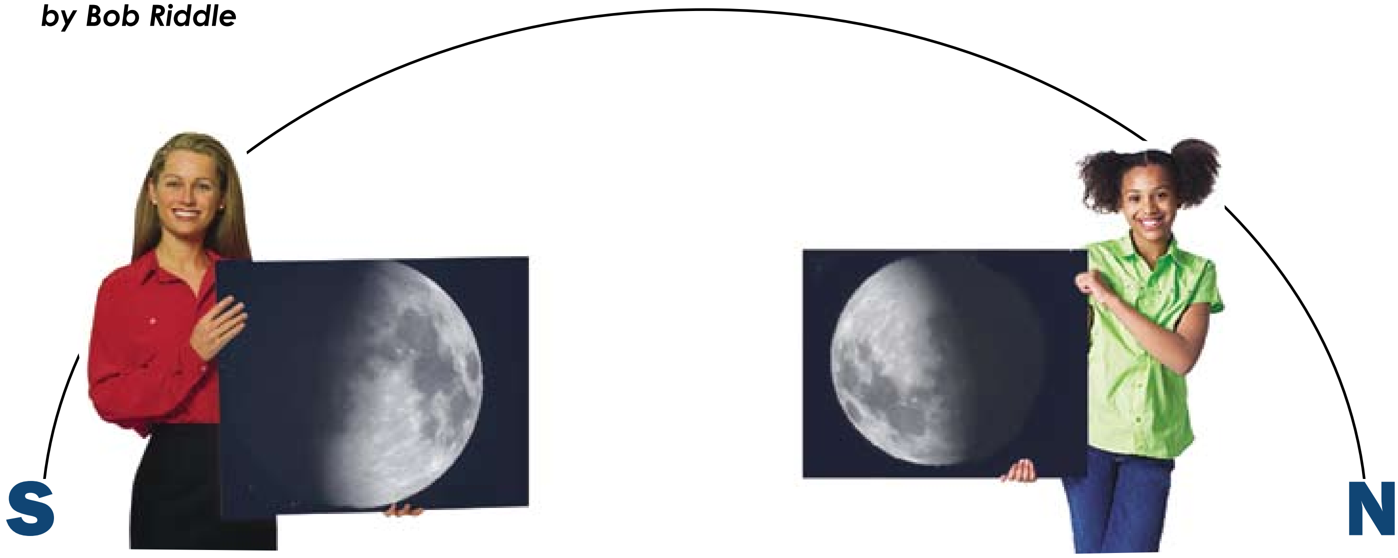
Lunar looks and latitude

by Bob Riddle



During December, the Sun gains a bit of notoriety as its celestial position this month marks a change of seasons, a solstice. The word *solstice* describes the day, or moment, when the Sun stops its north or south apparent motion. It comes from the Latin words *sol* for Sun, and *sistere* for stand still. This month, the Sun reaches the low point in its position relative to the Earth's latitude system for those who live north of the equator. On Sunday morning, December 21st, at 0704 EST, the Sun stands over the Tropic of Capricorn before heading north toward the equator and the March equinox. At that moment, the Sun will have the celestial coordinates of approximately 23.5 degrees south, and 18 hours of right ascension. From our perspective north of the equator at midday, the Sun will be low over our southern horizon. However, from the Southern Hemisphere, the Sun (with the same celestial coordinates) will be at its highest point above the northern horizon.

The height that the Sun reaches in the sky depends entirely on the viewer's latitude. However, regardless of the latitude, the viewer will nearly always have to look toward the equator to view the Sun. This is because of the apparent path the Sun and other celestial objects follow during the day and night. From the Northern Hemisphere we look east, south, and west to follow the apparent paths of most celestial objects, while from the southern hemisphere we look east, north, and west to follow the same celestial objects. Both hemispheres do share one common apparent sky motion, that of *circumpolar motion,* or the apparent circular path objects near either celestial pole follow around their respective celestial pole.

So, what else is different or not different about the sky as seen from north or south of the equator? Figure 1 shows two images of the nearly first quarter Moon at sunset. The longitude is the same for both images, however the latitude for one is 40 degrees north, and the other is 40 degrees south. Can you tell which is which and, if so, how? One way would be to know the general appearance of the Moon using the patterns of the dark areas, or *maria*. However, how many of us know the Moon well enough to differentiate that way? A much easier way, and one that lends itself nicely to teaching Moon phases, is to explore the relationship between the Moon and the Sun. During all lunar phases, the rounded side of the Moon is toward the Sun. And, most noticeably during crescent phases, the points or *cusps* of the Moon always point away from the Sun.

With this in mind, look at both Moon images. Based on the rounded side of the Moon, the Sun must be to the right in image A, and to the left in image B of Figure 1. Because the Moon is waxing during first quarter phase, it will be following the Sun toward the west as the Earth rotates. So this means that image A is the first quarter Moon as seen in the northern hemisphere over the south horizon and image B is the first quarter Moon as viewed from the Southern Hemisphere over the north horizon—both at approximately sunset.

You can have students dynamically or kinesthetically model the differing appearances of the Moon caused by latitude with a hands-on activity. Draw and cut out a circle on a sheet of paper. Color one half of the circle darker to represent the unlit portion of the Moon.

FIGURE 1 First quarter Moon from different latitudes

Southern view Northern view

Hold the cutout with the dark side on the left at arm's length at an upward angle. This is a view of the first quarter Moon as seen facing south from the Northern Hemisphere, north of the equator. The visible (white) rounded side is to the right or west, meaning that the Sun is to the right as well.

Explain that this will be a model that shows how traveling south toward the equator and beyond affects the position and appearance of the Moon. Ask students to predict what would happen to the angle between the Moon and the horizon if you were to travel south. How would the Moon change in appearance? When traveling south, latitude decreases and all celestial objects over the south horizon, including the Moon, will get higher in the sky until reaching the zenith (straight up). Then, as one continues traveling south, those objects near the zenith will start lowering but over the north horizon. Students should imagine that the Moon is following a curved line that goes from due south up to the zenith then down to due north. (In astronomy, this curved line is known as a *meridian*.)

To model the effects of traveling south to the equator, students should increase the angle of their arm, so that the Moon images are directly above their heads. If they were to keep moving south, they would need to lower their arms behind their backs. Rather than snapping their arms off at the shoulder, students can simply turn around and face the opposite direction—toward the north. Be sure that they *do not rotate* the Moon model as they turn around. In other words, at the beginning all students should face the same direction in the room (call this south) and always keep the lighted side of the model toward the wall on their right (west). As they continue to lower their arms facing north, they should observe that the rounded side of the Moon is now to their left, but still toward the west and the Sun.

The conclusion should be, as one student said, "The Moon is the Moon in the sky. It doesn't change, but I do." That student saw that the Moon, when viewed facing south, looks different when you face north and look at the same Moon.

Visible planets over the eastern or western horizon are also viewed differently from other latitudes. The descriptions I use for the visible-planets information is based on a mid-northern latitude, of 40 degrees. The further south one is from that latitude, the higher and better-placed these rising and setting objects will be over the horizon. This month, Mars is described as low over the eastern horizon, so if you live in Florida, for example, Mars will be higher and more easily seen then it will be from further north at 40 degrees.

Visible planets

Mercury will be visible over the western horizon for most of the month and will move east to catch up with Jupiter by month's end.

Venus will be visible over the southwestern horizon at sunset, setting several hours after the Sun.

Mars is still low over the eastern horizon but will start becoming more visible over the eastern horizon before sunrise during this month as it rises earlier each day.

Jupiter will be visible over the western horizon at sunset and will pair off with Mercury on New Year's Eve.

Saturn will be visible over the southeastern horizon before sunset.

December

1 Launch of Herschel-Planck satellite
5 Mars in conjunction with Sun
12 Moon at perigee: 356, 568 km
13 Geminids meteor shower peak
17 50th anniversary of Project Mercury
21 December Solstice (0704 EST)
Cassini spacecraft *Titan* flyby
26 Moon at apogee: 406,602 km
28 Thin waxing crescent Moon near Mercury

Questions for students

1. What effect, if any, does longitude have on one's local view of celestial objects above the horizon?
The only effect your longitude (and consequently, your time zone) will have on your view of celestial objects is the time at which the objects will rise in the east and set in the west.
2. What effect does latitude have on viewing celestial objects?
The altitude of an object is related to the latitude of the observer. Objects appear higher above the horizon for viewers at lesser latitudes, or conversely, lower for viewers at greater latitudes.

3. Toward which direction do the phases of the Moon change? Is there a difference when viewed from either Northern or Southern Hemisphere?
Throughout a lunar cycle the changes in the Moon's phase appearance are always on the side opposite from the Sun—remember the curved side is toward the Sun. In the Northern Hemisphere we see this as increasing from right to left until full Moon, then decreasing from right to left until new Moon. It is the opposite as seen from the Southern Hemisphere.
4. How can you tell which Moon is which in Figure 1 from looking at the patterns of the maria, or lunar seas?
Look at Image A in Figure 1. Notice the rounded lunar sea on the right side? That is Mare Crisium. To the left are two larger rounded maria, and below them is sort of a V-shaped pattern. These are what we first see as the Moon waxes. In the Southern Hemisphere they see the same pattern of lunar seas emerging as the Moon waxes.

Resources

Solar Dynamics Observatory—*http://sdo.gsfc.nasa.gov*
Cassini—*http://saturn.jpl.nasa.gov*
SFA star charts—*http://midnightkite.com/starcharts.html*
Northern and Southern Hemisphere Star Maps—*http://skymaps.com*
Virtual reality lunar phases—*http://tycho.usno.navy.mil/vphase.html*
Complete Sun and Moon data—*http://aa.usno.navy.mil/data/docs/RS_OneDay.php*
Home Planet—*http://fourmilab.ch/homeplanet*

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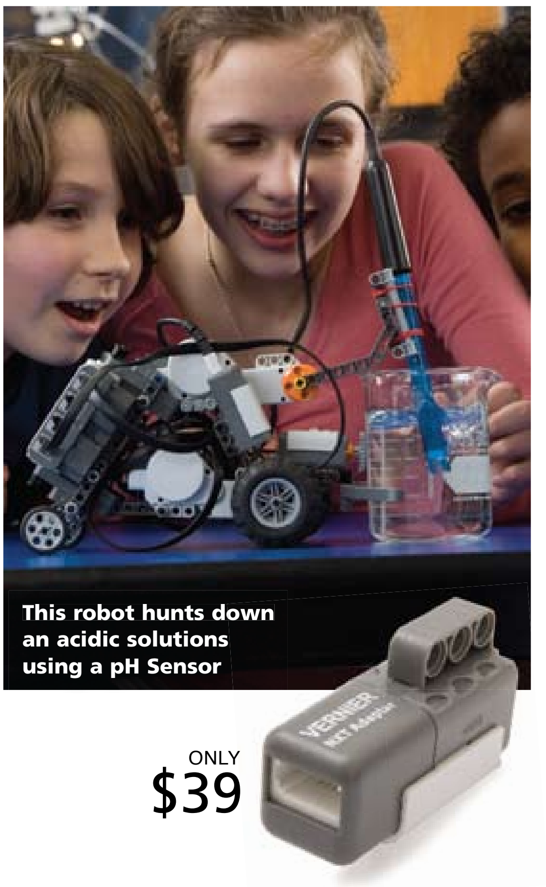
Correction: In the October 2008 Scope on the Skies column, it was incorrectly implied that exoplanet transits of stars cause a momentary dimming of the star's light. In fact, the transits, and consequent dimming, last several hours.



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