

WHAT'S UP IN AUGUST

By Bernie Reim

The month of August derives its meaning from the Latin word *augere*, which means to increase. Augustus was a title given to Roman Emperors and it means esteemed or venerable and worthy of respect. The fantastic highlights for this month of August will give all of us a chance to feel more esteemed and venerable as nature itself will be showing off with an excellent meteor shower with no moon to interfere, a near-total lunar eclipse that we CAN see without going anywhere, and to top it off, the universe's greatest display of power and majesty, at least for us earth-bound humans, a total solar eclipse on August 12.

Of course the universe has FAR more spectacular and powerful events to show us than "mere" solar eclipses, but we need huge telescopes in all wavelengths of light and even in gravitational wavelengths, which is nothing like the electromagnetic spectrum represented by photons of light, plus a knowledge of math and physics to really appreciate a common event like a merger of two black holes many times the mass of our relatively "little" daystar, the sun, which generates nearly the power of the original Big Bang itself on a daily basis somewhere in our vast but still very limited observable universe which is nearly 100 billion light years in diameter.

We have only been able to witness about 300 of these events since 2015 with our two LIGO observatories in Hanford, Washington, and Livingston, LA. This stands for Laser Interferometer Gravitational Wave Observatory. They don't look anything like a "normal" optical or even radio telescope. They each have two long arms of 2.5 miles each at right angles. A laser beam is shined into the instrument, then a beam splitter splits the light, sending identical beams along each arm. Secondary mirrors make the beam travel back and forth hundreds of times before returning to the beam splitter at the end. Any passing gravitational wave would cause the arms to minutely expand or contract, so that each beam travels a slightly longer or shorter distance compared to its counterpart. Then the beams would recombine out of phase and not cancel out, resulting in some light at the detector.

The idea is simple enough, but the accuracy required is phenomenal, and many other factors have to be taken into account, like the curvature of the earth itself over those short two and a half miles, tidal effects on the earth from the sun and the moon, tiny vibrations from any source, and many other factors. The gravitational wave only stretches and compresses the very fabric of space-time like ripples on a pond by one thousandth the width of the proton inside the nucleus of the atom.

Albert Einstein predicted that these gravitational waves must exist, but he never thought we would ever develop sensitive enough instruments to discover a fluctuation that tiny. The first black hole merger we definitely discovered happened 1.3 billion years ago since it was 1.3 billion light years away in a galaxy in the southern sky.

Just think about what the earth really looked like 1.3 billion years ago when this powerful event occurred. The single-celled prokaryotes with no nucleus had already ruled the earth for about a billion years, the oxygen revolution had occurred and the more evolved eukaryotes with a cell nucleus containing DNA were just evolving into multicellular organisms that set the stage for all future evolution on Earth that led to modern humans about 200,000 years ago and eventually to Albert Einstein himself, a human that was smart enough to actually predict that such gravitational waves must exist. We finally found our very first one exactly 100 years after

Einstein's Theory of General Relativity was published in 1915. Humans may be slow but we will get there eventually.

Three scientists won the Nobel Prize in physics in 2017 for this great feat of engineering, physics, and insight and vision into what is possible. They are: Rainer Weiss, Barry Barish, and Kip Thorne. Kip Thorne is best known of these three since he was the science advisor on the popular movie INTERSTELLAR, released in November of 2014.

The remaining highlights for this month pale in comparison to the solar and lunar eclipses that will be visible. Unfortunately, the total solar eclipse on Wednesday afternoon, August 12, will only be about 20% partial for us here in Maine and it will be even less partial the farther south you go. Parts of Canada will see up to a 53% partial eclipse.

The moon's shadow will take a strange curved path over mostly water and uninhabited land for this eclipse. It will start in Northern Russia, curve over near the North Pole, continue down the entire coast of eastern Greenland, pass just west of Iceland, and end up over northern Spain at sunset before the moon's shadow lifts off the earth again over the Balearic Island of Mallorca in the Mediterranean Sea. Reykjavik will be in the path of totality, but not on the center line, so the eclipse will be shorter there and the weather in Iceland is not always great in summer like it will be in northern Spain.

I was told by an eclipse expert that Leon, Spain will be the best place to see this short eclipse near sunset. It will just miss Barcelona and Madrid, so those 5.2 million inhabitants will have to travel a few short miles to place themselves directly in the path of the moon's shadow if they want to experience this remarkable, and often only once-in-a-lifetime celestial and terrestrial event that will lift them right off the planet and give them an entirely new perspective of our place in space and the power and majesty of our sun, moon, and the earth that all 8.4 billion of us currently share.

Most of Europe will see at least a partial eclipse. Only 15 million people, mostly in northern Spain, live directly in the path of this fairly short total solar eclipse. I am sure many Europeans will travel directly into the path of totality to see the whole thing, but it will draw far fewer people than the great pair of U.S. eclipses of August 21, 2017 and April 8 of 2024. It is estimated that about 50 million people experienced the 2024 eclipse and even more people saw the 2017 great American total solar eclipse which only covered only this country from coast to coast, Oregon to South Carolina, from "sea to shining sea". The 2024 eclipse included parts of Mexico and Canada.

I recommend that you find your eclipse glasses from 2024 and make sure they don't have any tiny holes in them if you want to use them again. If they are not in perfect condition, get a new pair or a sheet of aluminized mylar or # 14 welder's glass to safely view this partial solar eclipse on Wednesday afternoon, August 12, starting at 1 pm EDT. The maximum will occur at 1:30 pm our time which is 7:30 pm in Spain. Also make some practice runs with your cameras and filters if you plan to photograph this partial eclipse.

Just because we are not in the path of totality for this eclipse, doesn't mean you can't see it anyway thanks to the "magic" of technology. Of course, that will never be as good as being there in person, but it will still be exciting and educational and if you saw any eclipses before, it will bring back some good memories.

There are several sources that will broadcast this great natural event; not like World Cup soccer, which is man-made. They are National Geographic, Slooh, and Scientific American,

which will set up a live You Tube feed from the island of Ibiza starting at 1 pm our time. They will include live interviews with astronomers and photographers and many others that will add to your knowledge and enjoyment of this remarkable and fairly rare event.

The deep partial lunar eclipse will be visible over all of North and South America. It will be 96% covered by the shadow of the earth, so it will be almost as good as a total lunar eclipse when the moon remains completely immersed in our shadow for about one hour. The moon will turn some nice shades of orange and only 4% of it will remain directly in the sunlight in the earth's much fainter penumbral shadow.

The interesting and continually changing colors are caused by the atmosphere of the earth bending or refracting the sunlight around us like a giant lens and then onto the moon. It is mostly red and orange due to the longer wavelengths of light being scattered out, similar to a red sunset or sunrise. In a much more dramatic way to look at any lunar eclipse, just think that what you are really seeing with these colors that give you a lot of information about the condition of our atmosphere at the time, is the combined effect of all the sunrises and sunsets on earth at the same time then projected onto the moon!

This lunar eclipse will happen two weeks after the solar eclipse because we are in an eclipse season now with the earth, sun, and moon aligned just right. That happens every 6 months. This lunar eclipse will start on Thursday, August 27, at 10:33 pm EDT. The full moon will rise at sunset and soon thereafter enter our nearly one-million-mile-long shadow cone that we always project into space like a conical wizard's cap.

Maximum eclipse happens at 12:13 a.m. EDT and it is all over 99 minutes later on Friday morning the 28th. Try to get some good pictures of this event. Although not nearly as spectacular as a total solar eclipse, any lunar eclipse can still tell you many things about our place in space and the great motions and speeds of the sun, moon, and earth through space. Half the earth gets to see a lunar eclipse when it happens, so they are much more common than solar eclipses and you don't have to travel to see one.

A good way to remember August 27 is to remember that Mars made its closest approach to Earth in 60,000 years on August 27 of 2003. It was just under 35 million miles away. It can be up to 250 million miles from Earth at its farthest. Usually, it is closer to 50 million miles away, even at its closest approach which happens every 26 months. A hoax was perpetrated through the fairly new internet at the time that Mars would be as large as the full moon in our sky at that time. That hoax lasted for about 10 years thereafter, saying that Mars would be the size of the full moon every August 27!

Mars was actually about 60 times smaller than the full moon, which covers half a degree of the sky. Mars can get as large as 30 arc seconds of the sky, which is about the size that Venus is now, but that is still 60 times smaller than the full moon at 1800 arc seconds, or half a degree of the sky. You can measure one full degree of the sky by holding up your index finger at arm's length. A fist at arm's length covers 10 degrees. Right now, Mars is very small and only covers 5 arc seconds of our sky. Mars will be at its best at opposition on February 19 of 2027 and again on March 25 of 2029. Jupiter appears as our largest planet now, covering 32 arc seconds of our sky.

Venus continues to climb higher in our evening sky. It will be exactly half illuminated by the sun on August 12, the same day of the solar eclipse and the Perseid Meteor shower. Then it will continue to get less illuminated by the sun even as it gets closer to Earth and larger in our sky.

You will need a small telescope to see its phases. Mercury also goes through phases because they are both inferior planets, meaning that they are closer to the sun than the earth. The phases of Venus and Mercury were an early proof that the earth could not be the center of our solar system or the universe.

Venus shines brilliantly at magnitude minus 4.4 now and will get even brighter to magnitude minus 4.6 by the end of this month when it will be only 39% lit by the sun and cover a full 30 arc seconds of our sky, or 1/60 the width of the full moon, which is half a degree. Venus now sets about 90 minutes after sunset and will spend this entire month in the constellation of Virgo, approaching its brightest star, Spica, to within 1.7 degrees on the last day of August. Watch for a waxing crescent moon to pass just 3 degrees south of Venus on the 15th.

Saturn now rises before 11 pm in Pisces. It is getting a little brighter and larger and closer each night on its way to its October 4, 2026 opposition when it will rise right at sunset and be at its closest and best and brightest for the year. It now covers 19 arc seconds of our sky and shines with a soft golden light at 0.5 magnitude, which is still about 40 times fainter than brilliant Venus.

Jupiter and Mercury make a nice return very low in our eastern morning sky 40 minutes before sunrise around the middle of this month. They will be less than half a degree apart just below M44, the Beehive open star cluster in Cancer the Crab.

Mars is in Taurus the Bull now and rises around 2:30 am. It shines at magnitude 1.3 and covers 4.8 arc seconds of our sky, but it is very slowly getting a little brighter and larger each morning on its way to its next opposition which won't happen until February 19 of next year. Compare the orange color of Mars and its brightness to nearby Aldebaran, a massive red giant star which marks the fiery eye of the bull in Taurus which is 65 light years away and 1.7 times the mass, 44 times the diameter, and 518 times the luminosity of our sun. Its name means "the follower" in Arabic because it always appears to follow the Pleiades open star cluster in Taurus, also known as the Seven Sisters, across the sky. In ancient Persia, it was also one of four "royal stars" that served as celestial guardians to the heavens and were sentinels of courage, power, and integrity, something all of us could use a lot more of, especially today.

Mars is now almost 6 magnitudes or 200 times fainter than Venus. Each magnitude equals 2.5 times difference in brightness and 5 magnitudes equals exactly 100 times difference in brightness. So, each magnitude is the fifth root of 100. It is a log arithmetic scale.

That covers all of the planets for this month. There are only two more highlights to cover, a nice comet in Pisces Austrinus, just below Capricornus, and a very favorable Perseid Meteor Shower. Comet 10P/Tempel, also known as Tempel 2, will pass perihelion, its closest approach to the sun on August 2. It could reach as bright as 7th magnitude, making it easily visible in binoculars. It rises late in the evening and will be high enough to view soon after midnight. It is best to look for it during the new moon around the middle of this month.

Be aware that this comet will pass very close to Mars many times in the far distant future and will have a good chance of actually hitting the red planet with continuing gravitational tugs from Jupiter, Ceres, and Mars itself. Hopefully there will be an intelligent civilization on Mars by then (maybe even our distant descendants) that will be easily able to blow up or divert this comet, which has a nucleus of 6 miles across. Even a little object much less than a football field across can cause a lot of damage if it impacts any planet.

The annual Perseid meteor shower begins on July 17 and will peak on Wednesday morning, August 12. It will last until August 24. That means that the trail of debris in space from its parent comet, 109P/Swift-Tuttle, which orbits the sun every 133 years, stretches over 60 million miles of space. At 67,000 miles per hour, the earth travels through 1.6 million miles of space every day around the sun. We are in this meteor shower for 37 days, so its debris trail is about 60 million miles wide. That is just one more example of our continuous and incredible motions through space around the sun and all the other motions that happen at the same time. For example, the moon continually moves about 2,000 miles an hour around the earth, which is its own width.

All of the Perseids will appear to emanate from one point in the sky in Perseus the Hero, called the radiant. Perseus will be low in the northeastern sky by 10 pm on the 12th. You will see more and more meteors as Perseus rises higher in your sky. Meteor showers usually tend to be better after midnight anyway since that is when the earth spins into the meteors instead of away from them, similar to snow on your windshield when driving. You could expect up to 100 meteors per hour from a good, very dark sky site with no trees or anything around to block any of the sky. The moon will not interfere at all since it is new and will cause a total solar eclipse a little later on that very eventful Wednesday, August 12 this month.

Even if you only see about 60 meteors an hour, or one a minute on the average, that will be very spectacular and probably the most meteors that most of you have ever seen. These are tiny pieces of comet dust smaller than a grain of sand that burn up high in our atmosphere at the edge of space about 60 miles straight up. The Perseids are among the fastest meteors, entering our atmosphere at about 40 miles per second on the average, which is just over twice as fast as the earth is always orbiting the sun. Many of these Perseids will leave bright fluorescent trails called persistent trains. The longer streaks will lie farther from the radiant in Perseus, so look about 45 to 50 degrees away from the northeast to catch these amazing glowing trails. Also try to get some photographs just by leaving your lens open on a tripod for a few minutes. Here you have yet one more incredible example of how alive the sky really is and our continuous motions through space and the nature of our protective and life-giving atmosphere and some of the myriad objects that we can encounter in space in our travels around the sun and through the galaxy over time.

August 1. Helen Sawyer Hogg was born on this day in 1905. She got her PhD in astronomy at Radcliffe and ran the Harvard Observatory for a while. Her specialty was variable stars and globular star clusters. She wrote a book in 1976, *The Stars Belong to Everyone, How to Enjoy Astronomy*.

Aug.2. Mercury is at greatest western elongation from the sun this morning at 19 degrees.

Aug.3. The Messenger spacecraft was launched to Mercury on this day in 2004. We have never landed any spacecraft on Mercury because of its proximity to the sun and its powerful gravitational field and fast orbit around the sun. It takes more energy for a spacecraft to reach Mercury than Pluto. We did a close flyby of Pluto within less than 8,000 miles, or the diameter of the earth, on July 14 of 2015 with the New Horizons spacecraft launched on January 19 of 2006, the fateful year that Pluto was reclassified as a mere dwarf planet and declared no longer a full-fledged planet, which status it had enjoyed for 76 years since its discovery in 1930 by Clyde Tombaugh. The moon passes 7 degrees north of Saturn tonight at midnight.

Aug.4. The Phoenix mission was launched to Mars on this day in 2007. I personally talked to one of the co-investigators on this mission after her presentation at an astronomy event at UNH and she said that they had actually discovered some ancient microbial life about a foot below the surface near its North Pole where the Phoenix mission landed on May 25 of 2008.

Aug.5. Last quarter moon is at 10:21 p.m. EDT.

Aug.6. The Curiosity Rover was launched to Mars on this day in 2012. It discovered many interesting things about Mars and it is still operating along with the much newer Perseverance Rover, which landed there on February 18 of 2021. The Curiosity Rover discovered a diverse array of organic molecules, chemical and mineral evidence that Mars could have supported microbial life, strong evidence of former liquid water at its landing site, the Gale Crater, which once contained a calm lake of liquid water on the much warmer Martian surface. It also provided us many valuable insights into the Martian atmosphere and climate history.

Aug. 8. Paul Dirac was born on this day 1902 in Bristol, England. He was one of the pioneers of quantum mechanics and won the Nobel Prize in physics with Erwin Shrodinger in 1933 for their discoveries in quantum mechanics and quantum electrodynamics. Specifically, he discovered the existence of antimatter through his equations which also described the behavior of fermions, which are particles like protons and neutrons which have half integer spin and are actually composed of quarks. Unfortunately for Dirac, quarks were not even discovered until 1967. Dirac also did a lot of work to find a unified field theory to connect General Relativity to Quantum mechanics, but never succeeded.

Aug.9. The moon passes 4 degrees north of Mars this morning at 2 am.

Aug.12. New moon is at 1:37 pm EDT. There will be a total solar eclipse today at the same time, but only visible from parts of Greenland, Iceland, and Spain. The Perseid Meteor Shower peaks this morning. Venus will be half lit by the sun.

Aug. 15. Venus is at greatest eastern elongation from the sun tonight at 46 degrees. Mercury passes less than one degree north of Jupiter this morning at 5 am.

Aug. 16. The moon passes 2 degrees south of Venus tonight. On this day in 0980, Avicenna was born in medieval Persia, now Iran. He was one of the most significant people of his time during the Islamic Golden Age. He is also known as the "Father of Modern Medicine". He was a polymath, physician, philosopher in the peripatetic style of Aristotle, chemist, and even musical theorist. He also wrote extensively to pass on his vast knowledge of the natural world.

Aug. 19. First quarter moon is at 10:46 p.m.

Aug.21. The moon passes 0.6 degrees south of Antares, the brightest star in Scorpius, this morning. The word Antares means "Rival of Mars". It is a red supergiant star marking the heart of Scorpius. It is one of the largest stars in our whole galaxy at 700 times the diameter of our sun and located about 500 light years away, similar to Betelgeuse in Orion. By comparison, Aldebaran, the red giant star near where Mars is now, is "only" 44 times the diameter of our sun.

Aug. 24. Timothy Ferris was born on this day in 1944 in Miami. He is a science writer and communicator that has written many books including *Seeing in the Dark*, and *Coming of Age in the Milky Way*.

Aug. 28. Full moon is at 12:19 am EDT. There is also a deep partial lunar eclipse today starting on the 27th at 10:33 pm. This is also known as the Sturgeon, Green Corn, or Blueberry Moon.

Aug.31. The moon passes 7 degrees north of Saturn this morning.

