that soliciting public participation in the form of stock ownership might raise the funds they needed (note that Pickering was almost certainly not involved in this decision). The Association issued "... capital stock [to the] ... amount of ten thousand ... dollars divided into one thousand shares ..." worth ten dollars each (Association Documents: 7). Thus, any interested member of the public could participate by buying shares to help support the Association. A public announcement in the local paper summed this strategy up nicely: "Probing Secrets of the Heavens: Scientists and Capitalists Organize to Promote Investigations—Photographing the Stars" (Probing Secrets of the

Heavens, 1904).³ On 27 July 1905 the *Gazette* announced that a site had been secured to build the observatory by aid of a generous donation of land from a Denver benefactor.

Loud's earlier success on Nob Hill with the Cooke lens and camera "... brought about the enlarging of the station and the work." (Observatory to be Built on Nob Hill, 1905). Although we know an observatory was in fact built, no photographs of it have been found. It was described as an observatory at least two stories high housing both the camera and meteorological instruments. It contained living quarters (including an exterior sleeping porch) and was likely used as a part-time residence by Loud and other observers. It even had a piano.

6.3 Ownership of the Photographic Plates

On 28 April 1905, the Association passed a resolution authorizing Loud to purchase "... the instruments now in use at the station on Nob Hill ... [and] accessory apparatus [for] the preparation or utilization of the plates obtained from this instrument ..." (Association Documents: 13). Pickering appeared to be in agreement as the resolution cited a letter of approval from him. Yet there may have been a bit of a 'turf war' go-

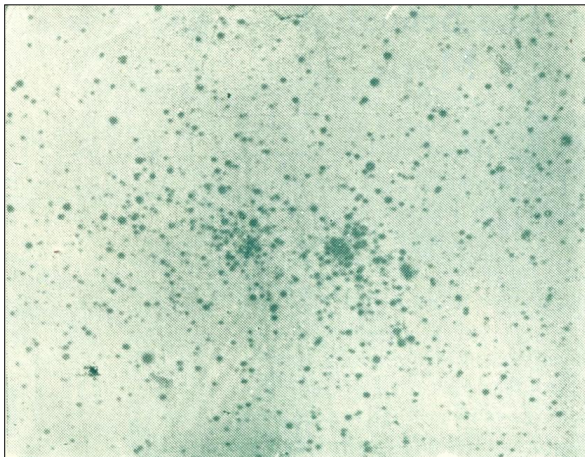


Figure 6: An image of double cluster in Perseus taken with the Nob Hill camera (courtesy of Colorado College, Tutt Library, Special Collections).

ing on over the ownership of the plates taken by the Association's camera, as the officers then went on to pass a resolution ensuring that the photographic plates taken at Nob Hill remained the property of the Association. The secretary (in this case, Loud) was authorized

... in regard to the ultimate disposition of the plates ... while conserving the highest scientific utility of the output of the station, to secure for the Association as large a permanent interest in the same as it may equitably claim. And no such arrangement, relating to the permanent disposition of the photographs taken at the station, shall be binding upon the Association until approved by a majority of the Board of Directors. (Association Documents: 13).

This last provision was key: a majority (of any three locals) could therefore override the President (Pickering) and one other member, thereby preventing the plates from going back to Harvard (or anywhere else for that matter) should such a request be made.

Whether or not there was an outright tug-of-war over the plates is unknown, but clearly Loud was keen to keep them in Colorado Springs, whereas Pickering might have preferred they go back to Cambridge. Perhaps as a result of the experience with the Association Pickering was more careful in the future. We have some hint of this from Pickering's visionary 1909 article "The Future of Astronomy" in which he outlines his ideal network of photographic observatories. This network would have a central

... very large observatory employing one or two hundred assistants, and maintaining three stations ... one in the western part of the United States, not far from latitude +30° ... moderately high, from five to ten thousand feet. [In comparison, Colorado Springs is around latitude +38° and about 6000 feet high.] These stations ... will not undertake much of the computation or reductions. This last work will be carried on at a third station, which will be near a large city where the cost of living and of intellectual labor is low. The photographs will be measured and stored at this station, and all the results will be prepared for publication, and printed there. The work of all three stations will be carefully organized so as to obtain the greatest result for a given expenditure. (Pickering, 1909: 115).

Pickering's vision of efficient calculation by distributing specific tasks among satellite observatories clearly differed from Loud's local, generalized ambitions to perform all work at one location. This does not prove the two were at odds with one another during Loud's management of the Nob Hill Observatory, but as Becker (2009) has demonstrated, Pickering and Loud had a history of not seeing eye-to-eye. Pickering desired control above all else as a precondition for effective astronomical progress and after his limited involvement with the Western Association for Stellar Photography he probably felt more convinced than ever of his vision for the future of astronomy.

6.4 Arson on Nob Hill and the Decline of the Association

It is not known how many photographic plates the Nob Hill Observatory produced (but see Figure 6), or to what degree the research ultimately proved useful to Loud or Pickering. Nob Hill certainly did not live up to Pickering's expectations as a North American Arequipa. We do know that the operations of the observatory were relatively short-lived. A tragedy befell the Nob Hill Observatory a few years after it was built and marked 'the beginning of the end' of the Western Association for Stellar Photography. On 5 July 1909 the observatory's caretaker, Lew Warriner, doused the floors with coal oil, set the Observatory on fire, and then shot himself. Loud was asleep elsewhere in the building when he was roused by the flames. According to the *New York Times*, Loud

... was making a vain attempt to extinguish [the fire] when he heard the shot which ended the caretaker's life. Despondency [due to tuberculosis] is said to have caused Warriner's act ... An examination of the burned structure shows that great damage was done to the scientific instruments, but the exact loss cannot be estimated. Special work for Harvard University was being conducted at the time of the fire. (Suicide in Observatory, 1909).

The extent of the damage is unknown but the camera and lens at least were spared.

Sparse record of the continued operation of the Observatory can be found after the fire. In 1910 the *Gazette* printed a photograph of Halley's Comet taken from Nob Hill. The article noted that the camera was still part of the Western Association of Stellar Photography and that "Professor F.H. Loud ... one of the officers, is in charge of the local observatory." (Much-Discussed Halley's Comet, 1910). At some point after 1910 the Association ceased regular operations. In 1922 Loud gave a brief history of the Cooke lens camera:

Originally set up on Nob Hill, it was moved, first a few blocks, then across the city. The last transfer was interrupted by a trip of fifty miles to a point on the line of totality of the solar eclipse of June 8, 1918. (Loud, 1922).

It is not known what fate befell the Nob Hill Observatory itself, but two houses were built in 1958 where the Observatory once stood. We know that some (possibly all) of the photographic plates taken with the camera remained in Loud's possession because he occasionally published them in a magazine he edited from 1920 to 1924 called the *Colorado Sky*. Loud published this magazine under the auspices of the Association, although at that point its existence was merely nominal. The final issue of *Colorado Sky* (February 1924) effectively marked the end of the Western Association for Stellar Photography.

7 THE 1918 ECLIPSE

On 8 June 1918, forty years after the eclipse of 1878 that initiated Loud's astronomical career, another total solar eclipse was visible from Colorado. Loud was appointed to the American Astronomical Society's Committee to help "... facilitate the cooperation among the members of the Society ..." in advance of the event ("Nineteenth Meeting of the American Astronomical Society," 1916: 582). He eagerly pitched in even though he was now in his late 60s. He and Florian Cajori from Colorado College played tour guide to Yerkes astronomer Edwin B. Frost, driving hundreds of miles northeast of Colorado Springs on dirt roads to scout out a suitable observing station (see Figure 7).

They located a small hill about two miles west of Matheson, Colorado, which they called the 'Colorado College Eclipse Station', and this is where Loud "... made preliminary arrangements for the observers." (Chant, 1918: 341). Contingents from four observatories would share the Matheson site: Washburn College (Kansas) which included a Yerkes party, Drake University (Iowa), the University of Toronto, and Colorado College. On 4 June Loud drove the 56 miles from Colorado Springs to Matheson by car, joined by his son, Francis, and his assistant, Kenneth Hartley.

As already noted Loud used the Nob Hill camera along with two others (another Cooke anastigmatic and a Goerz single anastigmatic) to photograph the eclipse. All three lenses were secured on a single

mounting. To keep steady motion in right ascension Loud developed a clever device:

Carefully sifted sand, placed in a sheet-metal tank, was allowed to run out through a small hole in the bottom; and as it ran out, a heavy weight placed on top of it descended slowly and uniformly. To this weight was attached a wire cable, which, after passing over several pulleys, was wound about the axis to be rotated. The apparatus worked admirably. (Chant, 1918: 342-343).

The photographs were a success, and the 1918 eclipse was Loud's final major astronomical event.

8 CONCLUDING REMARKS

8.1 Legacy and Influence

By the time of his death in 1927 Loud's astronomical career had spanned almost 50 years. He did not perform astronomical research that significantly advanced the field; yet he did do much to advance the science of astronomy in Colorado Springs, where astronomy went from non-existence to a cultivated science in just a few decades. By instructing students in astronomy, aiding fellow astronomers and helping to build two observatories, Loud laid the groundwork for further astronomical research in the area. Unfortunately when he was gone astronomy declined in Colorado Springs and



Figure 7: The scouting expedition for the 1918 eclipse, taken somewhere between Matheson and Simla, Colorado. From left to right: Guy Harry Albright (Colorado College), unidentified driver, Frank Loud (Colorado College), Edwin B. Frost (Yerkes Observatory), Roland R. Tileston (possibly Pomona College), and Florian Cajori (Colorado College) (courtesy: Special Collections Research Center, University of Chicago Library).

astronomy's center of gravity in Colorado shifted firmly to Denver.

One interesting result of Loud's career, however, was the influence he had on Donald H. Menzel, the theoretical astrophysicist and an eventual Director of the Harvard College Observatory. Born in Colorado in 1901, Menzel studied chemistry at the University of Denver and in 1918 witnessed both the solar eclipse and Nova Aquilae from Colorado. Just as Loud had experienced forty years earlier, witnessing the 1918 eclipse heavily influenced Menzel toward a career in astronomy. Menzel left the University of Denver for Princeton in 1921 to work with Raymond S. Dugan and Henry Norris Russell. Although young Menzel did not yet have 'full credentials', Dugan pushed for

his acceptance to Princeton because "... young astronomers are not appearing very fast at present and we would like to give this man any possible encouragement." (DeVorkin, 2002: 119). What early credentials Menzel did possess came to him in Colorado, in part via Loud. This we know from a footnote in *The Harvard College Observatory: The First Four Directorships, 1839–1919*, for which Menzel wrote the introduction. In an endnote from Chapter Six, on the Boyden Fund, the authors recall that Pickering played an important role in helping Loud establish astronomy at Colorado College. Then they note that Menzel, who would someday occupy the same position as Pickering, was himself nurtured by Loud:

Nearly forty years later Professor Loud, in turn, gave encouragement to Donald H. Menzel in his study of astronomy. In 1952, Dr. Menzel became the sixth director of the Harvard College Observatory. (Jones and Boyd, 1971: 470).

After Menzel left Colorado for Princeton he kept in touch with Loud. As editor of *Colorado Sky* Loud was able to procure from Menzel an article entitled "Stars and the Atomic Theory" for the final issue of *Colorado Sky* in 1924. This may be one of Menzel's earliest and least-known published articles. In *Colorado Sky* Loud praised the then 23-year-old Menzel as

... already well known to our readers, but perhaps not all of them know of the high quality of the work he has lately been doing, both at Princeton and at the Harvard College Observatory. Colorado has already reason, and will ere long have more, to take pride in the record of her new representative in the company of astronomers. (Loud, 1924: 2).

Loud was prophetic here and may have believed, via Menzel, that he was in some sense returning a favor to Pickering and Harvard. Of course Loud could not have known Menzel would someday occupy Pickering's former position as Harvard College Observatory's Director.

Like Loud, Menzel believed in the advantages of higher altitudes for astronomy. In his own career Menzel pushed for a high altitude observatory in Colorado. Having lived there he knew, as Loud did, what opportunities Colorado's mountains offered to astronomers. Although Loud did not live to see it, through Menzel Harvard finally established a high altitude observatory in Colorado. In 1940, just thirteen years after Loud's death, Menzel and one of his graduate students, Walter Orr Roberts, founded the High Altitude Observatory near Climax, Colorado.

8.2 Conclusion

While at Colorado College, Loud was one of the few active astronomers in the American west before 1900. Consider the list of participants at the Second Annual Conference of Astronomers and Astrophysicists, held in August 1898 at Harvard College Observatory. Of the 93 registered participants, 90 were from institutions on the east coast or no further west than Wisconsin. Two others were from foreign institutions (in Montreal and Leyden). Only one participant, Loud, was from an institution west of the Mississippi (Hale, 1898). Additionally, before 1900 the number of institutional and large private observatories established in the American west could likely be counted on two

hands. There were a handful of institutional observatories: Colorado College's Wolcott (1894); Denver University's Chamberlin (1894); two in Nebraska, the Boswell Observatory at Doane College in Crete (1883) and the Creighton University Observatory (1886); and in Seattle, the Observatory at the University of Washington (1895). The school district of Oakland, California opened the Chabot Observatory for public viewing in 1883. Then of course there were the larger, private research institutions: the Lick Observatory at Mt. Hamilton, California (1888), Percival Lowell's observatory in Flagstaff, Arizona (1894), and the Mount Wilson Solar Observatory (1904). It seems clear that by his retirement in 1907 Loud's position as an active astronomer in the American west, though not unique, had placed him in limited company.

The career of Frank Loud represents not only that of a pioneer astronomer working on the American frontier, but also an important link between the astronomical research programs being developed in the eastern United States and the development of astronomy in the American west, in particular the push toward high-altitude astronomy. Loud was active in that cohort of American astronomers described by Lankford in the period from 1860 to 1899, which saw the rise of astrophysics and the application of photography to astronomy (Lankford, 1997: 10). Yet Lankford's thorough study, which included astronomers "... who stood far from the center ..." (Lankford, 1997: 8), makes no mention of Loud despite Loud's close connections to Pickering, to Harvard College Observatory, and to the broader nineteenth-century astronomical community. This is not meant as a criticism of Lankford but rather underscores the paucity of historical coverage of western American astronomy during that period beyond the well-known observatories like Lick and Lowell.

Loud was a rare example of an astronomer who maintained a fairly-sophisticated program of astronomical research in a small frontier town far from the usual centers of astronomical work. Therefore, his career is significant in charting the history of nineteenth century American astronomy outside the better-known east- and west-coast astronomical institutions and observatories. Loud's efforts did not result in lasting astronomical fame, but his support of other astronomers as well as his instruction of Colorado students in the science of astronomy were themselves significant contributions, made all the more impressive by the limited resources available to him. Loud's expertise in mathematics, meteorology and astronomy demonstrates the many hats a frontier professor wore to be of service not only to science but to citizens of the American west. As a result of his expertise and passion, for a short time astronomy flourished in an unlikely location.

9 NOTES

1. Darin Hayton, Associate Professor of the History of Science at Haverford College, marshaled the resources of Haverford's library staff and Mathematics Department in an ultimately fruitless effort to determine which faculty granted Loud's Ph.D. in 1900; no thesis or dissertation (if there was one) could be located, but records do exist at Haverford

- confirming that Loud was granted a Ph.D. For their efforts I am grateful.
- The "Mr. L.R. Ingersoll" Loud mentions is Leonard Rose Ingersoll, the early twentieth-century University of Wisconsin Professor of Physics whose eponymous Physics Museum is well-known to many historians of science and technology (and their children) who have passed through Madison. Loud and Ingersoll presented a joint paper at the meeting of the American Association for the Advancement of Science in Denver in 1901, and Ingersoll's correspondence with Loud indicates he held his Professor in high regard.
 - The Association's account books indicate that only a minority of shares (315 total) were ever sold or otherwise distributed as gifts (Association Documents, Account Book: 3), which almost certainly means the Association did not raise enough money by selling stock to cover the cost of building the Nob Hill Observatory in 1905-1906. This leads to the conclusion that Loud paid for the construction of the Observatory, and purchased the camera and other equipment from Harvard himself. The fact that the Nob Hill Observatory was occasionally referred to as one of Loud's residences further supports this assumption. Loud came from an established Massachusetts family and may have had considerable personal wealth which he brought with him to Colorado, as he purchased land and built his own house just one year after arriving in 1878; yet given what we know about the College's initial lack of even its own buildings and limited funds Loud almost certainly could not afford to pay for a new house out of his teacher's salary. In the early years of Colorado College salaries were often 'overdue' and "... frequently little more than token payments." (Hershey, 1952: 132); concurrently residential land in Colorado Springs was selling for around \$1000 per acre in 1878.

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