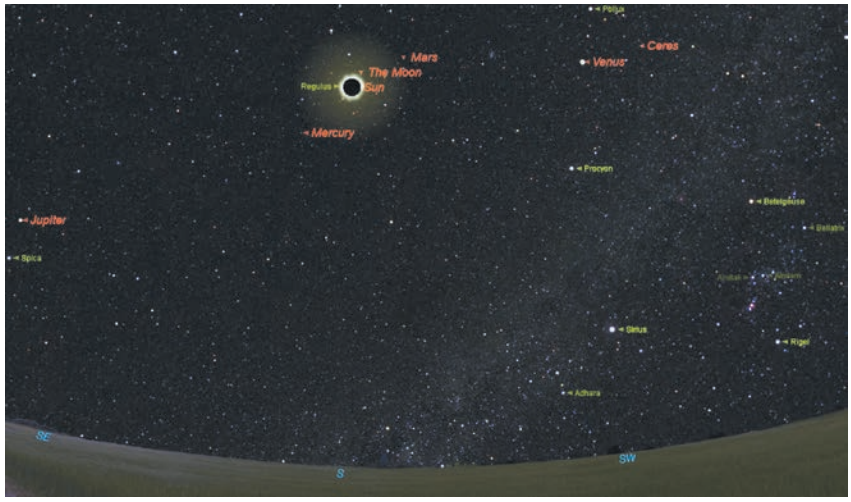
Vocabulary of the skies

BY BOB RIDDLE

In the summer, the sky does not get dark until late in the evening; then, it starts to brighten about eight hours later. Consequently, the shorter summer nights do not permit much viewing time. Nonetheless, there is always something celestial happening every night, with many chances to visualize phenomena that will help make abstract astronomy terms more concrete. The following is a list of astronomical terms that students can apply to events that they witness this summer.

FIGURE 1: The sky during mid-totality



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Aphelion: The greatest distance a Sun-orbiting object with an elliptically shaped orbit will be from the Sun.

Apogee: The greatest distance that an object with an elliptically shaped orbit is from the object it's orbiting, such as our Moon.

Ascending node: The intersection between an object's orbital path and the plane of the ecliptic, with the object moving north across the plane of the ecliptic.

Astronomical unit: The average distance between the Earth and the Sun (1 astronomical unit = 149,597,870.69 km; 92,955,807.26 mi.).

Descending node: The intersection between an object's orbital path and the plane of the ecliptic, with the object moving south across the plane of the ecliptic.

Elongation: The angle between a planet and the Sun, as viewed from Earth. Only the two inner planets (Mercury or Venus) will reach their respective elongations. Both planets reach a greatest eastern elongation where the inner planet, known as an *evening planet*, is to the east of the Sun and sets after the Sun sets. Approximately one-half orbit later, the inner planet will be on the opposite side of the Sun at greatest western elongation where the inner planet, known as a *morning planet*, is to the west of the Sun.

Inclination: The angle of a planet's orbit from the plane of the ecliptic.

Inferior conjunction: When an inner planet, Mercury or Venus, is between the Earth and the Sun (which is similar to a new Moon phase).

Lunar eclipse: Occurs when the Moon has a node crossing at or near the time of full Moon, with the Moon passing through the Earth's two shadows.

Opposition: When solar system objects beyond Earth's orbit line up so that the Earth is between the more distant object and the Sun. Objects at opposition rise at sunset and set at sunrise.

Perigee: The minimum distance an object with an elliptically shaped orbit is from the object it's orbiting.

Perihelion: The closest a Sun-orbiting object will be to the Sun.

The plane of the ecliptic: The Earth's orbital path used as a horizontal reference plane for other Sun-orbiting objects within our solar system.

Precession of the axis: A cyclical motion of the Earth lasting nearly 26,000 years. During this time, the poles of the Earth's axis point in a different direction. The motion of the poles, which resemble a spinning top, create a circle in the sky. Any star on or near the precession circle is known as a *pole star*. Precession also causes a shift in the Earth and the relative position of constellations along the plane of the ecliptic. Over time, a constellation's position along the ecliptic will have shifted toward the west (see Resources).

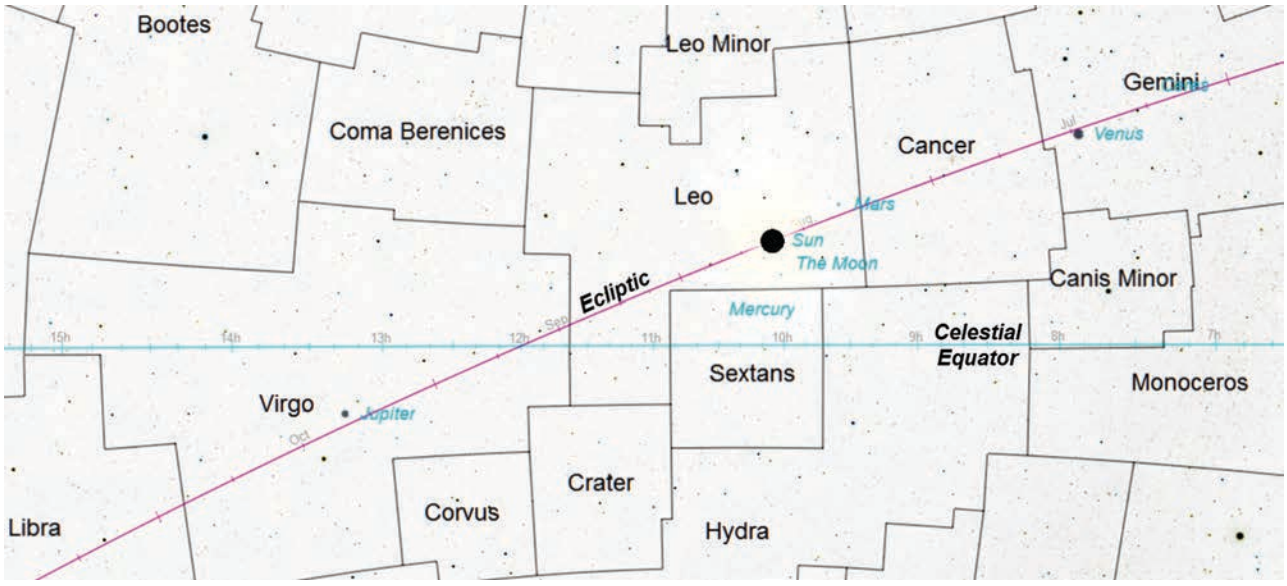
Quadrature: When an outer planet reaches a point along its orbit that places it at a right angle relative to the Earth and Sun.

Retrograde motion: When the faster-moving Earth passes a slower-moving outer planet, the outer planet appears to slow down and move backward toward the west. After a while, the outer planet slows down and resumes its regular motion toward the east.

Solar conjunction: When an outer planet moves behind the Sun or is close to the Sun as viewed from Earth.

Solar eclipse: Occurs when the Moon has a node crossing at or near the time of new Moon.

FIGURE 2: Equatorial map of the sky around the eclipsed Sun



June

1 First quarter Moon
Venus near Uranus
3 Venus at greatest elongation: 45.9°W
Waxing Gibbous Moon near Jupiter
4 Venus at theoretical dichotomy
Neptune at western quadrature
Cassini spacecraft flyby of Pan and Epimetheus
6 Mercury near the Pleiades
8 Moon at apogee: 406,402 km (252,526 mi.)
World Oceans Day
9 Full Moon
Moon near Saturn
10 Jupiter ends retrograde motion
Cassini spacecraft flyby of Pan and Janus
12 Venus at aphelion (0.7282 AU)
14 Moon at descending node
Mercury at ascending node
Earliest sunrise at 40°N
15 Saturn at opposition
16 Neptune begins retrograde motion
17 Last quarter Moon
Cassini spacecraft flyby of Prometheus, Atlas, and Daphnis
19 Mercury at perihelion (0.3075 AU)
20 Moon near Venus
June solstice 00:24 EDT (June 21 4:24 UT)
Sun enters Cancer (astrological)
Mercury at superior conjunction
21 Sun enters Gemini (astronomical)
22 Moon near Aldebaran
23 New Moon (Super Moon no.3)
Moon at perigee: 357,938 km (222,412 mi.)
St. John's Eve (mid-summer)
Cassini spacecraft flyby of Epimetheus, Daphnis, and Pandora
25 *Cassini* spacecraft flyby of Titan
26 Moon near Beehive Cluster
27 Mercury near Mars
Moon at ascending node
Moon near Regulus
Sunset at 40°N
30 First quarter Moon
Cassini spacecraft flyby of Pan, Daphnis, Prometheus, and Janus

July

1 Moon near Jupiter
2 Venus near Pleiades
Halfway through the year (182 days left)
3 Earth at aphelion: 152,093,163 km (94,506,310 mi.; 1.01668 AU)
5 Moon at apogee: 405,934 km (252,235 mi.)
6 Moon near Saturn
Jupiter at eastern quadrature
Cassini spacecraft flyby of Daphnis and Pan
8 Full Moon
9 Mercury near Beehive Cluster
Pluto at opposition
10 *Cassini* flyby of Titan
11 Jupiter and Uranus at heliocentric opposition
12 Moon at descending node
13 *Cassini* spacecraft flyby of Epimetheus, Pandora, Atlas, and Prometheus
16 Last quarter Moon
Venus near Aldebaran
19 Moon near Aldebaran
Cassini flyby of Atlas and Janus
20 Moon near Venus
Sun enters Cancer (astronomical)
21 Moon at perigee: 361,238 km (224,463 mi.)
Uranus at western quadrature
22 Sun enters Leo (astrological)
23 New Moon (Super Moon no. 4)
Mercury at descending node
24 Moon at ascending node
25 Moon near Mercury
Moon near Regulus
Mercury near Regulus
Cassini flyby of Titan and Pan
26 Mars in solar conjunction
27 *Cassini* flyby of Titan
28 Moon near Jupiter
29 Mercury at greatest elongation: 27.2°E
30 First quarter Moon

August

1 Venus near M-35 star cluster
Cassini flyby of Prometheus, Pandora, and Pan
2 Mercury at aphelion (0.4667 AU)
Moon at apogee: 405,026 km (251,671 mi.)

3 Moon near Saturn
Uranus begins retrograde motion
7 Full Moon
Partial lunar eclipse
Cassini flyby of Janus, Atlas, and Epimetheus
8 Moon at descending node
10 Sun enters Leo (astronomical)
11 *Cassini* flyby of Titan
12 Perseid meteor shower
Mercury begins retrograde motion
14 Last quarter Moon
Cassini flyby of Atlas and Prometheus
16 Moon near Aldebaran
18 Moon at perigee: 366,129 km (227,502 mi.)
Moon near Venus
20 Moon near Beehive Cluster
Venus near Pollux
Cassini spacecraft distant flyby of Pandora, Pan, and Daphnis
21 New Moon
Moon at ascending node
Total solar eclipse
22 Sun enters Virgo (astrological)
25 Moon near Jupiter
26 Mercury at inferior conjunction
Cassini flyby of Titan
27 *Cassini* flyby of Janus, Daphnis, Prometheus, Epimetheus, Pandora, and Pan
28 *Cassini* flyby of Titan
29 First quarter Moon
30 Moon at apogee: 404,307 km (251,225 mi.)
Moon near Saturn

Superior conjunction: When an inner planet is on the opposite side of the Sun from the Earth.

Supermoon: Each year, the closest of the perigees, regardless of the phase, is called the "supermoon."

Theoretical dichotomy: When Venus appears equally divided, covered with 50% sunlight and 50% darkness.

Indirectly viewing the eclipse

If you will be viewing the August 21 solar eclipse within the path of totality, take a look at the sky around the eclipsed Sun, when day becomes night. A guide can

Visible planets

Mercury will be visible above the eastern horizon in early June. On June 21, it will move behind the Sun into superior conjunction. In July, Mercury will be visible over the western horizon at sunset. By early August, Mercury will be close to the Sun and approaching inferior conjunction on August 26.

Venus will remain an easily visible morning planet above the eastern horizon through June, July, and August. Venus will reach its greatest western elongation on June 3, meaning that its angle relative to the Earth and Sun will appear to stop its westward retrograde motion and will resume moving east toward the Sun.

Mars will move behind the Sun relative to Earth during June, but will not be visible until later this year.

Ceres will start off the summer months too close to the Sun to be easily seen, but by August, the dwarf planet will rise a couple of hours before the Sun. With a magnitude between 5 and 6, Ceres will be visible with binoculars. Ceres is the closest dwarf planet and one with an active exploration mission in place, known as the *Dawn* mission (see Resources).

Jupiter will be the brightest nighttime planet this summer. Starting in June, Jupiter will be above the southwestern horizon but will set each evening close to sunset due to the Sun's apparent 1° daily motion toward the east, allowing it to catch up with Jupiter.

Saturn will initially be over the eastern horizon a couple of hours after sunset but will be over the southwestern horizon at sunset by the end of summer.

help you determine which planets and bright stars will be visible during totality (Figure 1). If your location is close to but not within the path of totality, the sky may still darken enough for planets and stars to become visible.

It is absolutely safe to watch a lunar eclipse, as there is no harm in looking at moonlight. Viewing a solar eclipse, however, requires proper viewing equipment such as a telescope equipped with a solar filter, which not only reduces the intensity of sunlight but also blocks harmful ultraviolet and infrared radiation. There is another safe way to view the eclipse, known as indirect viewing. Here are a few suggestions for how you can indirectly view the eclipse.

See Eclipse and Shadows in the Resources for pictures of an eclipse using some of the methods described below.

- Go outside and find a place on the ground near a tree where the sunlight is broken by the leaves and branches. The speckled patterns on the ground will show the eclipse.
- If there isn't a tree nearby, a colander can generate eclipsed Sun spots on the ground.
- Spreading and overlapping your fingers to form a lattice will cast a pattern of dark and bright eclipse spots on the ground. During the eclipse, multiple eclipses will form on the ground where sunlight passes through the spaces between your fingers.
- Stuck indoors? Cut or poke a small pinhole in the center of an index card. Then cut a small square of tinfoil a little larger than the hole. Use a hole punch to make a clean hole in the tin foil. Line up the holes and tape the tinfoil to the index card, then tape the index card onto a flat pocket mirror. Lay the mirror on a windowsill facing south toward the Sun and watch a reflection of the eclipse on the ceiling.
- Alternately, mount the mirror on a camera tripod and set it outside so that it will reflect the Sun's image onto a shaded wall. The size of the image increases as the distance between the mirror and wall increases.
- During the eclipse, listen and look around to see how your environment changes (e.g., sounds, colors, how animals react to the changes, and how the air temperature feels).

For students

1. All planets in our solar system have a perihelion and an aphelion. What does this suggest about the shape of a planet's orbit? [*The orbits are not circular but elliptical.*]
2. If you are within the path of totality, you will be able to see the true, or astronomical, position of the Sun once the sky darkens. During August, the Sun will be within the constellation of Leo the Lion, near the western side. How does this compare to the location of the Sun, according to the pseudoscience of astrology? (see Figure 2) [*According to astrology, the Sun will still be within Leo; however, it will be on the opposite side of Leo, near its eastern boundary and less than 24 hours from being in Virgo, the next constellation east.*]
3. View the International Space Station on video or in a picture (see Resources).

Viewing supermoons this summer

This year, the Moon will follow a winding path as it meanders north and south across the plane of the ecliptic. With its approximately 7° inclination from the ecliptic, the Moon's orbit will have its high points and low points. There are also times when the Moon will cross the ecliptic. If the Moon were to cross the ecliptic around the time of a new Moon or full Moon, there would be an eclipse. With this in mind, follow the Moon this summer as it passes by

planets and stars near the ecliptic. This summer, there will be two supermoons, which occur when the Moon reaches its perigee near the time of a full Moon or a new Moon phase. Both of these supermoons, the third and fourth closest this year, will happen near the new Moon phase. ●

RESOURCES

Bobs-Spaces—*www.bobs-spaces.net* (astronomy and viewing information)
Dawn mission—*http://dawn.jpl.nasa.gov*
Great American Eclipse—*www.greatamericaneclipse.com*
Precession—*www-istp.gsfc.nasa.gov/stargaze/Sprecess.htm*
Sky live—*www.theskylive.com* (interactive star map)
Star map—*https://nightsky.jpl.nasa.gov/download-view.cfm?Doc_ID=335*
Sky maps—*www.skymaps.com* (download monthly star map and observing guide)
Solar eclipse—*www.bobs-spaces.net/explore-the-solar-system/2017-august-moon-at-ascending-node-and-a-total-solar-eclipse*
Eclipse and Shadows—*http://tinywild.deviantart.com/journal/Eclipse-and-Shadows-520968860*
United Nations World Oceans Day—*www.un.org/depts/los/reference_files/worldoceansday.htm*
Venus theoretical dichotomy—*http://adsabs.harvard.edu/full/2000JBAA..110...83M*
Viewing the International Space Station—*https://spotthestation.nasa.gov/sightings*
World Oceans Day—*www.worldoceansday.org*

Astronomy Apps

Heavens-Above
ISS Detector Satellite Tracker
SkyPortal
Solar System Scope

Bob Riddle [*bob-riddle@currentsky.com*] is a science educator in Lee's Summit, Missouri. Visit his astronomy website at *www.bobs-spaces.net*.