WHAT'S UP IN NOVEMBER

By Bernie Reim

The month of November can be bleak since most of the brilliant foliage will have faded by the end of this month as New England prepares for another winter. Due to a super El Nino, the predictions are for a warmer and wetter winter for the northeast. However, there are always still some very nice days in November to enjoy before winter sets in by the end of next month.

We also set the clocks back an hour on the first of this month as Daylight Saving Time ends. That means that the sun will suddenly set at 4:34 PM on Monday the second, the day before the big election day on November 3rd. Civil twilight will end at 5:02 pm, Nautical twilight at 5:36 pm, and it will be pitch black by 6:09 pm, which is called Astronomical twilight when the night officially begins. That is further defined as the sun reaching 18 degrees below our horizon. Each of the other twilights is defined by the sun getting another 6 degrees lower. After that the days will only keep getting shorter until winter starts on December 21. Astronomical twilight will end at 5:44 pm by the end of this month.

However bleak things may appear on Earth this month, the heavens above always hold many interesting highlights in store for us regardless of the seasons. This month that includes a close conjunction of Jupiter and Mars near Regulus in Leo on the 15th, a nice triple conjunction of the very thin crescent moon, Venus, and Spica in Virgo on the morning of the 7th, Neptune and Saturn still hanging out close together near their best in Pisces, the planet Uranus in Taurus along with the nearly full moon between Aldebaran and the Pleiades open star cluster at 9 pm on the 23rd, Mercury moving into our morning sky around the middle of this month, a thin crescent Venus reaching its greatest brilliancy for the year at minus 4.9 magnitude, the main-belt asteroid Vesta in the evening sky in Cetus the Whale, a comet traveling from Aquila the Eagle into Sagitta the Arrow, and another comet traveling through Cetus the Whale, and to top it off, a favorable Leonid Meteor Shower which peaks on the morning of the 18th in Leo the lion just above Venus in Virgo and right where Mars and Jupiter will gather.

Jupiter and Mars both continue to get a little bigger and brighter and closer and they rise a little earlier each night as the faster-moving Earth is catching up with them in our respective orbits around the sun. They are both still in prograde or direct eastward motion in Leo against the fixed background of stars. Jupiter will begin its retrograde motion on the 12th of next month and reach opposition on February 11 of next year.

Orange Mars rises first soon after midnight, followed by Jupiter half an hour later in Leo. Mars will start its own retrograde motion on January 10 of next year and reach its best at opposition on February 19 and then will return to its normal prograde motion on April 1 of next year.

Mars now shines at 0.7 magnitude, which makes it about 12 times fainter than Jupiter which is very bright at minus 2.1 magnitude and covering 37.3 arc seconds of the sky. Mars only covers 7.1 arc seconds of the sky now. Mars will double in size to nearly 14 arc seconds and get fully 6 times brighter than it is now when it hits its opposition in February of next year.

By comparison, the full moon covers half a degree of the sky which is 30 arc minutes which is also 1800 arc seconds since there are 3600 arc seconds in a full degree. There are 60 arc seconds in an arc minute.

Mars will be just 1.2 degrees north of Jupiter near Regulus in Leo on Sunday the 15th. Look for many nice transits of Jupiter's 4 large Galilean moons across its face through a telescope this

month. Remember that you can see the 4 largest moons, Ganymede, Callisto, Io, and Europa, just in a good pair of binoculars, but you could not see the transits without a small telescope.

On November 4, the day after the election, Venus will be just 2 degrees south of Spica, the brightest star in Virgo at first magnitude. Venus is still near its brightest at minus 4.8 magnitude, which makes it about 250 times brighter than Spica. By the 7th of this month, the very slender waning crescent moon with earthshine will be just 2 degrees below Venus while Venus itself will be even a little closer to Spica. Try to take some pictures with your cell phones of this nice triple conjunction as it unfolds early this month in the eastern morning sky around 6 am.

Golden Saturn is still just 7 degrees below bluish Neptune in Pisces the Fish. They both rise just before sunset and become visible as soon as it gets dark enough, but you will need a good pair of binoculars or a telescope to see Neptune since it is 7 magnitudes or over 600 times fainter than 0.5 magnitude Saturn. Saturn takes nearly 30 years to orbit the sun once, so it will spend over 2 years in each zodiac constellation and Neptune takes 165 years to complete one orbit, so it will spend nearly 14 years in each zodiac constellation.

Taurus the Bull, part of the famous Winter Hexagon, now rises by 8 pm on the first of the month and even Orion the Hunter will be completely above the horizon by 10 pm. Look for the planet Uranus halfway between the orange star Aldebaran and the Pleiades open star cluster around 9 pm in the eastern sky. The full moon will join the trio on the evening of the 23rd, a few days before Thanksgiving.

Mercury will move into our morning sky by the 13th after its inferior conjunction with the sun on the 4th. Our first planet reaches greatest western elongation from the sun at 20 degrees on the 20th in the eastern morning sky. Mercury will be 62% lit by the sun that day and it will grow to 84% lit, similar to a waxing gibbous moon, by the end of the month. Venus is a large and thin crescent now that is only 13% lit by the end by the middle of this month in the morning sky.

The second biggest asteroid, Vesta, is doing a retrograde curve in Cetus the Whale this month which is near Saturn and Neptune. Vesta is 320 miles in diameter, or about the size of Arizona. Vesta will reach 6.5 magnitude, just beyond the visual limit of 6rth magnitude, so you would need a pair of binoculars to see it. Since Vesta was struck by a large object about a billion years ago when the whole solar system was still a dangerous place with a lot of major collisions, about 5% of all the meteorites now found on Earth can be directly traced back as having been part of Vesta at one time.

Comet 10P/Tempel is in Cetus the Whale now and will reach about 10th magnitude, so you would need a telescope to see it. Then Comet 161P/Hartley-IRAS is traveling northward from Aquila the Eagle into Sagitta the Arrow this month. The best time to see it is during the moon-free window this month near new moon from the 7th to the 14th and again at the end of this month. It will also reach about 10th magnitude and you should see a short, broad fan for a tail and a circular green coma that will make for some great pictures with a good telescope as it floats across the rich Milky Way region north of Altair, the brightest star in Aquila. Discovered in 1983, this comet returns every 21.5 years, but it will not be this bright again until 2069. Halley's Comet returns before that, in 2062.

The last big highlight this month is the annual Leonid Meteor shower. It lasts for most of the month, from the 6th to the 30th, but it will peak on Tuesday night the 17th into Wednesday morning the 18th. The moon will be just past first quarter, which means that it will set around midnight, which is perfect because most meteor showers get much better shortly after midnight

because that is when the earth is spinning into the meteors instead of away from them similar to driving into the snow and looking out the front window of your car instead of the back window.

The radiant for this shower is in Leo the Lion, hence the name Leonids. All of the Leonids will appear to originate from that spot in the sky, but you will be able to see them anywhere in the sky, although you can trace every single one of them back to this radiant in Leo., You may see other meteors also, but if they don't originate from this spot, they are stray meteors and not Leonids. The constellation of Leo doesn't rise until about midnight anyway, so the timing is perfect. You can certainly start looking before then, but the moon will wash out most the meteors except for the brighter bolides until the moon sets around midnight.

A nice coincidence for the Leonids this year will be what else is visible in this part of the sky. Mars and Jupiter are very close together right at their radiant in Leo and Venus and Spica will be a few degrees to the lower left of this active area in the sky during this shower. So even if you don't see that many meteors, you can enjoy a dramatic and planet-filled sky that Wednesday morning the 18th around 5 am.

The peak rate this year is only predicted to be 15 meteors per hour from a dark-sky site with no trees around. Leonids are very swift, entering our atmosphere at around 40 miles per second, which is twice as fast as the earth is always orbiting around the sun. The Leonids are known to leave many glowing persistent trails, caused by slightly larger-sized pieces of its parent comet, Comet 55/P Tempel-Tuttle.

Most of the meteors you can see during any meteor shower are about the size of a grain of sand since they are just comet dust. If they are slightly larger, the size of a pebble, they would create a nice fireball and leave a trail that could last for many seconds up to a minute or so. Most meteors will only last for about a quarter of a second, so you have to be looking right at it to catch it at all.

Most of them burn up right at the edge of space about 60 miles high, also called the Karmen line. That is also about where most of the northern lights take place. That is where there are so few air molecules left in our atmosphere that the sky becomes black even in the daylight. The sky is only blue because the air molecules (mostly nitrogen and oxygen) scatter out the shorter blue wavelengths of light during the day closer to the earth's surface.

As soon as these tiny, sand grain-sized pieces of this comet encounter any resistance they will burn up. They are so bright because they generate this ionization energy because of their great speed. Comet 55P/Tempel-Tuttle was discovered in December of 1865, just after the Civil War ended in April of that year. This comet last returned in 1999, which created some great meteor showers for several years thereafter because the sun strips off more material from a comet when it is closest to the sun.

Its period is 33 years, so the next really good Leonid shower will happen in 2032. We cross right through this debris path every year at the same time, but a few years after its closest approach to the sun the rate will greatly increase because there will be so much more material in its trail. Comets are basically just dirty snowballs with a lot of ice and loose rock. The nucleus is only about 5 miles across, but its coma can be around the size of the earth and its tail can stretch 100 million miles into space at perihelion when it is closest to the sun.

The most dramatic and amazing event I ever saw in astronomy other than a total solar eclipse and powerful and colorful dancing displays of long-lasting aurora borealis was the 2001

Leonid Meteor shower. We had just built our new observatory in west Kennebunk the year before. The skies above us were strangely quiet during the night of the 17th into the 18th because this meteor shower occurred just over 2 months after 9/11/2001 and very few planes were allowed to fly until later that year.

About 30 of our club members of the Astronomical Society of Northern New England had gathered during the course of that very frigid but perfectly clear November night. We were all in for an experience of a lifetime. I had counted over 10 meteors in the less than one minute it took me to walk from our parking lot to the observatory about 30 years away. I stopped counting right after that, knowing that I could never keep up anymore at that frantic rate. I just settled in and enjoyed the show for the next 4 hours right up to twilight when the sky got too bright to see any more meteors.

We saw nearly 1000 meteors every hour for those 4 hours. That averages to one very 4 seconds. The neat thing was that there was never any lull more than 10 seconds long, which is very unusual. Even if you have 100 meteors per hour, which is an excellent rate for any shower, only attained by the Perseids every August 12 and the Geminids every December 13 under perfect conditions with no moon, you may still have lulls of many minutes with no meteors since they come in clumps.

At one time around 4:30 am I saw 7 meteors in one second attacking us from their radiant in Leo. It was literally raining meteors for that entire most memorable night. That is technically called a meteor storm and no longer just a shower.

The rate of all of these meteors was so prolific that I could actually sense the earth's motion through space for the first and only time so far. It is easy to sense our relatively slow rotation on our axis when you watch the full moon rise out of the ocean. That takes only 2 minutes in real time since the moon covers half a degree of the sky and the sky appears to rotate 15 degrees every hour based on our rotation towards the east at about the speed of sound, 750 mph.

However, the earth is always revolving around the sun at a much greater speed, 18.6 miles per SECOND, or 67,000 mph. That would bring you from NYC to LA in under 3 minutes! That speed is also exactly 10,000 times slower than the speed of light in a vacuum, which is 186,000 miles per SECOND. It was almost like a real-life version of that classic 1979 video game by Atari called ASTEROIDS. Fortunately, we did not have to shoot down any of these asteroids and there were no periodic UFOs to fire counter attacks on our spaceship Earth. It was just an absolutely awesome display of the peaceful power of nature all above us for anyone that made the effort to witness and enjoy this majestic event.

We also saw about 15 brilliant bolides or fireballs that night who's long, twisting trails lasted for over a minute even while several other shorter meteors would cut right through these dusty trails in space high above us. Some of these fireballs were so bright that they lit up the entire sky like a bolt of lightning. You could even see shadows on the ground as if a giant flashbulb went off that froze everything around us in a static and brilliant image as if everything was caught in a dream.

To top off that perfect out-of-this-world night, I even saw the zodiacal light for the first time in the southeast starting around 4:30 before dawn even started. You can look for that all this month if you have perfect conditions and no moon to shed any light since that is a very subtle and ephemeral phenomena. It is also called the false dawn. It is best seen when the angle of the ecliptic is at its steepest in relation to our horizon. That happens every September through

mid-November in the morning sky and March and April about an hour after sunset in the evening sky, when it is called the false dusk. Remember that it is always there, but that is the only time you can see it in the sky.

The zodiacal light is caused by sunlight reflected off trillions of tiny dust particles trapped in the ecliptic plane of our solar system that came from comets and asteroids and also some dust from Mars as they recently discovered. It forms a haystack or pyramid of subtle light starting at the southeastern horizon that can stretch 30 degrees or more into the sky. This month it could stretch right from Venus in Virgo up to Mars and Jupiter in Leo to better define the ecliptic and add some more interest to this area of the sky.

We were not only watching about 1000 meteors per hour raining down all around us fairly close by, but we were at the same time witnessing the combined effect of countless trillions of dust particles from all the comets from eons past.

Nov.1. Last quarter moon is at 3:28 p.m. EST. Change the clocks back one hour this morning at 2am.

Nov.2. The moon passes 1.1 degrees south of Mars this morning and 0.5 degrees south of Jupiter. Harlow Shapley was born on this day in 1885. He was an American astronomer that helped discover the structure of the Milky Way galaxy and he worked with Edwin Hubble.

Nov.3. The moon passes 0.8 degrees south of Regulas and Venus passes 2 degrees south of Spica this morning.

Nov.3. Sputnik 2 was launched on this day in 1957, carrying the first living creature to orbit the earth, a dog named Laika.

Nov. 4. The northern Taurid meteor shower peaks this morning. Caused by Comet Encke, these are also called the Halloween Fireballs.

Nov. 7. The moon passes 1.1 degrees south of Venus this morning.

Nov.8. Edmund Halley was born on this day in 1656.

Nov.9. Carl Sagan was born on this day in 1934. New moon is at 2:02 am EST.

Nov. 11. Vesto Slipher was born on this day in 1875. He was an American astronomer who worked on stellar spectra and discovered galactic rotation.

Nov.14. Mars passes 1.2 degrees north of Jupiter this morning.

Nov.15. William Herschel was born on this day in 1738. He discovered the planet Uranus on March 13 of 1781.

Nov.17. First quarter moon is at 6:48 a.m. The Leonid meteor shower peaks tonight into the next morning.

Nov. 19. Venus passes 1.8 degrees north of Spica this morning.

Nov. 20. Edwin Hubble was born on this day in 1889. He first discovered that the entire universe was expanding in 1929 based on red-shift measurements of other galaxies. The moon passes 5 degrees north of Neptune this evening. Mercury is at greatest western elongation from the sun.

Nov. 22. Allen Stern was born on this day in 1957. He is the lead scientist on the New Horizons mission to Pluto and beyond. It discovered many amazing new things about Pluto when it got within just 7800 miles (less than the diameter of the earth, which is 8000 miles) of its surface on July 14 of 2015. Pluto has a bit of an atmosphere and cryovolcanoes and colorful nitrogen ice fields and countless other amazing and unexpected features and active processes. New Horizons then also made a close encounter with Arrokoth, another Kuiper belt object, on

January 1 of 2019. It is now 6 billion miles away, about 2 billion miles beyond Pluto and still healthy and functioning well bringing us continual data from this area of our solar system.
Nov. 24. John Brashear was born on this day in 1840. He was an American optician who built a beautiful 30 foot-tall 18-inch refracting telescope in 1894 that was used to make many discoveries on Mars and Saturn and other objects. Full moon is at 9:54 am. This is also called the Frosty or Beaver Moon. Mars passes 1.8 north of Regulus in Leo this morning.
Nov. 26. Chris Lintott, a British astronomer was born on this day in 1980. He is a professor at Oxford and he started the citizen science platforms named GALAXY ZOO and ZOONIVERSE that anyone can join to contribute useful and interesting citizen science data on a huge range of topics.
Nov. 27. Anders Celsius was born on this day in 1701. He was a Swedish astronomer, physicist, and naturalist that also developed the Celsius temperature scale.
Nov. 29. Christian Doppler was born on this day in 1803. He was the Austrian physicist who discovered the Doppler Effect in 1842. It is the change in frequency or wavelength of a wave relative to the observer as the wave source is moving towards or away from the observer. This works for sound as well as light (light is blue-shifted as it approaches and red-shifted as it recedes) and is the primary method to determine the speed and rotation of objects in space or even how fast you are driving or how fast you can hit or throw a ball or anything else. There is also Doppler radar now which greatly helps us in determining much more detail in weather phenomena including dangerous storms and hurricanes and tornadoes. Venus reaches its greatest brilliancy for the year at minus 4.9 magnitude even though it is only 25% illuminated by the sun similar to a waxing crescent moon. It is so brilliant now because it is so large and close to Earth. When it is fully illuminated at superior conjunction with the sun it is at its smallest and farthest away.
Nov.30. The moon passes 1.2 degrees south of Jupiter and 3 degrees south of Mars this morning.