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# Ansel Adams an "Autumn Moon"

GLACIER POINT in Yosemite National Park commands one of the most spectacular views in the American West. The often-photographed panorama includes Yosemite Valley 3,000 feet below, with Yosemite Falls to the northwest and the distinctive profile of Half Dome to the east. But, near sunset a half century ago, Ansel Adams was captivated instead by the distant Clark Range to the southeast, where a waxing gibbous Moon was rising. The resulting photograph is known as *Autumn Moon, the High Sierra from Glacier Point*.

Since there has been some confusion over when *Autumn Moon* was taken, we wondered if we could derive a precise date. The photograph is assigned to 1944 in a current traveling exhibition (Ansel Adams: Inspiration and Influence, 2002–06), but several books give 1948 as the year instead. "Ansel was notoriously bad at dating his own negatives . . . though he kept immaculate records of each negative's f/stop, lens, and exposure," notes Mary Street Alinder, Adams's friend and assistant, in *Ansel Adams: A Biography* (Henry Holt, 1996).

Even for the date of his most famous photograph, *Moonrise, Hernandez, New Mexico*, books and articles by Adams gave various conflicting years. This uncertainty was finally resolved when S&T's Dennis di Cicco used astronomical methods to show that Adams must have created the Hernandez image on November 1, 1941, at 4:49:20 p.m. Mountain Standard Time (S&T: November 1991, pages 480 and 529). Our own group

used similar techniques to date Adams's *Moon and Half Dome* to 4:14 p.m. Pacific Standard Time on December 28, 1960 (S&T: December 1994, page 82).

#### POSSIBLE DATES

As an initial step, we studied topographic maps and photographs to identify the mountains in *Autumn Moon*. Under the clouds at the far left is Mount Clark, which rises to 11,522 feet (3,512 meters) above sea level. The sharp point of Gray Peak (11,574 feet) falls just to the right of center, while the granite domes of Mount Starr King (9,092 feet) dominate the right side of the image. Although Starr King appears tallest in the photograph, this is a result of Starr King's relative proximity to Glacier Point, where the elevation is 7,214 feet at the valley overlook.

For a first approximation of the Moon's altitude, the differences in these elevations allowed us to calculate that the photograph's apparent horizon, formed by the distant Clark Range roughly nine miles from Glacier Point, was raised about 5° above the ideal geometric horizon. Knowing that the lunar diameter is about 1/2°, we estimated that the Moon stands roughly 7° in altitude above the ideal horizon.

Determining the Moon's azimuth was not so straightforward. We needed to know exactly where Ansel Adams set up his tripod in the Glacier Point area, which extends from the parking lot for more than a thousand feet out to the railing at the valley overlook. Park ranger David Balogh, well known to

Among the clues to the famous photograph's date is the Moon's unusual tilt.



A rising Moon and shadows cast by the setting Sun allowed the authors to find the date when Ansel Adams took this classic image. *Autumn Moon* was captured at Glacier Point in California. It shows Mount Clark at far left, Gray Peak just right of center, and Mount Starr King at far right.



Cartographer Heinrich Berann painted this aerial view looking generally eastward across Yosemite Valley to the peaks of the High Sierra. The red dot marks the location where Ansel Adams set up his camera on Glacier Point, above the east end of Yosemite Valley, and looked toward the southeast to watch the waxing gibbous Moon rise over the Clark Range.

made sense, because Adams’s interest in moonrise photography may have increased following his successful Hernandez photograph in 1941. The year 1959 was a firm upper limit because *Autumn Moon* appeared in Adams’s book *Yosemite Valley*, published that year.

Our search using computer planetarium software produced several dozen possible dates within this time period. It happened that one of our most promising dates fell in 1944, as the ongoing exhibition states, and another in 1948, as favored in several books.

**WEATHER** An online archive of daily weather maps, available under “Imaged Documents and Maps” at [www.lib.noaa.gov](http://www.lib.noaa.gov), made it easy to determine the conditions in California on all our possible dates. The weather records provided a good consistency check but didn’t help us establish a unique date for *Autumn Moon*, because northern California has such an abundance of clear skies in the weeks near the fall equinox.

**LIBRATION** We were more successful in rejecting some of the possible dates by considering the lunar surface features visible on enlargements of *Autumn Moon*. The north polar region appears to be tilted toward Earth, with Mare Frigoris very favorably

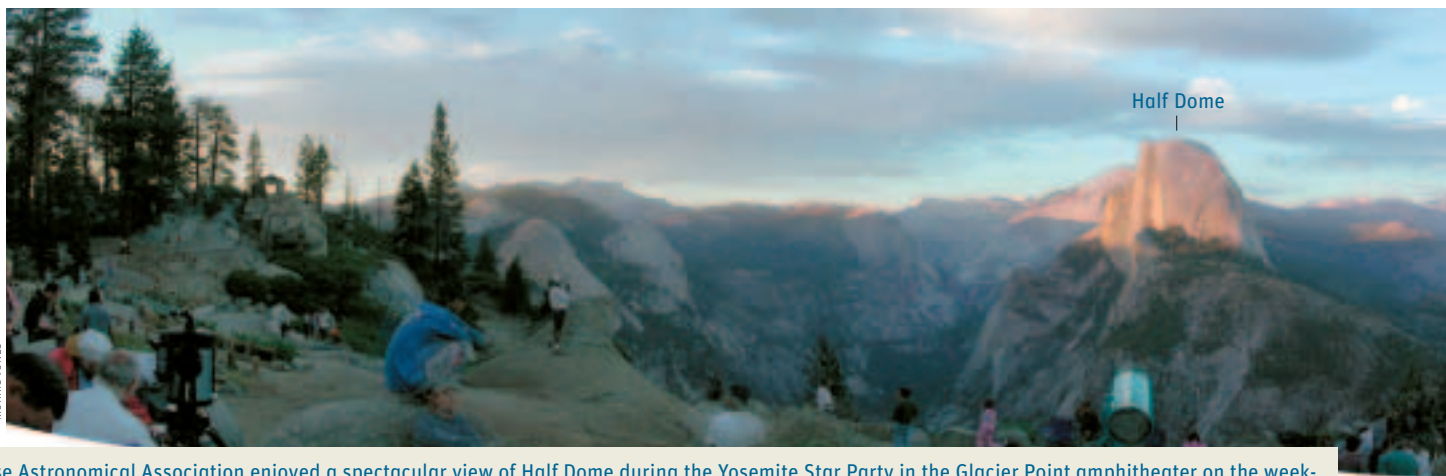
placed for observation, indicating a large positive libration in latitude. Therefore, we could rule out the dates (for example, August 23, 1942) when the Moon had the correct phase and position in the sky but a negative libration in latitude.

**ANSEL ADAMS IN COLOR**

Our continuing literature search then turned up something very unexpected that allowed us to eliminate all the possible dates after 1954. Ansel Adams is best known for his black-and-white photography — but in the July 1954 issue of *Fortune* magazine we were surprised to find a color version of *Autumn Moon*! Beginning in the 1940s, Eastman Kodak commissioned noted photographers to test new color sheet films and published the results in an article titled “Test Exposures: Six Photographs from a Film Manufacturer’s

California’s amateur astronomers as the founder of the Yosemite Star Party, helped us by taking a series of photographs from various locations on Glacier Point. Mount Starr King in the foreground was clearly shifting relative to the Clark Range in the background, and this told us that Adams’s camera must have been near the Geology Hut, a stone building about halfway between the parking lot and the railing. Using topographic maps, we estimated that his line of sight to the Moon was directed toward an azimuth of roughly 118° (that is, 28° south of due east).

We decided to search the years from 1941 to 1959, looking for dates when a waxing gibbous Moon rose in the sky between Gray Peak and Mount Starr King. The initial year



The San Jose Astronomical Association enjoyed a spectacular view of Half Dome during the Yosemite Star Party in the Glacier Point amphitheater on the weekend of July 5–6, 2002. For *Autumn Moon*, Ansel Adams set up his tripod near the Geology Hut, a stone building visible between the trees near the left side of this panorama. Instead of focusing on Half Dome, Adams pointed his camera toward the rising Moon above the distant Clark Range, far to the right.

Files." The Ansel Adams moonrise was described as a "romantic landscape" captured with a "three-second exposure, on Ektachrome."

Although no date was given for this image, the clouds in the sky above Mount Clark prove that the color and monochrome versions were from the same day. By overlaying the two photographs and measuring how far the Moon had risen between the two exposures, we determined that the color image preceded the black-and-white version of *Autumn Moon* by 2½ minutes, just enough time for the expert photographer to change the 8-by-10-inch film holder and adjust the settings on his view camera. The reddening that is apparent on the Clark Range in the Ektachrome suggests a time in the late afternoon, with the Sun very near the western horizon.

The photographs include an even more important clue. Below Gray Peak a sharp triangular shadow extends to the left, toward the ridge of the Clark Range. Topographic maps show that this triangular shadow was cast by an unnamed peak (elevation 10,660 feet) that lies ⅔ mile to the northwest of Gray Peak. From the length and direction of the shadow, we could determine the altitude and azimuth of the Sun.

During the Yosemite Star Party held over Labor Day weekend in 2004, Richard Ozer of the Mount Diablo Astronomical Society assisted us by taking an accurately timed series of comparison photographs at 1-minute intervals in the half hour before sunset. Ozer's photographs showed that the shadow developed only when the Sun was very low, within 2° of the horizon. Therefore, for Adams's images we ruled out the dates (for example, September 28, 1944) with a gibbous Moon in the correct part of the sky but with the Sun too high to cast a shadow like that seen in the photographs.

From the direction of the shadow, we established that the sunlight was slanting in from just slightly north of due west, a position reached by the setting Sun on a few days in mid-September, about a week before the fall equinox.

#### TRIP TO YOSEMITE

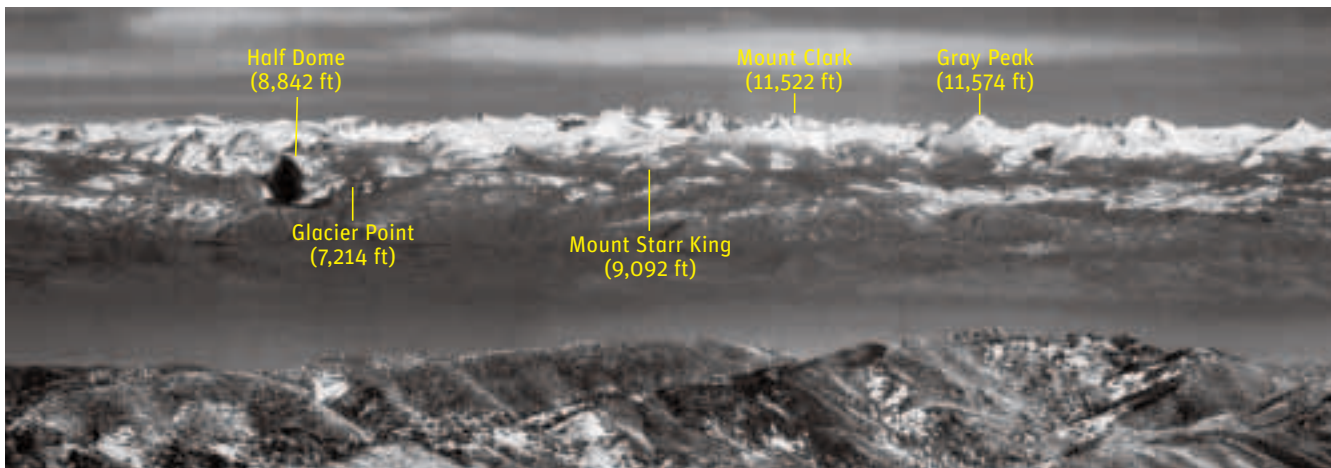
To complete our analysis, we traveled to Yosemite during June 2005. Our first task was to find the coordinates for the precise location of Ansel Adams's tripod. On Glacier Point



This color version of *Autumn Moon* appeared in the July 1954 issue of *Fortune* magazine. According to the authors' calculations, it must have been taken 2½ minutes before the black-and-white one, just enough time for Adams to change film holders on his view camera.

we used a small refractor to study how bright albedo features in the granite on Mount Starr King aligned with distinctive features on the mountains in the background. We confirmed that we could match the photographer's view only from GPS coordinates 119° 34' 22.4" west, 37° 43' 45.2" north (in the WGS84 datum), and elevation 7,220 feet, a location on the hillside 25 feet east of the Geology Hut.





J. Fred Chappell used an infrared-sensitive plate on December 13, 1931, for this panorama of the snow-covered Sierra Nevada as seen from Lick Observatory. The distinctive profile of Half Dome is plainly visible, 118 miles away. Chappell also captured the Clark Range, fully 124 miles from the observatory. Although Mount Starr King appears to stand the tallest in *Autumn Moon*, it is barely visible in this Lick panorama. The more distant Clark Range actually has a much higher elevation, which helps to explain how its peaks can catch the last rays of the setting Sun when Mount Starr King is already in shadow.

From this spot, the distances to the mountains are so great that our computer program had to allow for both atmospheric refraction and the curvature of the Earth in order to calculate precise altitudes and azimuths of the peaks. We could now set an angular scale for the photograph and accurately determine the altitude and azimuth of the Moon.

During the daytime we searched at the Yosemite Research Library for early appearances of Adams photographs in books, journals, and park publications. We also examined detailed records from the park’s weather station, located in the valley below Glacier Point.

At night we took star-trail photographs with moonlight illuminating the mountains as the stars of Capricornus rose between Gray Peak and Mount Starr King. Overlaying our star-trail photographs with *Autumn Moon* gave us an additional method for determining the Moon’s coordinates. A combination of the topographical and astronomical data now provided enough information for a definite conclusion.

#### HARVEST MOON

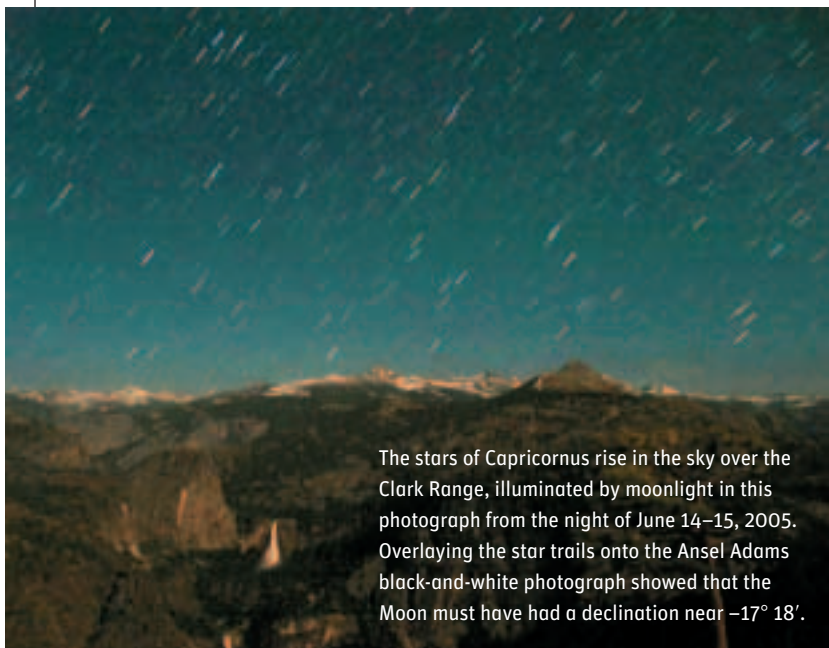
Ansel Adams must have created both the color and monochrome versions of *Autumn Moon* on September 15, 1948. The Ektachrome came first, at 7:01 p.m. Pacific Daylight Time, followed by the black-and-white image just after 7:03 p.m. The Yosemite weather records show that clear skies prevailed, with a high temperature of 90°F (32°C). The calculated lunar illumination on this date is 95 percent, in excellent agreement with the Moon’s appearance in the photographs. The topocentric lunar librations were +2.0° in longitude and +7.0° in latitude, near the maximum possible value in latitude and in perfect accord with the favorable view of Mare Frigoris.

Behind Adams, the sinking Sun had nearly reached the horizon at azimuth 274°, exactly the position required to cast the shadows seen in the photographs. After allowing for refraction, we find that the center of the Sun was only 1/2° above the geometric horizon at the time of the color photo. When the black-and-white image was exposed, the Sun’s disk was just crossing the horizon, which helps to explain why Mount Starr King looks darker there. In both photographs the ridge of the Clark Range is still catching the last rays of sunlight. Our analysis helps us to understand exactly how Adams captured such an interesting moment — a lighting effect that lasts for only a few minutes — to achieve the dramatic impact in the resulting photographs.

The next full Moon in 1948 fell on September 18th, followed by the equinox on September 23rd. Therefore the Adams photographs technically depict not an autumn Moon but a scene three days before a summer Harvest Moon, according to the definition that this name applies to the full Moon nearest the autumnal equinox.

#### LETTERS AND THE ECLIPSE COMET

Ansel Adams’s published correspondence includes a letter dated September 15, 1948, the exact date calculated for the photographs. Unfortunately, the place of origin is not given for this letter, although several references in the text suggest that Adams was in northern California, perhaps in San Francisco or Yosemite. A more definite result came from archivist



The stars of Capricornus rise in the sky over the Clark Range, illuminated by moonlight in this photograph from the night of June 14–15, 2005. Overlaying the star trails onto the Ansel Adams black-and-white photograph showed that the Moon must have had a declination near  $-17^{\circ} 18'$ .

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*Left:* Ansel Adams was not the first famous person to visit Glacier Point. Naturalist John Muir guided President Theodore Roosevelt through Yosemite in May 1903, including the stop shown here at the Glacier Point overlook, with Yosemite Falls in the background.



COLLECTION OF DONALD W. OLSON

*Right:* The Moon aligns with Glacier Point in this vintage postcard showing the view from Camp Curry in Yosemite Valley. It doesn't show one of Yosemite's waterfalls but instead depicts the Firefall, a bonfire that was pushed off the overlook at Glacier Point at 9 p.m. on summer nights for the amusement of spectators below.

Leslie Calmes of the Center for Creative Photography in Tucson, Arizona, who searched the unpublished letters in the Ansel Adams Archive. Several of these prove that Adams was in Yosemite from September 10 through 30, 1948.

We found a surprising link to astronomy in the letters from 1948. On November 18th, Adams was out well before sunrise and observed a "comet in the clear pre-dawn sky." This must be a sighting of the famous Eclipse Comet discovered during the total solar eclipse on November 1, 1948 (*S&T*: January 1949, page 59, and January 1997, page 47). The photographer's interest in astronomy continued a family tradition begun by his father, Charles Hitchcock Adams, a longtime officer of the Astronomical Society of the Pacific.

#### 1948 AND 2005

The year 2005 will offer a special astronomical anniversary of *Autumn Moon*. Exactly three 19-year Metonic lunar cycles have elapsed since the scene was captured from Glacier Point. Therefore, the calendar dates of lunar phases in 2005 very nearly repeat those of 1948.

On September 15, 1948, a waxing gibbous Moon was 95 percent illuminated (2.3 days before full Moon) and had a declination of  $-17^{\circ} 18'$  as it rose above the Clark Range to be photographed twice by Ansel Adams, at 7:01 and 7:03 p.m. PDT.

On September 15, 2005, the waxing gibbous Moon will

be 94 percent illuminated (2.0 days before full Moon) and have a declination of  $-17^{\circ} 29'$  when it will again rise between Gray Peak and Mount Starr King and match Adams's photographs at 6:50 and 6:52 p.m. PDT. As the Sun sinks toward the horizon in 2005, even the direction of sunlight and shadows will be repeated. This year, weather permitting, observers near the Geology Hut on Glacier Point will have a chance to share Ansel Adams's experience — the same kind of scene described in the words of English poet Alfred, Lord Tennyson's *Ulysses*:

*The long day wanes: the slow moon climbs. . . .*

#### ACKNOWLEDGMENTS

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DON OLSON and RUSSELL DOESCHER teach physics at Texas State University. Their students in the Mitte Honors Program worked on the *Autumn Moon* puzzle during the 2004-05 academic year.

The Texas State group traveled to Glacier Point in June 2005. *Center:* The Clark Range and Nevada Fall form the background for Donald W. Olson, Louie Dean Valencia, Ashley B. Ralph, and Kara D. Holsinger. Russell Doescher is in the first photo at far left.



L-R: LOUIE VALENCIA, RUSSELL DOESCHER, MARILYNN OLSON