Glimpse The Moon's Far Side

Gary Seronik

GET 9% MORE MOON AT NO EXTRA COST — THANKS TO LUNAR LIBRATION!

TWO-FACED MOON On the night this picture was taken, the Moon's southeastern (lower-right) limb was tilted a bit toward Earth, bringing into view a portion of the lunar "far side" and a number of features usually hidden from view.

GARY SERONIK

Maybe it's just my own personal brand of lunacy, but the Moon never fails to impress me. It doesn't matter if it's a swollen orb rising red in the east or a close-up telescopic view of its battered surface — I find the Moon irresistible. Whenever it's up in the sky, you can usually find me eagerly setting up my telescope in the hopes of seeing something new. And one of my favorite places to look is the far side of the Moon.

I can hear you now: "Wait a minute — you can only see one side of the Moon!" That's true, but thanks to *libration* you can from time to time see a bit of the "far side" — the hemisphere that's hidden from our view. How's that possible? Read on!

Aside from its constantly changing phases, the most obvious aspect of the Moon's appearance is that it always presents the same face toward Earth. You might think that having just that one hemisphere in view must mean that the Moon doesn't spin. But you can prove otherwise by walking in a circle around a tree while facing inward, keeping your eye on the tree. Even though the tree is always in view, you'll see the world beyond it slowly spin by. When you've completed one "orbit," you'll have turned through an entire 360° rotation.

In like fashion, the Moon takes the same amount of time to spin once on its axis as it does to travel completely around Earth: 27.3 days.* This apparently amazing coincidence, known as *synchronous rotation,* is actually a common situation among large satellites in our solar system.

How did this come about? The short answer is "tidal friction." When it formed eons ago, the Moon was much, much closer to Earth. That proximity created strong tides on both bodies. Not only did the Moon raise tides in Earth's oceans, but our planet's gravity subtly distorted the lunar interior as well. The Moon probably was rotating much faster then too, but over time the tidal tug of war slowed the Moon's spin rate until it eventually matched its orbital period.

Going Round in Circles

The situation today isn't quite so neat and tidy. While it's true that the Moon always keeps the same side facing Earth, in reality we can see a little more than half of its surface thanks to libration. Sometimes the "man in the Moon" looks as if he's very slowly nodding yes or no to us — or both at the same time — over the course of a month. As a result of this side-to-side and up-and-down nodding,

* This *sidereal period* is measured with respect to the Moon's position among the stars. But since Earth is also moving in its orbit, the Sun's position gradually shifts eastward among the stars. So the Moon takes a bit longer to catch up to the Sun, requiring 29.5 days — its *synodic period* — to cycle from new Moon to new Moon.

over time we actually get to see 59% of the lunar surface.

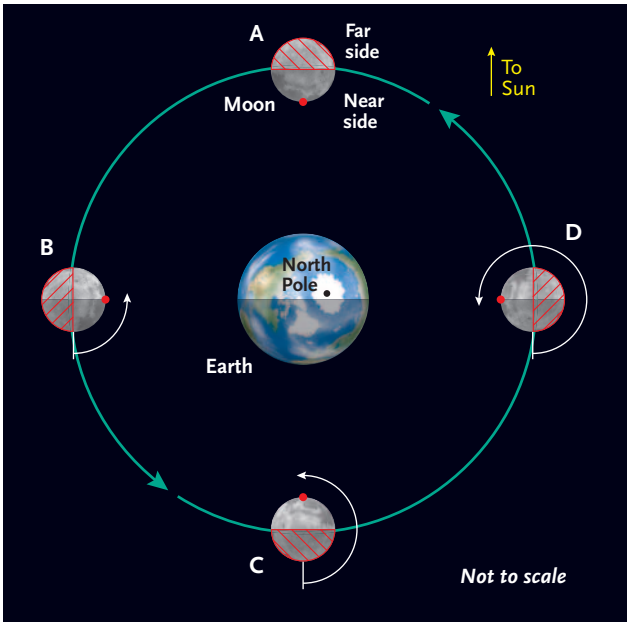
That 9% bonus results from three kinds of libration working in combination (and shown on the next page). The most significant of these is called *libration in longitude,* which allows us to see a little more of the landscape near the Moon's east and west limbs. It can be as much as 7½° in longitude, or about 140 miles at the lunar equator.

Libration in longitude happens because the Moon's orbit isn't a precise circle but rather an ellipse. So the Moon is sometimes a little closer to us than at other times, and as a result its orbital speed varies a bit. But it all averages out so that the Moon completes one orbit in the same time it takes for it to rotate exactly once on its axis. To make more sense of this, imagine you've driven your car for an hour and covered a distance of 40 miles. Although your average speed was 40 miles per hour, you might have moved at 35 mph for half the time and 45 mph for the other half — and you'd still travel 40 miles in an hour.

But the Moon maintains a constant rate of spin even though it speeds up and slows down while circling Earth. So sometimes its orbital speed gets a little ahead of its rotation and we see a bit more of the eastern limb, and sometimes it falls a little behind and we see a little bit more of the western limb.

The second mode is *libration in latitude,* which imparts an up-and-down nodding that brings a bit more of the lunar polar regions into view. The Moon's polar axis is tipped nearly 7° with respect to the plane of its orbit around Earth. So for half of each orbit we see slightly more of the north pole when its tipped toward us, and for the other half we see slightly more of its south pole.

Third (and least important) is *diurnal libration.* This time it's you, the observer, who does all the work. As the Moon rises in the east, you are positioned on one side of our planet, and by the time it sets in the west, Earth's rotation has carried you to the other side. This change in position, about 6,000 miles for viewers in the US and Europe, produces a slight parallax effect that adds about another 1° of libration in longitude.



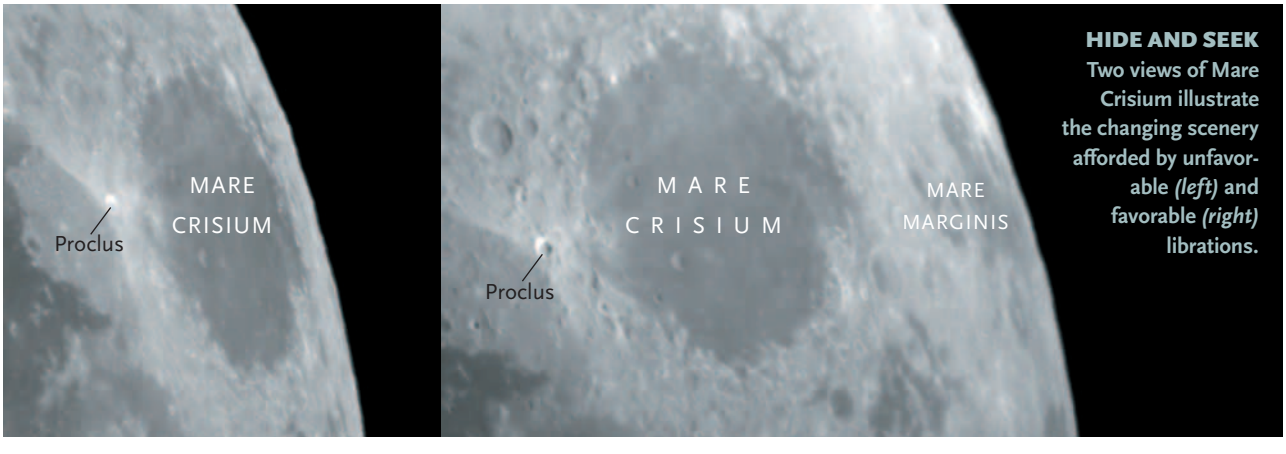
S&T: GREGG DINDERMAN

SPINNING IN SYNC In the time the Moon takes to circle Earth once, it also completes one full rotation on its spin axis. As a result, we mostly see the same side of the Moon facing us at all times.

Observing on the Edge

All of this bobbing and nodding would be little more than an extra-credit problem in trigonometry if it didn't provide something worth seeing. The biggest prize for libration hunters is the Orientale basin, the freshest and best-preserved impact basin on the Moon. It's huge — nearly 600 miles across and sporting three mountainous rings (see page 63). It lies just beyond the Moon's southwestern limb and can be spotted only when the libration is very favorable. Fortunately, especially good opportunities occur in early and late May, and at the end of June.

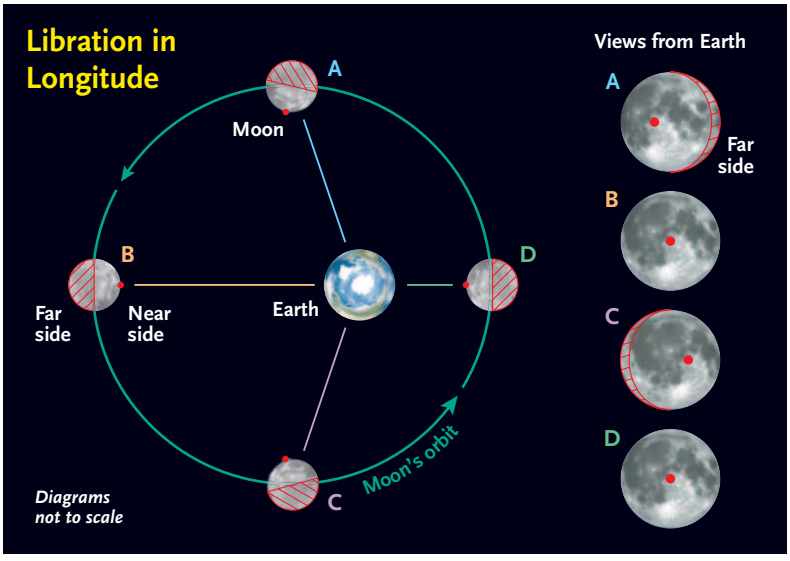
Many other intriguing lunar features can be glimpsed if you take advantage of well-timed librations. In addition to Orientale, a few of my favorites are highlighted on page 69, along with the best dates in April, May, and June to

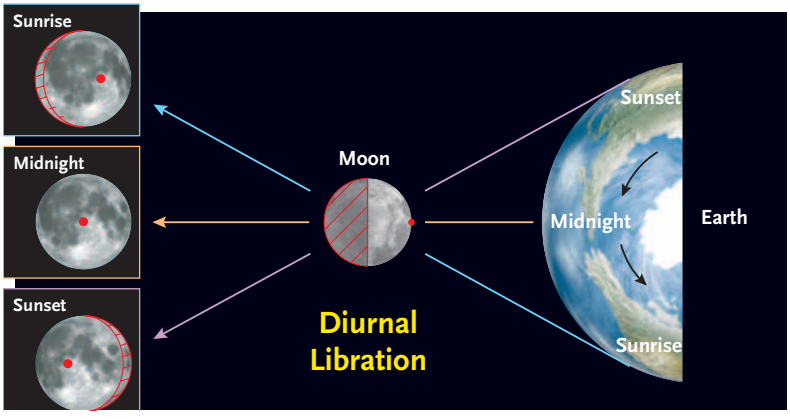


HIDE AND SEEK Two views of Mare Crisium illustrate the changing scenery afforded by unfavorable *(left)* and favorable *(right)* librations.

GARY SERONIK (2)

S&T: GREGG DINDERMAN (3)





look for them. Just remember: you need the right combination of libration and illumination. Not only does the libration have to be favorable, but the limb tipped our way also has to be in sunlight.

A great resource for identifying features in the libration zones near the limb is *Sky & Telescope's Field Map of the Moon*, which features the skilled cartography of Antonín Rükl. And you can find out which limb of the Moon is tipped favorably toward Earth by checking the Exploring the Moon column in each issue of *S&T*.

You can also get a specialized program for your computer. My favorite is Alister Ling's *Lunar Calculator*, which is available as freeware/shareware from www3.telus.net/public/aling/lunarcal/lunarcal.htm.

Perhaps the best all-around computer resource is the freeware program *Virtual Moon Atlas* by Christian Legrand and Patrick Chevalley. Although it doesn't provide as much libration information as *Lunar Calculator*, it does present the Moon's appearance with libration and phase taken into account. It can be downloaded at www.astrosurf.com/avl.

If all these librations have your head spinning, perhaps it's time to pause and pour yourself a libation. That might not improve your understanding of libration, but you'll feel better. All you really have to remember is that if your timing is right you can see 59% of the Moon instead of 50%. I'll drink to that! ✦

A Moon-gazer since childhood, ***Gary Seronik*** *collaborated with Antonín Rükl to produce* Sky & Telescope's Field Map of the Moon *(available from ShopatSky.com).*

Libration in longitude **allows us to view beyond the usual east and west edges of the lunar disk because the Moon's orbital speed isn't constant.** ***Libration in latitude*** **can amount to as much as 6½° and allows us to see a little more of the lunar polar regions.** ***Diurnal libration*** **occurs as our planet's daily rotation carries you from one side of Earth to the other and changes your viewing perspective slightly.**

Libration "Best Bets"

Mare Australe This is one of the weirdest dark-colored "seas" on the Moon. Unlike most maria, which are continuous plains of erupted lava, this one looks like a collection of lava-flooded craters. The biggest of these is Lyot, 87 miles across. Some of Mare Australe can be seen even during so-so librations.

Favorable librations occur April 7th to 14th; May 7th to 11th; and June 5th to 8th.

Mare Marginis As its name implies, this feature really is on the edge of observability. It's easy to locate, though — just find the conspicuous oval of Mare Crisium and shift your gaze limbward. After you've found Marginis, head south to Mare Smythii, which requires favorable libration to be seen. Between these two dark lunar "seas" is the complex 85-mile-wide crater Neper, which can be tough to identify.

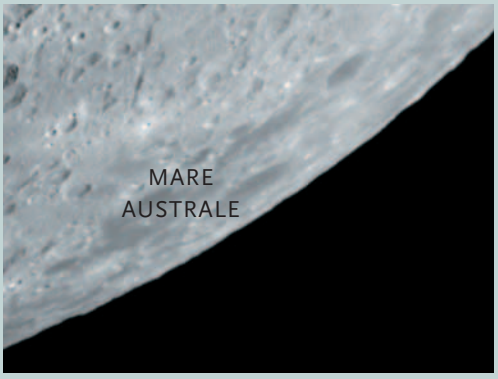
Favorable librations occur April 12th to 18th; May 10th to 15th; and June 6th to 13th.

Mare Orientale Lying just beyond the Moon's southwestern limb, this complex feature is nearly 600 miles across and sports three mountainous rings. These rims are most obvious in the days just before full Moon, whereas the dark, lava-flooded floor of Mare Orientale and the finger-like flows Lacus Veris and Lacus Autumni are seen best around the time of last quarter. See page 63 for an observing guide.

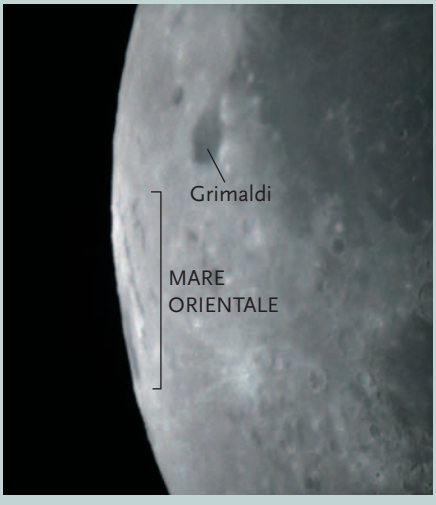
Favorable librations occur on April 2nd and 3rd; from April 30th to May 3rd; May 27th to June 1st; and June 24th to 28th.

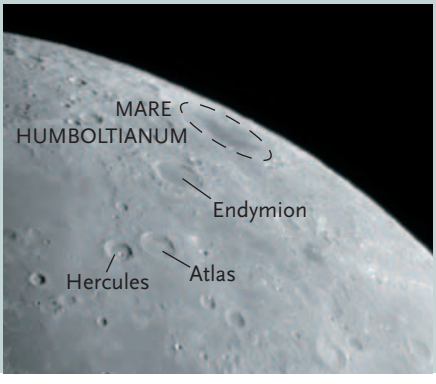
Mare Humboldtianum While you're looking for Mare Marginis, slide northward from Crisium to have a look at another limb-hugging lunar plain. You can home in on Mare Humboldtianum by first locating the paired craters Hercules and Atlas, then moving toward the limb past the lava-filled crater Endymion, which is 76 miles across.

Favorable librations occur April 15th to 20th; May 12th to 19th; and June 8th to 16th.



To get a feel for the Moon's "bobblehead" motion, check out the time-lapse animation at SkyandTelescope.com/LibrationMovie.





GARY SERONIK (4)