February's Total Lunar Eclipse   — Howard L. Cohen

Unlike Florida's two prior total lunar eclipses, which could only be partially seen, February's eclipsed Moon remains above the Florida horizon for the entire event. In addition, large brightness variations across the eclipsed lunar disk should make this eclipse especially colorful and intriguing. Brightness estimates during totality can help establish a history of optical thickness of volcanic dust layers in Earth's atmosphere

At least twice each year the Moon passes through all or a part of Earth's shadow—a shadow cast by our planet blocking solar rays. This results in at least two eclipses of the Moon of some type every calendar year. In addition, about two weeks before or after these lunar eclipses, the Moon passes partially or fully in front of the Sun. This also produces a minimum of two solar eclipses of some type per year.

Two lunar eclipses and two solar eclipses occur in 2008, the minimum number for each type in any given calendar year. These eclipses include a total and partial lunar eclipse, and an annular and total solar eclipse. However, only the first, a total eclipse of the Moon, on February 20/21, is visible from Florida.

(The most significant and dramatic eclipse of 2008, of course, is the total solar eclipse of August 1 but is only visible from extreme northeastern Canada, northern Greenland, the Arctic, central Russia, Mongolia, and parts of northern China.)

The Lunar Eclipse

Florida must, therefore, settle for February's total eclipse of the Moon. Still, this eclipse is special since *the entire eclipse is visible from the eastern United States*. The previous two total lunar eclipses (2007 March 3 and 2007 August 28) were only partially seen from North Florida since the Moon rose or set during these eclipses, respectively. However, the upcoming total lunar eclipse is conveniently timed for Florida beginning in early evening on Wednesday, February 20 and concluding shortly after midnight on Thursday, February 21.

In fact, this eclipse is well-placed throughout most of the Americas and western Europe. (Observers in western North America miss the first part since the Moon will not rise until after the eclipse begins.) Furthermore, in Gainesville, Florida, the Moon's position on the sky at mid-eclipse is near-perfect, about a 52-degree altitude above the southeastern horizon. This is high enough to clear horizon obstacles but not too high that necks must painfully bend to view the Moon!

Table 1 lists Eastern Standard Times for stages of this eclipse. Notice *mid-eclipse* occurs at 10:26 p.m. EST on the evening of February 20. This corresponds to February 21, 03:26 UT (*Universal Time*). Since UT is five hours *ahead* of EST, eclipse announcements may

give the "date of occurrence" as February 21 but the eclipse really begins the evening of February 20, a Wednesday night for us on the East Coast. Table 1 also gives the altitude of the Moon above the horizon for each stage as viewed from Gainesville. (Altitudes will be similar to the tabular values for other locations in North Florida.)

Public Viewing Session: The AAC with Santa Fe Community College will hold a public viewing event for this eclipse at the SFCC NW campus. More details can be found elsewhere in the January/February issue of *FirstLight*. Also consult the AAC web site (floridastars.org) for details as the eclipse date approaches. In addition, subscribers to the AAC e-mail list (AAC-L) will get reminders.

Table 1. Lunar Eclipse Time Table: 2008 February 20/21 (Times Eastern Standard)

Event	Time of Event (EST)	Moon's Altitude (Gainesville)
Penumbral Eclipse Begins	07:37 p.m.	17°
Partial Eclipse Begins (Moon Enters Umbra)	08:43 p.m.	31°
Total Eclipse Begins (Moon Entirely within Umbra)	10:01 p.m.	47°
Mid-Eclipse (Greatest Eclipse)	10:26 p.m.	52°
Total Eclipse Ends	10:51 p.m.	57°
Partial Eclipse Ends (Moon Leaves Umbra)	12:09 a.m.	68°
Penumbral Eclipse Ends	01:16 a.m.	69°
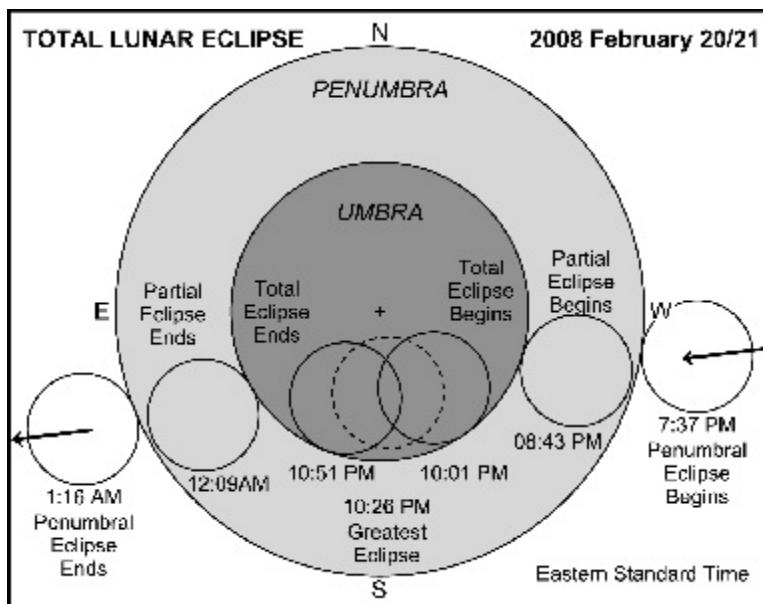
Fig. 1. Projection of the Earth's shadow on the sky showing the position of the Moon during the total eclipse of 2008 February 20/21 for Florida (all times Eastern Standard). Although the daily motion of the sky will cause the Moon to move westward across the sky during the eclipse, the eastern side (*limb*) of the Moon will first enter the Earth's shadow since the Moon also moves eastward *among the stars* due to its orbital motion around the Earth. (Diagram based on data from SkyMap Pro 11 software by C.A. Marriott.)

During this eclipse the Moon will spend three hours and twenty-six minutes passing through Earth's *umbral shadow* (darkest portion). Coincidently, notice this time (3h26m) is the same as the UT of mid-eclipse (03:26)! Although the Moon begins to enter the brighter, outer portion of Earth's shadow (the *penumbra* or partial shadow) slightly more than one hour before first contacting the umbra, this event is difficult to see. *Still, vigilant observers can attempt to detect at what point within the penumbral shadow slight darkening on the Moon first becomes detectible.*

Also, during this eclipse the Moon does not pass centrally through the Earth's umbra but passes very close to the southern edge of

the umbral portion with totality lasting only about 50 minutes (Fig. 1). *Brightness and color variations can vary significantly from one lunar eclipse to another due to factors as the Moon's position with the Earth's shadow and conditions within Earth's atmosphere.* Although one might expect the Earth's umbral shadow to be very dark, sunlight scattered by Earth's atmosphere into the shadow can sometimes produce bright eclipses.

The shorter duration of totality (50 min.) compared with last August's eclipse (90 min.) results from the Moon's passage close to the edge of the umbra (Fig. 1) rather than near the umbra's center as it did during the last total eclipse. (Longest total lunar eclipse durations are approximately 107 minutes. The last was 2000 July 16, 106.4 minutes, the next 2123 June 9, 106.1 minutes.)

Since the southern edge (*limb*) of the Moon will remain very close to the edge of the umbra, one can expect *large differences in brightness across the lunar disk* for the upcoming eclipse between the Moon's southern limb, which may remain relatively bright, and the northern limb, which may appear much darker due to its much deeper immersion in the umbra. In addition, color variations often depend strongly on dust, especially volcanic dust in our atmosphere, which can block sunlight from entering the Earth's umbra. This can cause eclipses to vary from bright orange to bloody red to even dark brownish or grayish. However, major volcanic eruptions have not occurred recently which may help make this eclipse brighter and more colorful than usual.

Evaluating the Lunar Eclipse Brightness

Observers who wish to evaluate the visual appearance and brightness of the Moon during this lunar eclipse can use the five-point ***Danjon Scale***. The following description and use of this scale are adapted from the *RAS Observer's Handbook 2008*, pg.130:

L = 0 Very dark eclipse
        (Moon almost invisible, especially at mid-totality)
L = 1 Dark eclipse, grey or brownish
        (Details distinguishable only with difficulty)
L = 2 Deep red or rust-colored
        (Very dark central shadow, while outer umbra relatively bright)
L = 3 Brick-red
        (Umbral shadow usually has bright or yellow rim)
L = 4 Very bright copper-red or orange
        (Umbral shadow has bluish, very bright rim)

Judge "L values" with naked eye, binoculars or small telescope every ten minutes especially near mid-totality. Also examine the Moon's appearance just after totality begins and ends to provide an "L-value" for the outer umbra. Note any variations in color and brightness through the umbra including the apparent sharpness of the shadow's edge. Finally, note the visibility of lunar features within the umbra. Make notes and sketches. Report results to *Sky & Telescope* and to Dr. Richard Keen, Department of Atmospheric and Oceanic Sciences at the University of Colorado (richard.keen@colorado.edu). Dr. Keen has a strong interest in lunar eclipse brightness, which he uses to calculate a history of optical thicknesses of volcanic dust layers in our atmosphere.

Andre Danjon (1890–1967), a French astronomer, devised the above scale and thought the "L-value" was related to the 11-year solar cycle. (See Meeus 1997). Low values of "L" were believed to occur during the first two years after solar minimum. Then the brightness of the Moon was supposed to increase till the next solar minimum. Finally, eclipse luminosity was expected to drop dramatically with the cycle then repeating. However, more recent analysis by Jean Meeus (1997) has cast doubt on the "Danjon Law." Still, future observations should further help resolve whether sunspot activity plays a role in determining lunar eclipse brightness.
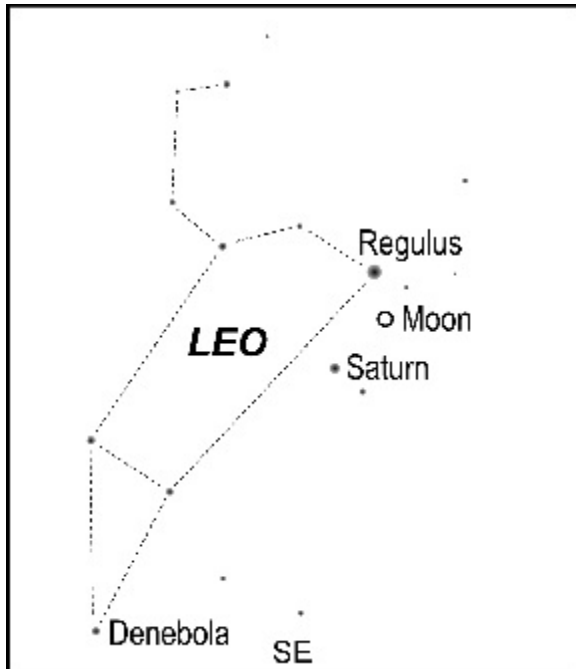
Fig. 2. The eclipsed Moon will lie in *Leo* with bright Regulus and Saturn close neighbors. (Diagram based on data from SkyMap Pro 11 software by C.A. Marriott.)

The Lunar Eclipse Sky

During this eclipse, the Moon will lie in the constellation of *Leo*, less than three degrees south of bright Regulus (magnitude +1.4). Saturn, too, will lie nearby, less than four degrees to the south and east of the eclipsed Moon (Fig. 2.)! Indeed, Saturn will be near maximum brightness shining at magnitude +0.2 since *the ringed planet comes to opposition with the Sun only a few days later*, on February 24. A wide-angle photo of this scene would make an electrifying picture. (Telescopic views of Saturn should show a disk 20 arc seconds across with the rings spanning about 45 arc seconds.)

Total lunar eclipses no longer have major scientific value and do not have the breathtaking power of a total eclipse of the Sun. However, no two lunar eclipses are quite alike, are intriguing to watch, stimulate imaginations and interest in nature, especially among our young, and are a testament to our ability to predict at least some cosmic events.

The Future

Total eclipses of the Moon occur every few years *on the average*, In fact 87 occur in the period 2000–2099 according to Jean Meeus (2004). However, the Moon must obviously be above one's horizon at the time of the eclipse to be observed. Also, weather can ruin chances to see one of nature's beautiful, elegant displays. So you can ignore the February eclipse and hope to see the next, three years later, on December 21, 2010. Then, it will not be until April 15, 2014 when another total lunar eclipse can be seen from Florida. Better to take them as they come. Mark your calendars for February 20 and don't lose a chance to spend an evening with the Moon as she performs her ancient graceful and colorful ritual.

For those interested in still other future eclipse events, know that *six eclipses occur in 2009*, four eclipses of the Moon and two of the Sun! This is close to the maximum number of eclipses possible in a calendar year—seven, a rare event. (At least two must be lunar and two solar of some type, with the remaining three lunar or solar.) The next year seven eclipse year occurs in 2038 with three of the Sun (two annular, one total) and four of the Moon (all penumbral).

Although four lunar eclipses occur in 2009, the first three are all penumbral and will hardly be noticed since the Moon barely darkens during this type of eclipse. (In any case, the first penumbral eclipse is not visible from Florida, and the latter two only partially visible.) The last lunar eclipse of 2009 is a partial eclipse but is not visible from Florida.

The two solar eclipses include an annular and total but, again, neither is visible from the USA. So, unfortunately, *none of the six 2009 eclipses are suitable for viewing from the Florida peninsula.*

Still, the latter solar eclipse, is worth keeping in mind since *this eclipse has the longest duration of totality for any total eclipse of the Sun in the 21st Century* (6m39s in the Pacific Ocean south of Tokyo). The total eclipse path begins on the west coast of India and crosses southern China (including Shanghai) where maximum duration of totality is more than five minutes. Finally, the Moon's shadow moves out over the Pacific Ocean south of Japan through Iwo Jima and ends in the mid South Pacific Ocean between Australia and South America.

Some readers may remember the last very long solar eclipse, on July 11, 1991, with a maximum duration of nearly seven minutes east of Baja California Sur. Both the 1991 and 2009 total solar eclipses are, in fact, related, belonging to the same eighteen-year eclipse cycle called the *Saros* (about 6585.3 days). This Saros cycle (numbered 136), produced the longest eclipses of the last century and will continue to produce the longest eclipses of the present century. However, total eclipse maximum durations are now waning for this cycle. (The next after the 2009 eclipse occurs in 2027 with a maximum duration of 6m23s in Egypt.)

Note: Interested in seeing the 2009 total solar eclipse? Contact the author (cohen@astro.ufl.edu), who is currently planning a tour to China and the great 2009 solar eclipse.

Interested readers wanting to know more about February's lunar eclipse, including how to observe and photograph lunar eclipses, and how to judge eclipse brightness, should see the Espenak (2007) and the Deans & MacRobert (2007) references below.   ☼

References

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