

# Under the Big Top

## Spring 2020

In my Fall 2019 Newsletter, “**A Cosmic Conundrum**”, I wrote about a few of the over-hyped astronomy events that are often detrimental to popularizing our wonderful hobby. And, while most of the real work in astronomy is done in the outlying venues, where professionals hone their craft working long nights and longer days collecting, analyzing, and re-evaluating data, the large public crowds are attracted to the big discoveries that make up the eye-popping and exciting acts in the three-ring big top tent.

So, in this issue we’ll address a couple big-time astronomy showstoppers; the E-ticket rides that the public stands in line to experience. You may be surprised to find that these high-demand, flashy items are available to anybody! Well, how can that be; can we all get the experience of a masterpiece? Let’s just say it’s often about timing, perspective, and maybe just a bit of travel. So, “Wanna take a ride?” Get a ticket, hop aboard, and remember to keep your hands and arms inside the ride at all times...

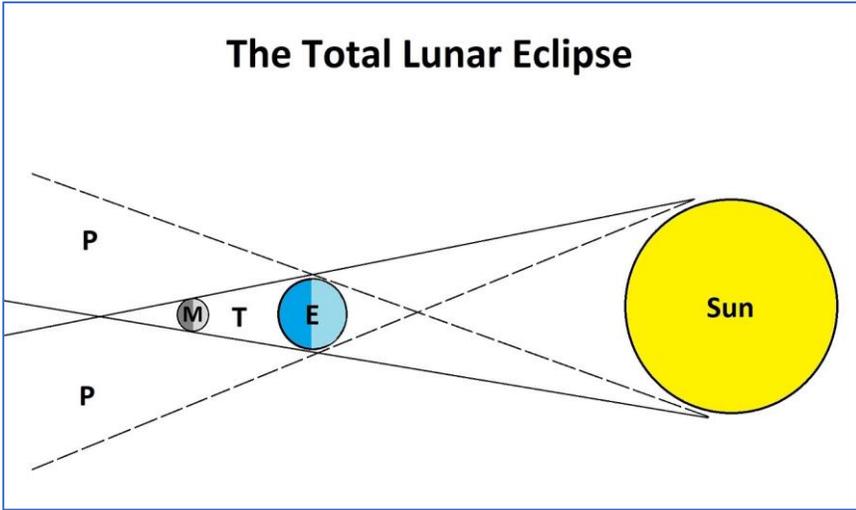
Just as we began in, “A Cosmic Conundrum”, the first, and perhaps most surprising “super ride” is **The Moon**. No, I’m not talking about the made-up “Super Moon”, though a naked-eye view of a huge rising full moon is often mesmerizing all by itself. I’m talking about the wondrous sights and events that the moon gifts us on a regular basis; it’s just a matter of knowing **WHEN** to look, and **WHAT** to look for! In my years as a Kitt Peak Guide I found that, while astronomers just hate the moon, few things elicit more “ooh’s-and-aaah’s” from the public and visitors than a telescopic view of our nearest neighbor. When viewed at the right time, using the proper equipment, the moon is a stunning visual spectacle.



Look at these two images of the Moon – they are the same lunar features, at the same scale. The difference is that the image at left was taken at **FULL MOON**, while the right image was taken during **HALF MOON** (first quarter). Notice the detail and subtle structures visible during first quarter – the dark shadows contrast with the bright features to provide a deep and pleasing 3-D effect. Shadows and detail are washed out at full moon – plus, it’s 10 times brighter and it hurts your eyes to look at it! You want to see the other half? Wait until **LAST QUARTER**! Viewing the moon is all about timing. Be sure to reference my winter newsletter calendar to book your own E-Ticket views of The Moon.

So, the moon offers beautiful views regularly, month after month. But, even at its worst, during the bleached out, over-bright full moon, we can occasionally catch something wonderful. It's only during full moon that half the earthlings on the planet are treated to a total lunar eclipse. With a precise Moon-Earth-Sun alignment, our moon eases into Earth's shadow, giving us what's called the "**Blood Moon**".

### The Total Lunar Eclipse



**The diagram (left) shows the Moon-Earth-Sun alignment for a total lunar eclipse – with the Moon in Earth's shadow. Not all eclipses are equal however! The lines show where light from the Sun reaches. If Luna lies in the "P" region, some sunlight still gets through; it's a *PENUMBRAL eclipse*, and our shadow is nearly invisible. The "T" marks the zone of totality – where sunlight can't reach – and then we get the Nick Dugan image seen on the right. But why red? Sunlight passes through Earth's atmosphere and gets "bent" toward the red end of the spectrum. The Blood Moon is the result of all sunsets from Earth lighting up the moon at the same time – a rare and beautiful display!**

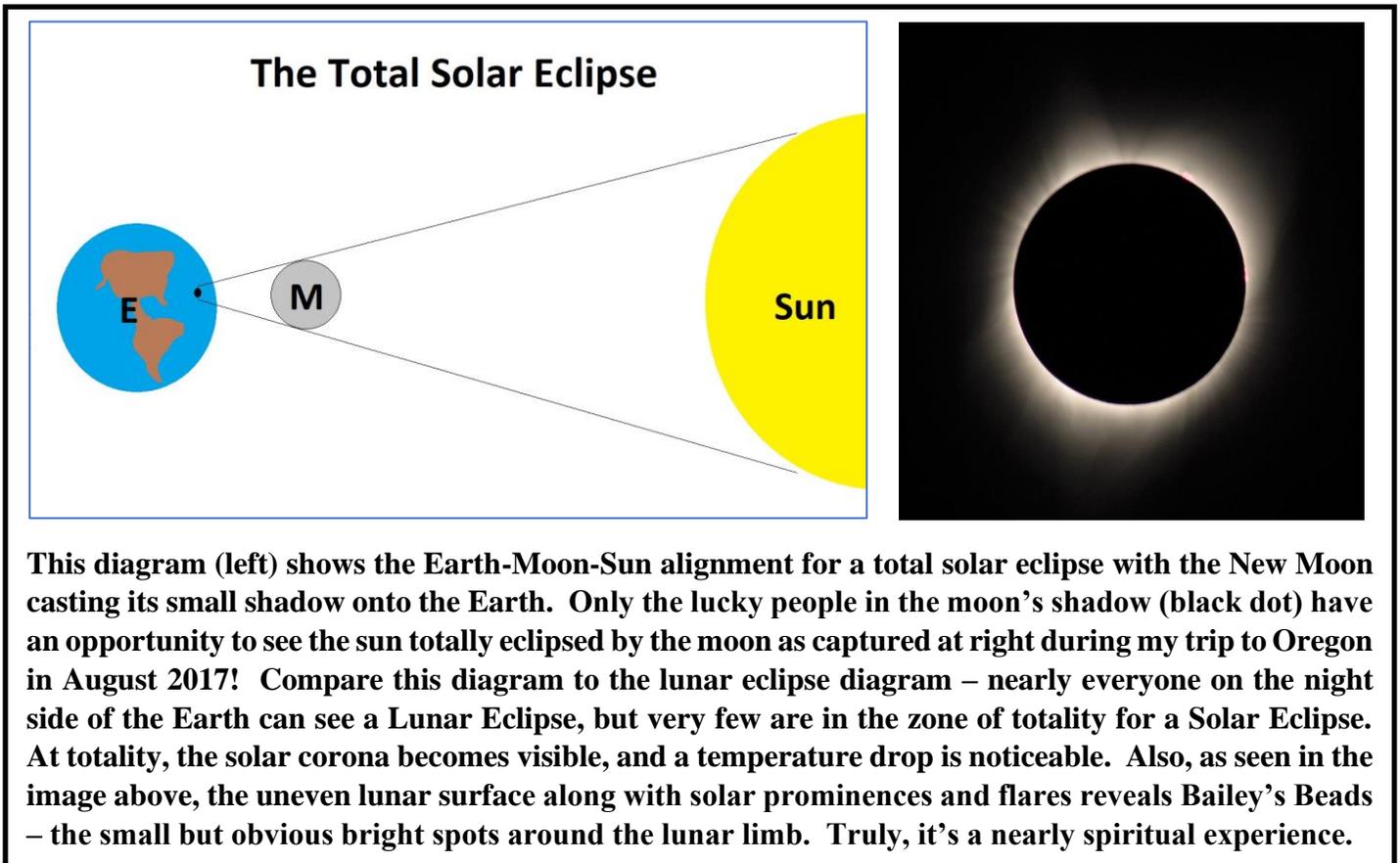
Unfortunately, a check of NASA's Lunar Eclipse Page shows that the last total lunar eclipse visible to everyone in the United States was in January 2019, and the next won't come until March 14, 2025. For die-hards, there are a handful of penumbral and partial eclipses, and two "totals" that will be visible to half of the U.S. between now and then. To check out the schedule for yourself, visit their page at: <https://eclipse.gsfc.nasa.gov/lunar.html>.

So, the moon provides gorgeous views during half of each month, and even a full moon can bring a surprise event on the rare occasion. But, what about when there is no moon in the sky? More specifically, what do we get at New Moon? Well, that could be the biggest astronomical thrill-ride yet! The Earth-Moon-Sun alignment during new moon is the only time that a comparative handful of people on the planet are treated to one of the rarest spectacles of all – a full **SOLAR ECLIPSE**. Why is it that the solar eclipse is rarer, viewed by far fewer, more challenging and exhilarating than other eclipses?

Consider this:

As of this date, there are nearly 200 moons (give or take) orbiting the planets (and Pluto) in our solar system. There are also, at any one time, a couple dozen still awaiting "official confirmation". While Earth only has the single moon, its size and distance combine to make ours one of the most unique relationships in the known universe. Our moon is approximately 1/400<sup>th</sup> the size of the sun. But, while the sun is 400 times LARGER, it is also about 400 times MORE DISTANT than our moon. This means that, at certain very specific times, the apparent size of the moon in our sky is almost exactly equal to the apparent size of the sun! This relative size equality is what makes a solar eclipse so stunning and why it offers so many fascinating features during the time of totality.

It is said that, on no other planet, is there any moon, anywhere, that so nearly matches the size of the sun in their sky. The unique spectacle of a solar eclipse, as we know it, is ONLY visible from Earth, and ONLY visible at this specific time, in Earth's history.



This diagram (left) shows the Earth-Moon-Sun alignment for a total solar eclipse with the New Moon casting its small shadow onto the Earth. Only the lucky people in the moon's shadow (black dot) have an opportunity to see the sun totally eclipsed by the moon as captured at right during my trip to Oregon in August 2017! Compare this diagram to the lunar eclipse diagram – nearly everyone on the night side of the Earth can see a Lunar Eclipse, but very few are in the zone of totality for a Solar Eclipse. At totality, the solar corona becomes visible, and a temperature drop is noticeable. Also, as seen in the image above, the uneven lunar surface along with solar prominences and flares reveals Bailey's Beads – the small but obvious bright spots around the lunar limb. Truly, it's a nearly spiritual experience.

As rare and exciting as a total solar eclipse is, these events too have their "good ones and bad ones". As I mentioned above, you must be in the path of the moon's shadow, as it sweeps across the planet, if you want to see the full Monte! The shadow is only about 100 miles in diameter, and it races over the surface at about 1,000 miles per hour! If you're one of the fortunate ones, you could see totality for anywhere from less than a minute up to about 7 minutes if conditions are perfect.

Yes, we're a lucky group of people – but nothing lasts forever, and sometimes the eclipse gods conspire to steal our pleasures. I mentioned that a total solar eclipse happens at "specific times". Remember the Super Moon from previous newsletters? The moon appears larger or smaller as it travels in its elliptical orbit about the Earth. When Luna is further away, it looks smaller in the sky, and at that time it isn't quite the same size as the sun...it's just a bit smaller. If the sun is eclipsed at this point, totality is robbed, and we suffer the indignation of an **ANNULAR eclipse** – or, "**The Ring of Fire**".



I suppose it's a matter of perspective, but I would want the full effect of a total solar eclipse. Somehow the annular version of this Earth-only event just doesn't capture my passion – but, opinions vary. In any case, solar eclipses of all types can be tracked on the NASA Eclipse Pages. Here in Arizona, we will be treated to a very convenient and spectacular annular eclipse on October 14, 2023. The path of totality will pass right over the Four-Corners area here in the southwest. The event will happen at about 4:30pm, and last for about 5 minutes. Make plans by visiting the NASA Page at: <https://eclipse.gsfc.nasa.gov/solar.html>

For the purists out there, the next **“Great American Eclipse”**, and the one for which I am already making plans, is scheduled for **April 8, 2024**. The path of totality will run from Texas’ southwestern border all the way up to Maine. At my Oregon 2017 event, totality lasted for 2 minutes and 10 seconds. True to Texas form, the 2024 eclipse will be even bigger and better; totality in the Lone Star State should last for nearly 4-and-a-half minutes! A true Triple-E-ticket ride!

And, be sure not to miss the next Great American Eclipse; remember, I said that nothing lasts forever? The moon is getting about 1 inch further away from Earth each year. In about 1 million years, the total solar eclipse that we Earthlings enjoy, will be no more. At that time, in the distant future, we will only get solar eclipses of the annular variety. I may be gone before we get to that point, but if not, I’ll be sure to warn you when we’re getting close!

Now, to be sure, not EVERYTHING interesting is an eclipse...well, at least it’s not CALLED an eclipse. In the last newsletter, “Just Going Through the Motions”, I pointed out that the moon was going to eclipse Mars on February 18, 2020. This type of an event is called an **OCCULTATION**, and they are fairly common occurrences. Asteroids at times will pass in front of a star, and the Sun will pass in front of stars that are near the ecliptic all the time. When the sun occults a star, we can’t see it...it’s DAYTIME! The moon too travels near the ecliptic, so it can sometimes pass in front of a star or a planet, at night – and that’s what happened on February 18, 2020 at about 4:30am. We don’t often notice that the moon moves from west to east in our sky, but an occultation provides just this sort of confirmation. I was able to make some time from 3:30am until about 6am to get some photos. They are not great – astrophotography is not my strong suit – but here is a series to capture the event.



**Just before dawn on February 18, 2020, at approximately 4:30am, the moon raced toward Mars, low in the southeastern sky. You can see the small, slightly reddish planet just below the moon’s waning crescent in the image at far left. As the crescent moon continues down toward the southeastern horizon, I captured a small Mars, just as it kissed the lunar limb, near the bottom in the center image. Finally, about an hour later at 5:40am, I caught the God of War as it emerged on the other side of the moon. You see it just coming out on the upper right of the moon’s “dark side” in the image at far right. Notice also the ghostly faint glow of “earthshine” as it subtly illuminates the moon’s dark side in all three shots!**

We also saw the passing of two era’s in 2019. The first, and more significant, in February 2019, NASA JPL announced that the **Opportunity Rover** on Mars had finally succumbed to the brutal Martian elements. In fact, contact was lost with the plucky explorer six months earlier, during a massive Martian dust storm. The agency held out hope that power could ultimately be restored, but the solar panels never recovered from the extended loss of the sun’s lifegiving light. Landing on the Red Planet in January 2004, Opportunity was to last 90 Sols (Martian days). Instead, it amazingly provided service and data for 15 years – a truly historic achievement. RIP Opportunity (Jan. 2004 – Feb. 2019).

The second passing, while arguably less historic, was quite often more visible. As of the end of 2019, the **Iridium Satellite System** is no more. The last of the venerable orbiting communications platforms was lost or de-orbited by year's end. Iridium satellites had large solar panels and antennae that were highly reflective, and these often made it possible to spot them sailing through the constellations during the pre-dawn and post-dusk hours. During the Nightly Programs at Kitt Peak, we guides often took special note of when these beauties would pass overhead. When properly oriented, they would often become the brightest object in the sky, surpassing even Venus, for a few seconds. Visitors loved the "**Iridium Flares**", and it's sad to now realize that we will see them no more.

**The following section has been reviewed and updated for Corona Virus Impacts:**

There are a couple of things to look forward to on the Spring Calendar. First up, there are two meteor showers coming, one each in April and May. The **May 5th Eta Aquarid** shower only peaks at about 20 per hour. However, with a nearly full moon in the sky, they might be best seen in the pre-dawn skies. The **April 21st Lyrid** shower is a different story though. While boasting the same peak rate of 20 per hour, they come at nearly the new moon! This gives you the best chance of seeing a decent display at nearly any hour of the night. In fact, I will be one of the featured guides/observers at the Sun City & Oro Valley Astronomy Club on that very night. If you want more info about **SCOVAC**, let me know – I'd be happy to pass your info on to the club president!

Next up, **Saturday May 2<sup>nd</sup> is Astronomy Day**, and there should be observing opportunities all across the U.S.A. I myself will be in Pinetop, Arizona on Friday night, May 1, for a "pre-Astronomy Day" Intro and Star Party for the **Blue Ridge Unified School District**. If anyone is interested in attending, or helping out, send me an email or give me a call.

I also have a few other events scheduled, and I can always use the help of another telescope operator. As always, enjoy Arizona's springtime skies and let me know how I can help you do it!

**As of March 30, 2020 the AAZ calendar has been severely impacted by the world-wide Corona Virus situation. Obviously, the meteor showers will continue without interruption, but the SCOVAC star party set for April 21, and a talk I had scheduled with their Women's Club on the previous day have been cancelled. Astronomy Day Activities on Saturday, May 2, 2020 have likewise been cancelled and the Blue Ridge USD Star Party set for Friday, May 1, 2020 has been rescheduled to October 2020. I look forward to being able to host events soon, after the virus threat has passed. In the meantime, let's all be SAFE and HEALTHY. During this time, I will continue to help with your questions on any astronomy subject...while maintaining the responsible social distancing, of course! Good luck everyone and take care.**



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