

One Good Target

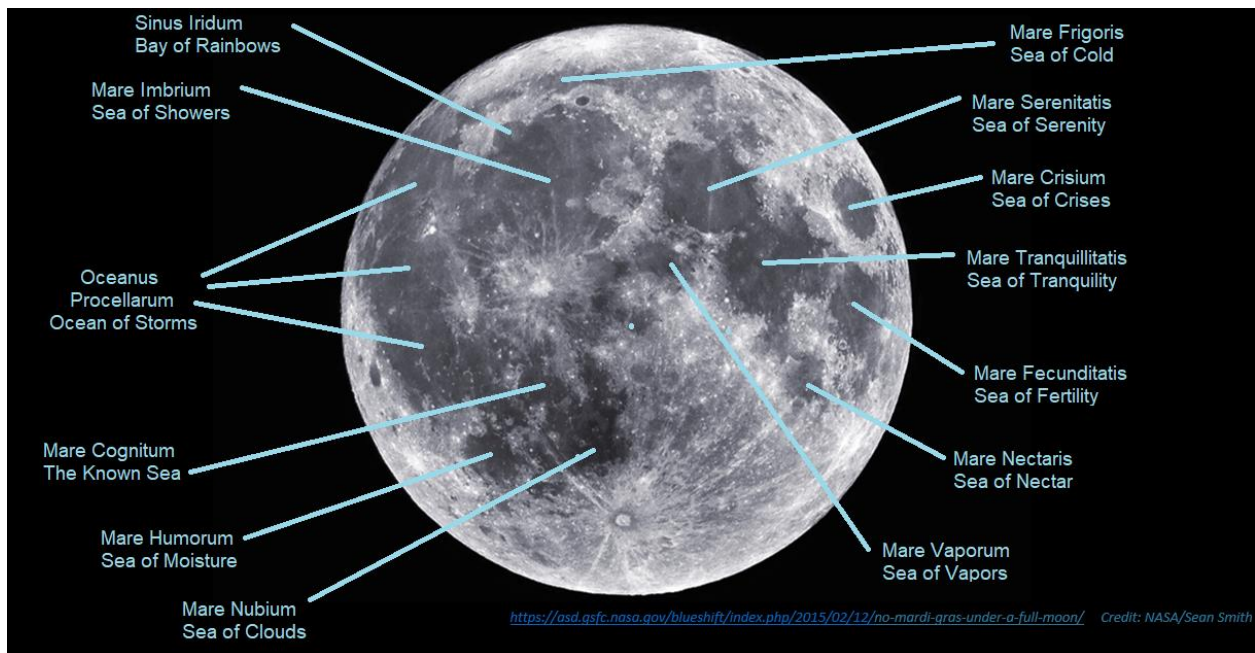
With Some Other Sights Worth Seeing
While You're in the Neighborhood

November

Making the Most of the Full Moon

Visual astronomers learn early on that the best views of the Moon are found along the *terminator*, the line dividing day and night: that's where lunar sunrise and sunset are happening, so the shadows are long and the features they reveal are therefore prominent. But as the Sun rises higher in the lunar sky, the shadows become shorter and the features less distinct, until we reach full Moon, when the Sun strikes the visible side of the Moon full-on, the shadows disappear, and the features that stood out so boldly in the preceding days are nowhere to be found. Not only is the Moon a suddenly uninteresting view, but to make things worse, the full Moon's intense brightness washes out everything else in a large area of the sky around it, making otherwise bright targets faint and faint ones invisible. As a result, the days around full Moon are when many observers leave their optics in the case, and catch up on their reading instead. But it doesn't have to be a total loss, because even when it's full, our Moon still displays a few sights worth looking at – if you know where to look and what to look for.

Major features of the Moon: The Principal Maria



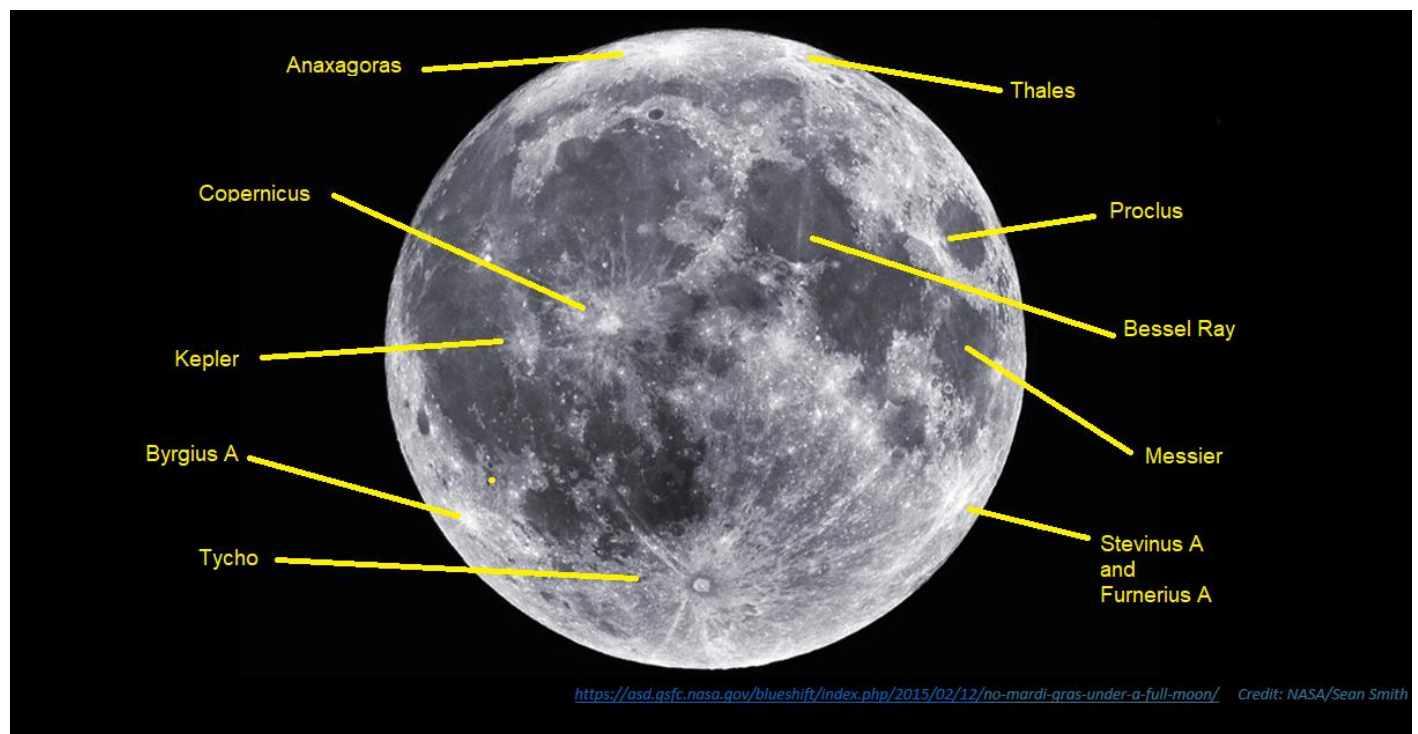
Note: Although it wasn't always this way, the current convention is that directions on the Moon's surface are given with north at the top, east to the right, and west to the left, just like on Earth maps, and not as on sky charts (where north is up, east is to the left and west to the right).

Also note that although some of the features discussed here can be seen without magnification – particularly the lunar “seas,” mountain ranges, and the larger rayed craters – it's not a good idea to observe the full moon naked eye because of its intense brightness, and neutral density filters should be used for all binocular or telescope views. If you want to observe it without magnification, sunglasses can reduce the glare below painful levels.

Since the locations of lunar features are often tied to a nearby lunar sea (Latin *mare*, plural *maria*), it's helpful to know which is which, and full Moon is a good opportunity to review that. A chart showing the major maria appears above. People have devised various memory aids to help them remember which mare is which: Mare Frigoris (the Cold Sea) is near the Moon's north pole, where we expect to find cold temperatures; Mare Vaporum (Sea of Vapors) marks the Man in the Moon's nose, where vapors would be inhaled; the Man in the Moon's eyes are Mare Imbrium and Mare Serenitatis, whose initials can stand for “I see”; Serenity is linked to Tranquility; Clouds arise from Moisture. Use (or make up) whatever memory aids work for you.

Although all of the Moon's “seas” are the lava-filled remains of huge ancient impact basins, careful examination reveals that they aren't all the same color. The lava that filled the Tranquillitatis and Fecunditatis basins had a higher proportion of iron and titanium dioxide, making them appear darker than the lava that formed Mare Imbrium and Oceanus Procellarum. Mare Serenitatis shows dark lava near its edges and lighter lava at its center because the center was flooded a second time, but the lighter-colored second round of lava flows were less extensive and did not reach all the way to the edges of the darker original mare.

Lunar ray systems

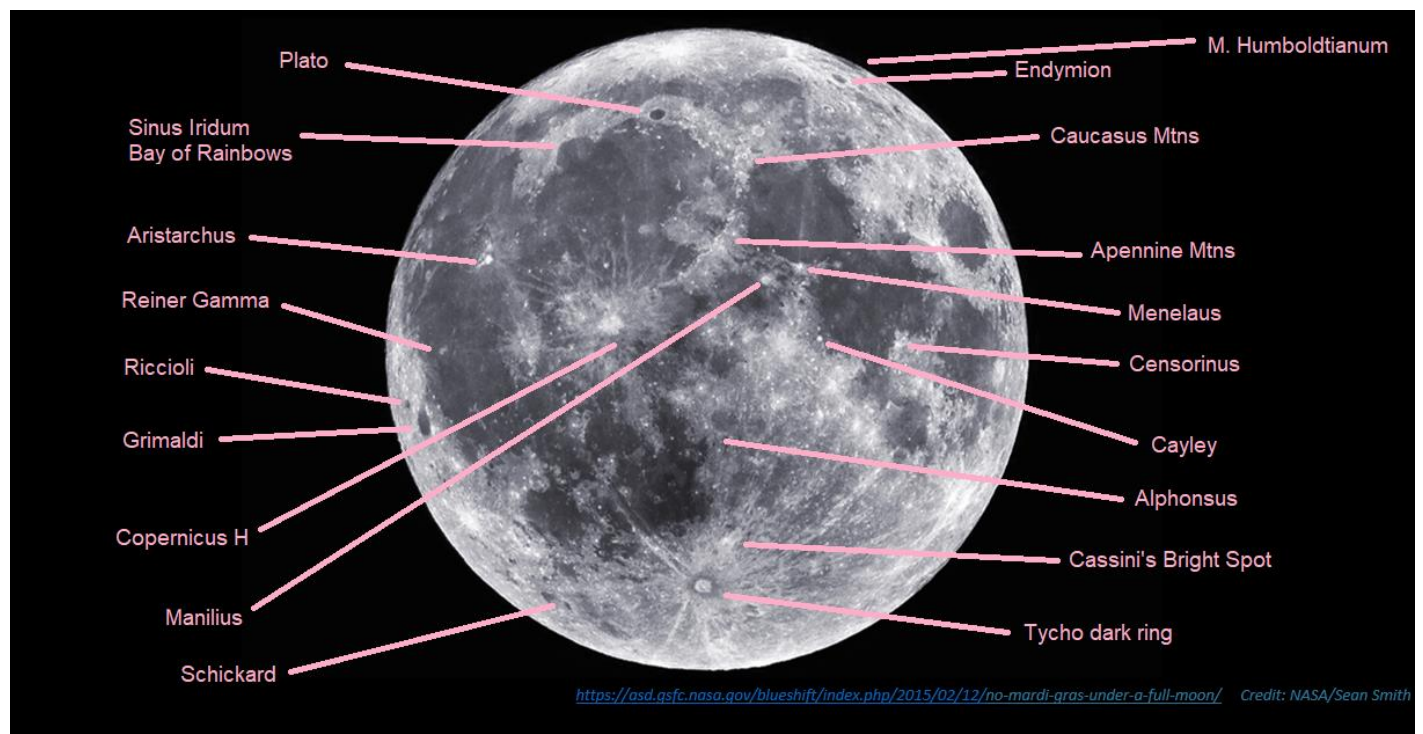


After the dark maria, the next most noticeable feature of the full Moon is its multiple rayed craters. Although the lunar highlands are much lighter in color than the dark basalt of the maria, they are distinctly gray, not white. The highlands rock is constantly bombarded by micrometeors that reach the surface unimpeded by any significant atmosphere, producing a layer of powdery material called *regolith* that covers the surface; the regolith is then further bombarded by solar particles that darken the color of the surface layer, leaving lighter-colored material below. When craters are formed, the impact often dredges up this light colored material and throws it for sometimes extreme distances across the face of the Moon. When the Moon is full, the resulting bright rays are easily visible against both the gray highlands and the darker maria. They're more difficult to see under lower illumination.

The most extensive ray system emanates from crater **Tycho**, near the lunar south pole. Tycho is the youngest major crater on the visible side of the Moon, formed only about 100 million years ago. The impact that produced Tycho threw light-colored debris at least as far as Mare Nectaris to the northeast and Mare Cognitum to the northwest, and possibly as far as Mare Serenitatis, where a white stripe known as the **Bessel Ray** – which traces back towards either Tycho or the much closer crater Menelaus (discussed further below) – crosses the mare basalt from south to north, 1500 km from the Tycho impact spot.

Major ray systems also emanate from craters **Anaxagoras** and **Thales** near the Moon's north pole, **Kepler** and its big brother **Copernicus** near center, the overlapping **Stevinus A** and **Furnerius A** systems in the southeast, and **Byrgius A** in the southwest. *Copernicus* is a relatively recent crater, only 800 million years old, and has the largest ray system after Tycho, extending 800 km from the impact site. The rays emanating from *Thales* and *Anaxagoras* splash across all the other nearby structures, indicating that these craters represent the most recent major events in the Moon's northern reaches. *Stevinus A*, *Furnerius A*, and *Byrgius A* are all very small craters, difficult to see when they're on the terminator, but clearly marked at full Moon by their prominent rays.

Other Bright and Dark features of the full Moon



Some ray systems don't extend in all directions from their impact site. **Tycho**, for instance, shows no rays to the west, while **Copernicus** has a relatively ray-free area to the SE, and the **Thales** rays extend west and SE but not north. Rays extend from **Proclus**, on the west shore of Mare Crisium, in every direction except SW – suggesting a low-angle ($\leq 15^\circ$) impact from that direction – while the twin parallel rays of craters **Messier** and **Messier A** run only westward from the center of Mare Fecunditatis, suggesting a very low ($\leq 5^\circ$) impact from the east.

In addition to its various bright ray systems, the full Moon also displays a number of **very bright craters**, characteristically consisting of a ring of bright ejecta surrounding a fairly recent (and often quite small) impact site. The brightest feature on the Moon's visible face is crater **Aristarchus**, in the Moon's NW quadrant. Aristarchus is a large 450 million year old crater, younger and brighter than Copernicus, but lacking its prominent ray system. While subtle rays extend from Aristarchus to the south and east, its only bright extension is a narrow blanket of light-colored ejecta pointing to the SW – it's often referred to as *the comet tail*. The crater sits on the SE wall of a large diamond-shaped raised area known as the **Aristarchus Plateau**, measuring 170 km from east to west and 200 km north to south, whose walls tower up to 2 km above the surrounding mare terrain. The plateau is darker than the mare, and consists of basalt glass and crystal formed in volcanic eruptions: it's the largest pyroclastic deposit anywhere on the Moon. It's been described as having a reddish, yellowish, olive, "mustard green," or ruddy coloring.

Other prominent bright craters include **Menelaus** and **Manilius**, occupying a strip of highlands between Mare Serenitatis and Mare Vaporum, and craters **Cayley** and **Censorinus**, which sit across from one another on the southern shore of Mare Tranquillitatis. *Censorinus* is an extremely small crater, only 3.8 km across, and is very difficult to see even when it's on the terminator – it's only under high illumination that its surrounding ring of light-colored material makes Censorinus stand out.

Another bright feature is known as **Cassini's Bright Spot**, an intensely light-colored patch lying near the origin of one of the rays of Tycho. It's believed to be the "whitish cloud" described by Italian observer G. D. Cassini in 1671. The Moon's most perplexing bright feature is **Reiner Gamma**, a bright oval swirl on the surface of Oceanus Procellarum, near the lunar equator on the Moon's west side. Its nature is mysterious: it is evidently quite flat, and marks one of the most powerful magnetic fields on the Moon. While it is the only "swirl" feature on the visible side, there are two others on the far side, both of which are similarly associated with strong local magnetic fields. The questions of how they formed, and what they consist of, both remain unanswered.

The full Moon also shows us a number of prominent **dark features**, many of them flooded-floor craters where lava seeped up through cracks in the crater floor, or in some instances spilled in from outside when rising lava inundated the area around the crater and overtopped its walls. The most easily seen flooded crater is **Plato**, a large crater just below Mare Frigoris in the Moon's north. Others include **Endymion** near the Moon's NE limb, and the very dark crater **Grimaldi** and its companion **Riccioli** along the Moon's western edge. The dark floor of *Endymion* is spattered with several small bright patches (part of the ray system of crater Thales to its west), while directly above Endymion, its dark form is echoed during favorable librations by **Mare Humboldtianum** on the Moon's northernmost edge.

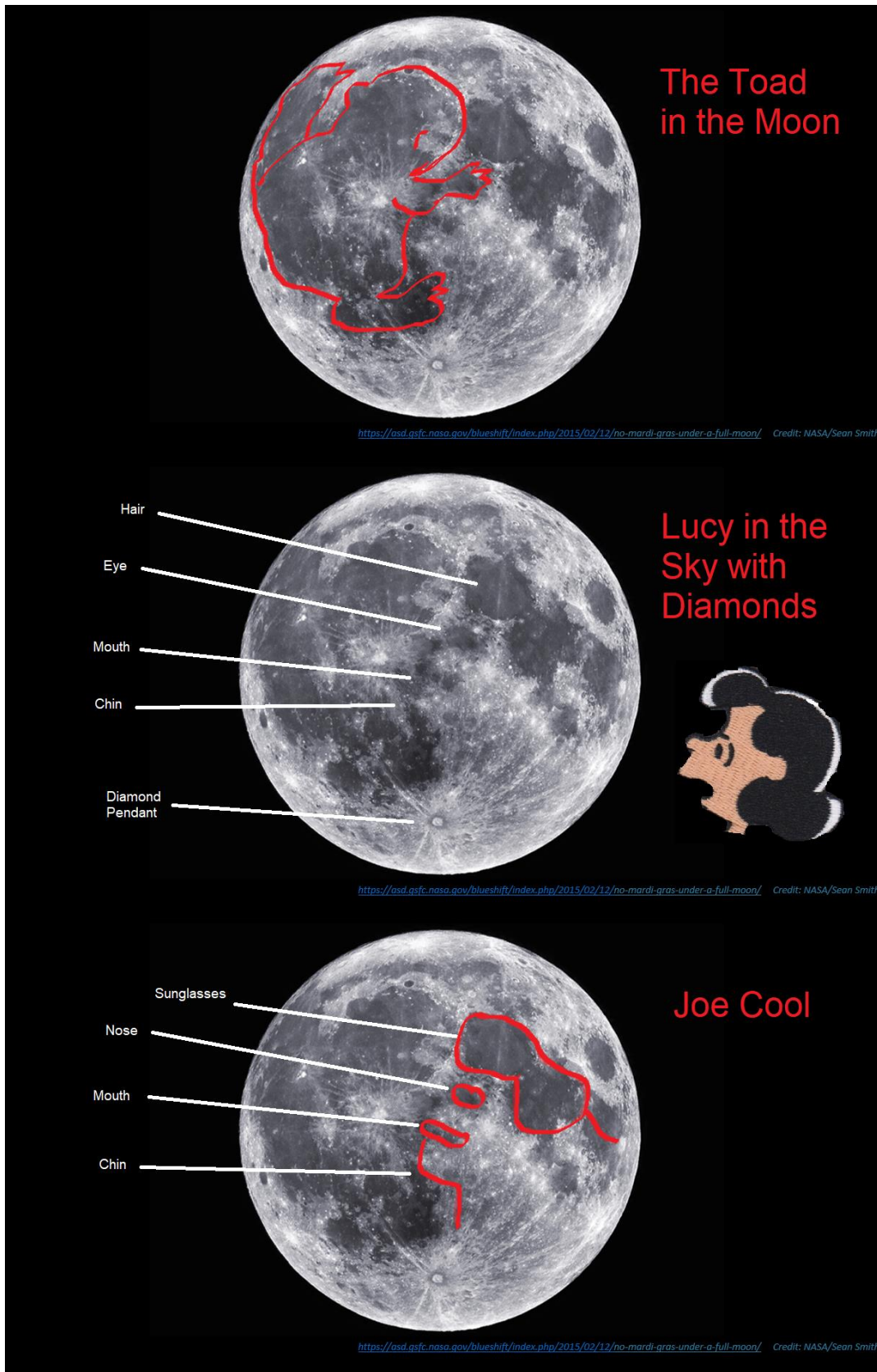
Crater **Alphonsus** is a large (118 km) crater occupying the middle spot in a similarly-sized north-south trio near the first quarter terminator and midway between the Moon's equator and its south pole. It does not exhibit a dark flooded floor, but its generally light-colored floor does show us a number of small dark spots. Best seen under high illumination, these dark halos represent cinder cones and surrounding ash deposits where pockets of magma erupted 3 to 4 billion years ago. The oval floor of crater **Schickard**, near the SW limb, is similarly two-toned under high illumination: it is believed that light-colored highlands material thrown out by the Orientale Basin impact landed on Schickard's already-flooded floor, leaving a wide bright stripe across the dark lava.

Rayed craters **Copernicus** and **Tycho** also display interesting dark features. The bright *Tycho* crater is surrounded by a 150 km wide ring of very dark material that was melted into a dark glass by the force of the Tycho impact. In the case of *Copernicus*, there is a tiny (15 km wide), perfectly round, and intensely dark spot visible just SE of the rayed crater. This dark crater, called **Copernicus H**, penetrated the apron of light-colored rock thrown out by the Copernicus impact, exposing the dark pulverized mare lava underneath.

Lunar pareidolia: the Man in the Moon and his friends

The contrast between the dark maria and the lighter highlands areas has inspired a wide range of fanciful images hidden in the full Moon. A few of the better known ones are shown below, but there are many others. One of my favorites that's not shown here – Jack and the Mutant Beaver – can be found at <https://www.cloudynights.com/topic/101963-memorizing-the-maria/> Don't say I didn't warn you!





The Toad
in the Moon

Lucy in the
Sky with
Diamonds



Joe Cool

Now let's spend some time enjoying the full Moon, instead of just wishing it would go away!

Rick Gering / November 2024