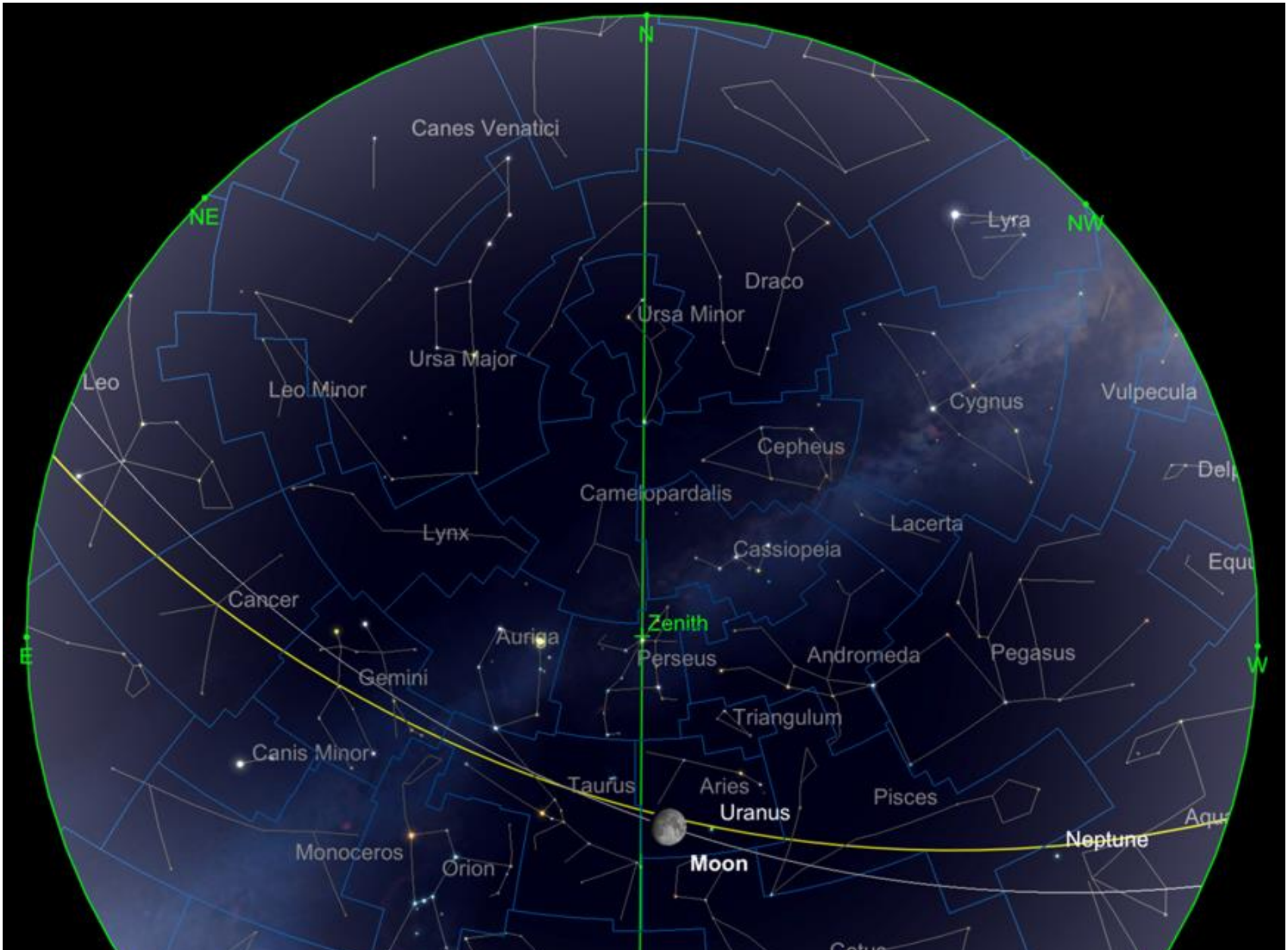

N
NE
NW
E
W
Canes Venatici
Lyra
Draco
Ursa Minor
Ursa Major
Leo
Leo Minor
Cygnus
Vulpecula
Cepheus
Camelopardalis
Lacerta
Lynx
Cassiopeia
Cancer
Zenith
Auriga
Perseus
Andromeda
Pegasus
Gemini
Triangulum
Canis Minor
Taurus
Aries
Pisces
Uranus
Neptune
Monoceros
Orion
Moon

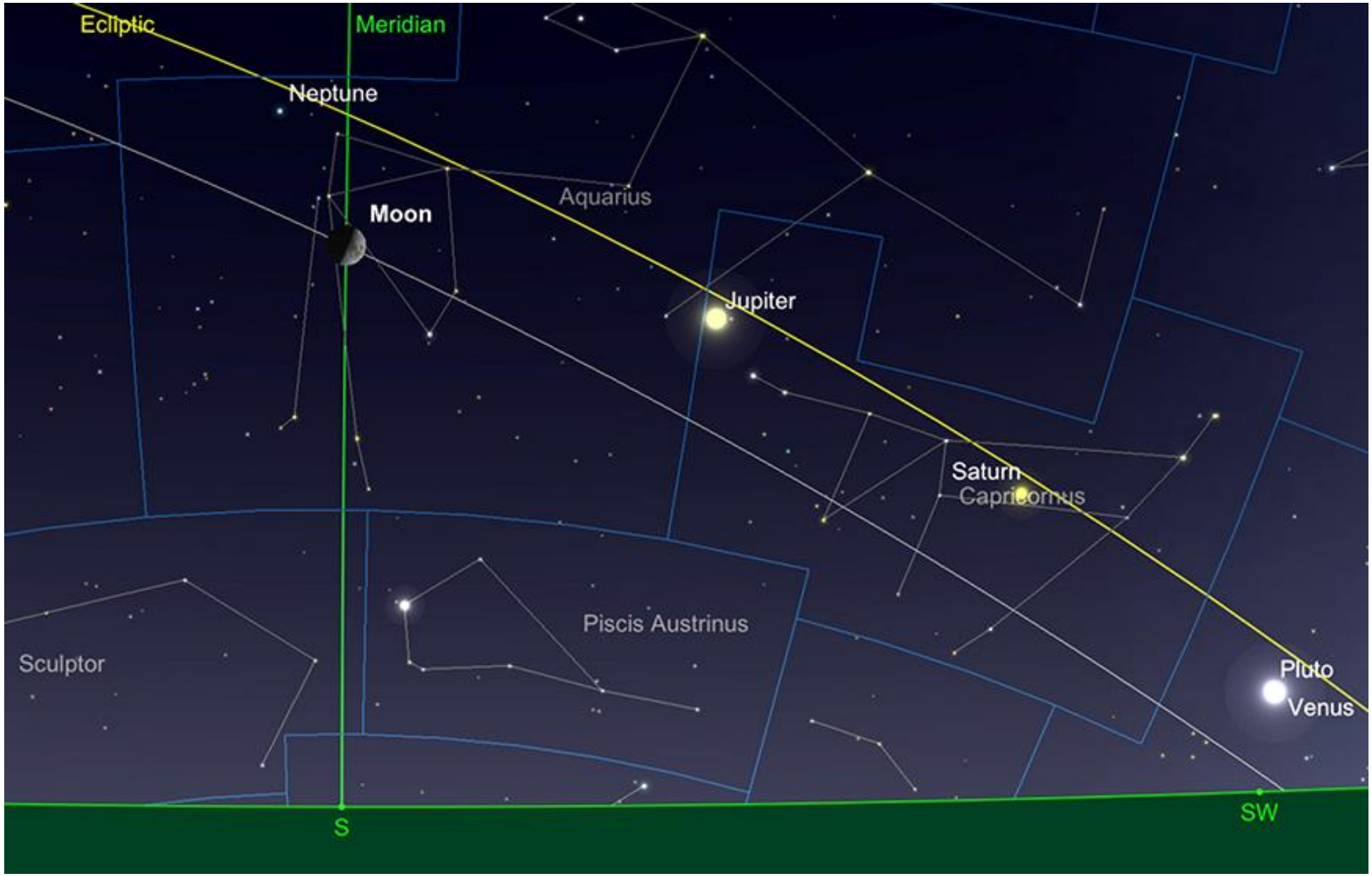
**The Moon**

The Moon begins December as a 10% illuminated Waning Crescent in Virgo. Rising at just before 3.45am (GMT) and setting around 11 hours later.

New Moon occurs on the 4th, making the early and latter parts of December are prime for deep sky observations. The Moon becomes New joining the Sun in the non-zodiacal constellation of Ophiuchus, after which it becomes an evening object.

The evenings of the 7th and 8th finds  the slim crescent of the Moon between the very bright Venus and Saturn and then Saturn and Jupiter on respective evenings. You'll need reasonable S/SW horizons to have a good view of the first evening's event, but less so the 8th's coming together with Jupiter and Saturn, which occurs a little higher in the sky.

First Quarter occurs on the 11th, in Aquarius. On this evening (and the prior 10th), the Moon can be found near to Neptune, providing a guide to its location in the sky. However, light scatter from our much brighter natural satellite can make detection of the far fainter planet tricky.


Ecliptic
Meridian
Neptune
Moon
Aquarius
Jupiter
Saturn
Capricornus
Piscis Austrinus
Sculptor
Pluto
Venus
S
SW

The Moon at First Quarter, Dec 2021. Image created with SkySafari 5 for Mac OS X, ©2010-2016 Simulation Curriculum Corp., skysafariastronomy.com.

The Moon becomes Full on 19th in Taurus, rising at just after 4 pm GMT and setting at a little before nine the following morning. This is the "highest" Full Moon of the year for those observers in the northern hemisphere. The Moon will appear to be nearly 64 1/2° elevation above the horizon at transit point (from 51° north). This will roughly coincide with the moons apogee (its farthest point from earth), meaning that this particular Full Moon will be the exact opposite of a so-called "Supermoon" and that this, coupled with its elevation above the horizon at transit, will cause the Moon to appear somewhat smaller than average at this time.

The moon will then appear to "roll down" the other side of the ecliptic plane as seen from the northern hemisphere, passing through Gemini, Cancer and Leo until it reaches last quarter in Virgo on December 27th. Luna libration at present causes this part of the month to be a particularly good one for those interested in observing the extreme western limb of our natural satellite, with features such as the Mare Orientale being more apparent than average.

We end 2021 with the moon in Scorpius, at a very Old Crescent phase, showing just 8.9% illumination in the morning sky. It will be just a couple of days into the New Year and the moon will become new again.

**Mercury**

Mercury is emerging from superior conjunction, which occurred in late November and as such will be unobservable for the first part of December. However as we are fond of pointing out nothing stays the same for very long as far as the innermost planet is concerned.

By the latter part of the month Mercury will have re-emerged into the evening sky and will be observable very low in the Southwest as the Sun sets. On December 31 Mercury will be found at sunset at around 8 1/2° elevation above the horizon (from 51° north), shining at steady -0.7 magnitude and displaying a disk just under six arc seconds in diameter. At this point in time

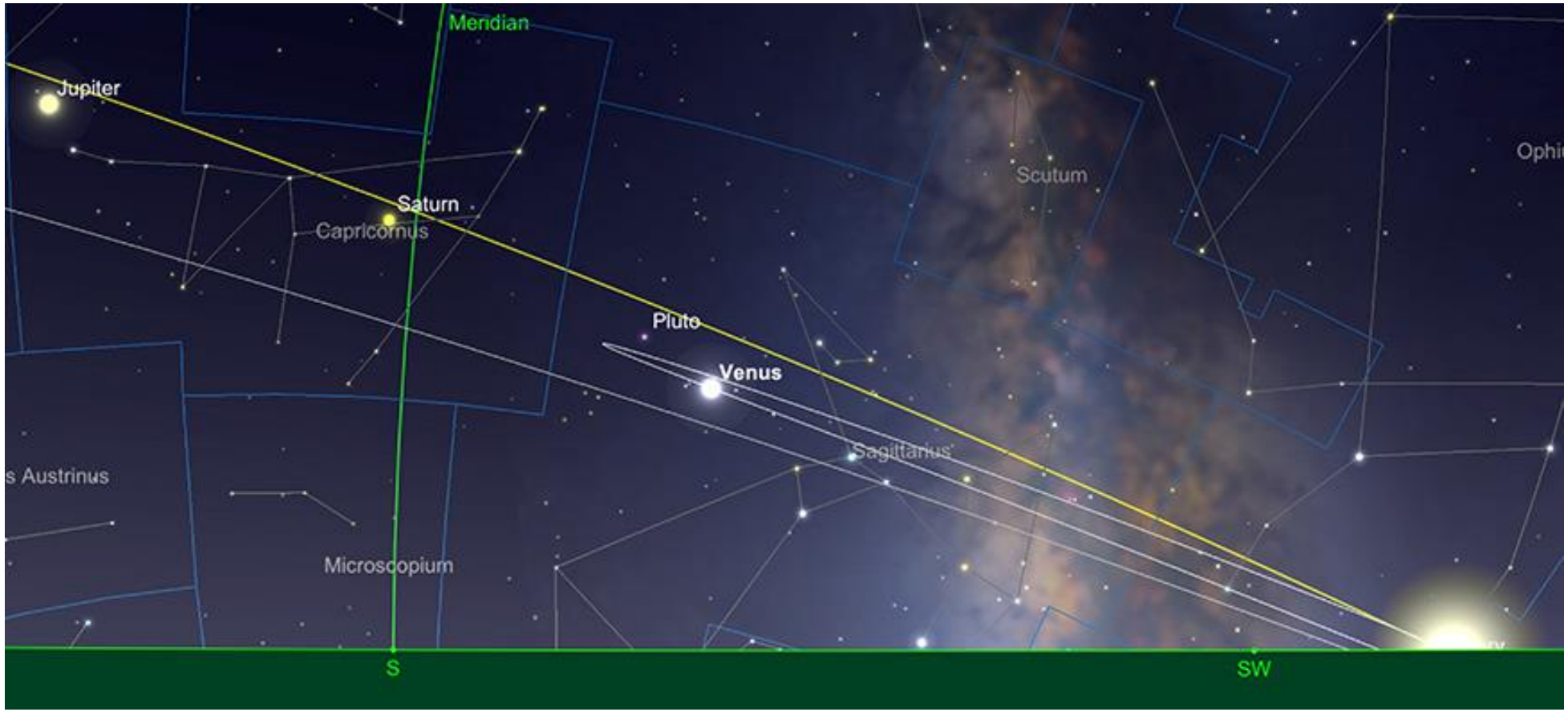
Mercury will be found in the same part of the sky as the much brighter Venus, which sits around 6° to the west.  Venus will act as a convenient signpost for the fainter Mercury, making it easier to find from the naked eye perspective, or using binoculars or telescopes.


M 72
Saturn
Capricornus
Barnard's Galaxy
Little Gem Nebula
M 75
Venus
Mercury
Pluto

Mercury at sunset, 31st December.  Image created with SkySafari 5 for Mac OS X, ©2010-2016 Simulation Curriculum Corp., skysafariastronomy.com.

**Venus**

We begin December with Venus at practically maximum brightness of -4.7 magnitude. At this point in the month, the planets will appear as a 28% illuminated crescent in binoculars and telescopes, displaying a 39 arc second diameter. The planet will be unmistakable in the Southwest at sunset, as it is brighter than any other object in the sky (bar the Sun and the Moon).  However, Venus, while bright, does not appear very high in the sky from a northern hemisphere perspective. The planet attains a reasonable altitude of just over 13° in the SSW at sunset on the 1st of December, but those in built-up areas will need reasonable horizons to be able to see it well.




Venus, sunset 1st December, flanked by Jupiter and Saturn.  Image created with SkySafari 5 for Mac OS X, ©2010-2016 Simulation Curriculum Corp., skysafariastronomy.com.

Venus reached maximum elongation from the Sun in November, and is now headed back towards our parent star from our perspective here on Earth. On the 1st December, Venus is separated from the Sun by just over 41°. By mid-December this separation will have diminished to just over 32°, though as Venus has now gone past its lowest point in the ecliptic plane (from

the northern hemisphere perspective) its altitude from temperate northern areas at sunset increases a little, to over 14° (from 51° north). By this point in the month Venus will have decreased in brightness fractionally to -4.6 magnitude.

The end of December finds Venus having faded a little further to a brightness of -4.3 magnitude, now showing a very large arc minute-sized disc, but with a sliver-thin crescent phase of just 2.6% illumination. The planet will sit around 9 1/2° above the horizon at sunset (from 51° north). At this point Venus will be separated from the Sun by just over 13 1/2°, and will be headed towards imminent inferior conjunction on January 8, 2022.

**Mars**

The red planet is a morning object in December though at +1.6 magnitude and just 3.8 seconds diameter on the first, will appear a very disappointing site to any observer. Nothing changes very much during the month as far as Miles is concerned. We end 2021 with Mars having brightened fractionally to +1.5 magnitude, now displaying a still-tiny 4 arc second disk. It is joined by the very Old Crescent Moon in the same area of sky at sunrise on the 31st.


Moon
Mars
m
Scorpius
Sun

Mars, alongside the Old Cresent Moon, sunrise, 31st December. Image created with SkySafari 5 for Mac OS X, ©2010-2016 Simulation Curriculum Corp., skysafariastronomy.com.

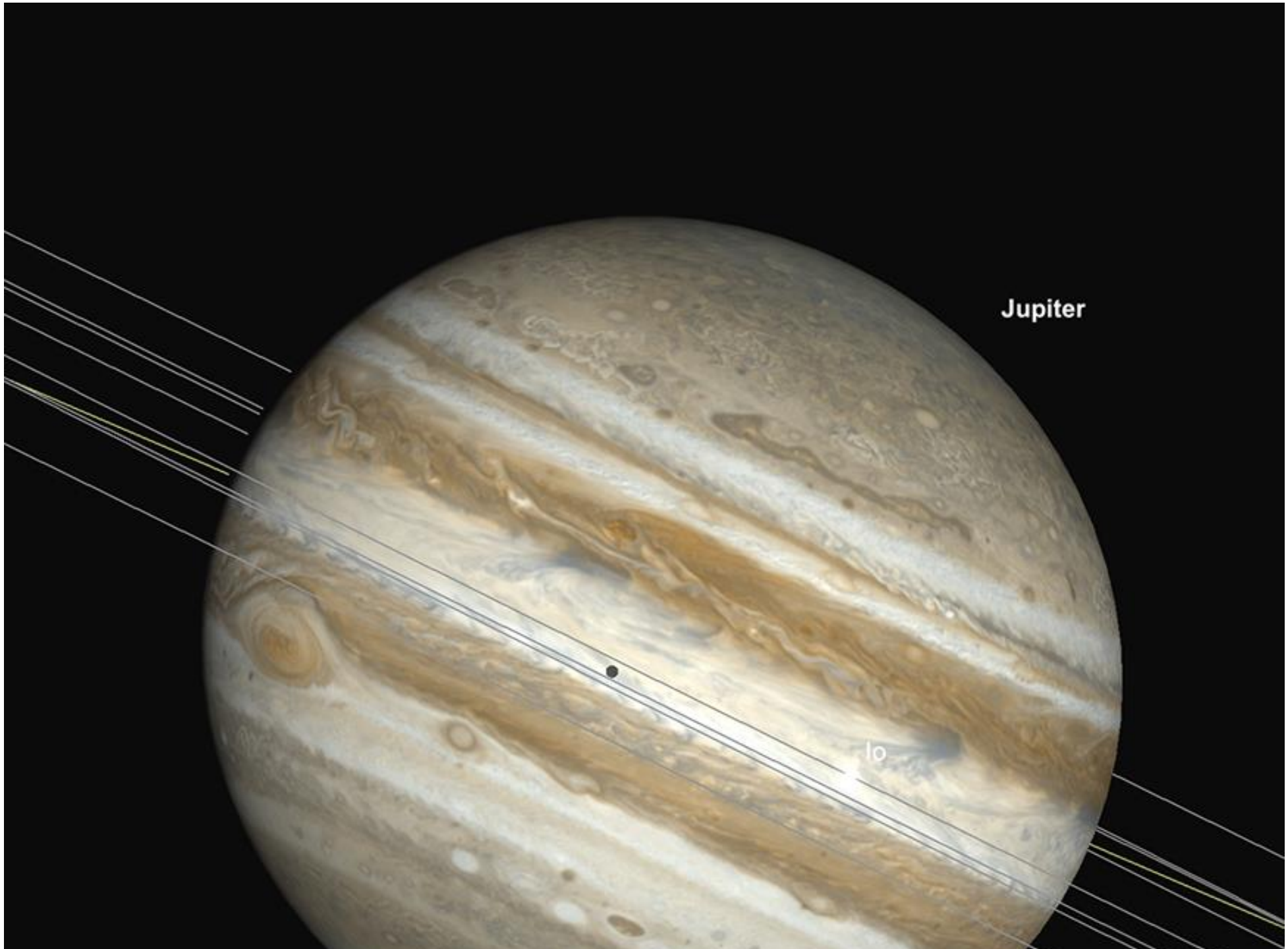
**Jupiter**

Jupiter is to be found in Capricornus on 1st, shining at a bright -2.3 magnitude, displaying a 38 arc second diameter disk. Reaching transit point at a little over an hour after sunset, Jupiter stands at an altitude of just under 25 1/2° (from 51° north). The giant planet's separation from the Sun is just under 76°, at this point in time. Jupiter will set at a little after 10:15 pm on the 1st December.

By mid-month, Jupiter has faded a little to-2.2 magnitude and is now displaying a 36.8 arc second diameter disk. It will transit at 4:35 pm - a little under half an hour after sunset. Jupiter's separation from the Sun on the 15th is now just under 64 degrees and the planet sets at just after 9:30pm (GMT).

Jupiter ends the year in the constellation of Aquarius, at a visual magnitude of -2.1. It will now show a 35 arc second diameter disk. The planet will set at around a 8:45 in the evening (GMT).

Notable Jovian transit events during December include a Europa transit around 5 pm on 3rd December; a very slim window of mutual Great Red Spot and Io transit, just before 6 pm on the 7th; Another Europa transit at just before 7 pm on the 10th; a nice mutual Great Red Spot, Io and Io shadow transit at just before 5 pm on the 16th - an event which re-occurs at just before 6pm on the 23rd. Further events include a mutual Great Red Spot and Europa transit starting at a little before 5 pm on December 28th, which is followed by a Ganymede transit at around the same time the following day. There's another mutual Great Red Spot and Io transit to observe, which starts just before 7 pm on December 30th. All times GMT.


Jupiter
Io

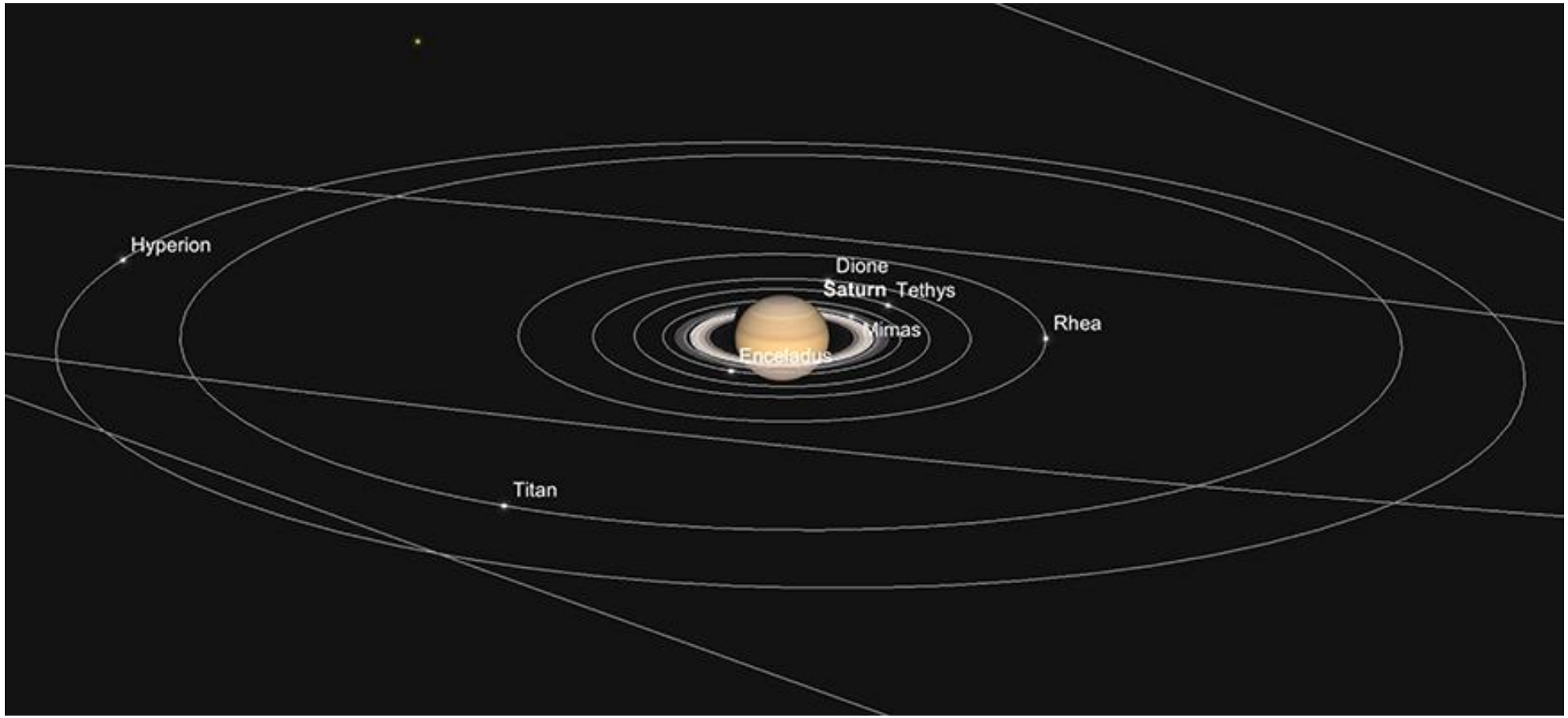
Jupiter, Great Red Spot and Io and Io shadow Transit, 5pm, 16th December.  Image created with SkySafari 5 for Mac OS X, ©2010-2016 Simulation Curriculum Corp., skysafariastronomy.com.

**Saturn**

The ringed planet is to be found some 16 1/2° to the west of Jupiter on the 1st. Being over 15° to the west of Jupiter in the sky, means Saturn will set just over an hour before its neighbouring world.  At +0.7 magnitude and displaying 16 arc second diameter disc, Saturn is by no means as bright nor as prominent as Jupiter, though is easy enough to find, as it appears about equidistant between it and the very bright Venus.

Saturn is just over 59° separation from the Sun on the 1st and attains a height of just over 20 1/2° above the horizon (from 51° north) at transit point, which it reaches at 4:17 pm (GMT). Although some way past opposition, Saturn is always a lovely sight in a telescope and those with a facility to observe it during the early evening in the earlier parts of December will doubtless be rewarded with a decent view. However, as we have pointed out in previous sky guides Saturn is still pretty low in the south from a temperate northern hemisphere perspective, so observers with telescopes are probably best advised to use modest medical magnification when it comes to Saturnian observation at this point in time. The observational window for Saturn is reasonably short, as it sets at a little after 8:40 pm (GMT) is on the 1st.

By mid month, Saturn will have shrunk a little to just under 16 arc seconds diameter, but will still display the same brightness as it did at the months beginning. By this point in time Saturn will set out a little before 8 pm (GMT).

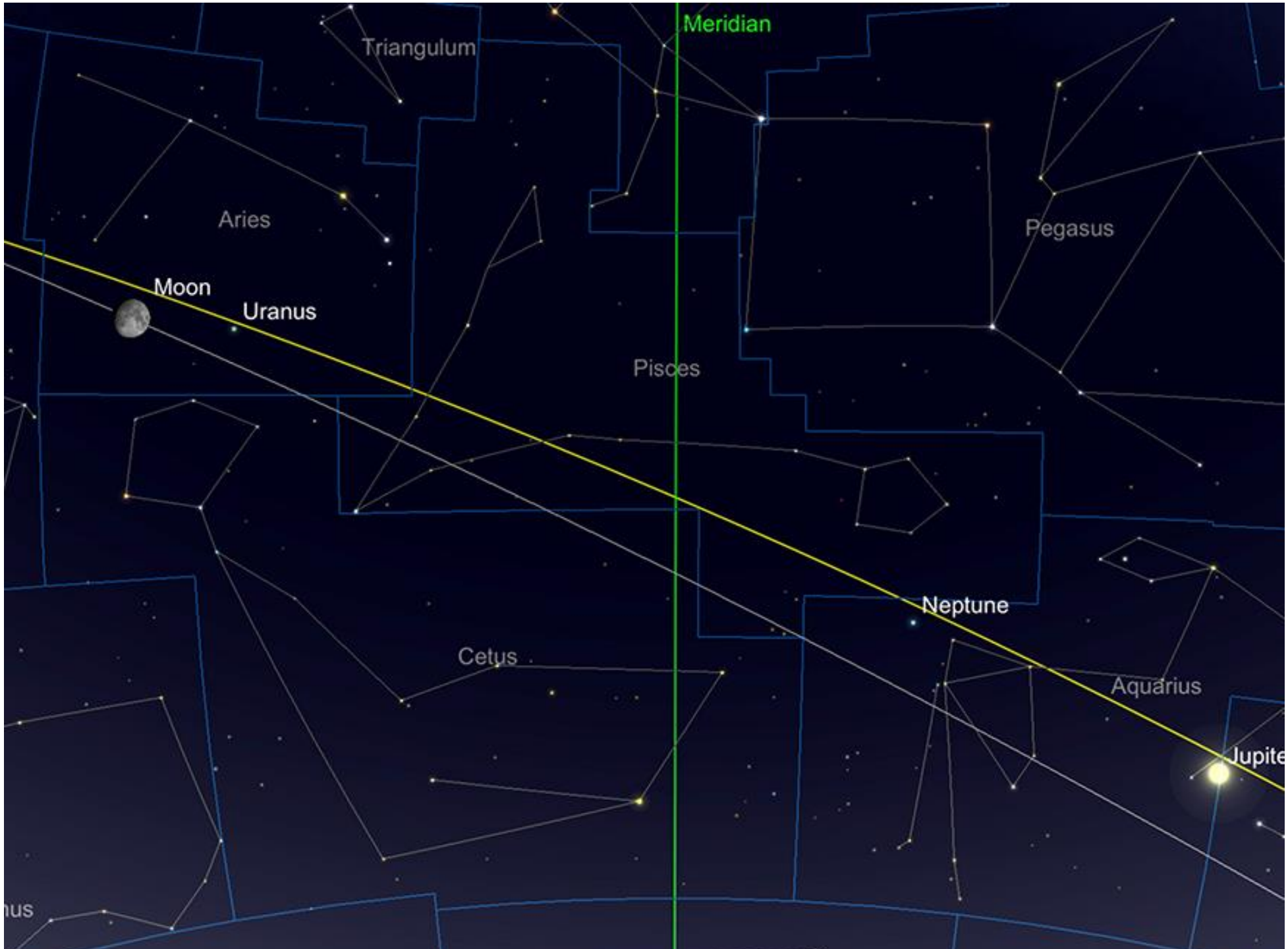



Saturn and Moons, sunset, 15th December.  Image created with SkySafari 5 for Mac OS X, ©2010-2016 Simulation Curriculum Corp., skysafariastronomy.com.

As we fast forward to the end of December, Saturn will appear much the same as it did at the beginning of the month, standing a little lower in altitude, at 17.4° (from 51° north. However, the planet now sets at 7 pm, meaning that the window for evening observation of Saturn is surely closing.

## Uranus and Neptune

The outer gas giants are both well-placed for observation in the evenings. Neptune being further west in the ecliptic in the constellation of Aquarius is always the more challenging of the two to observe: at +7.9 magnitude and 2.3 arc seconds diameter is now some way past opposition, but still close to its best for this year (as we've noted before, neither outer gas giant changes dramatically in brightness or diameter, even when fairly far from a opposition). Requiring a telescope to see any sign of its diminutive disc, Neptune can never be seen with the naked eye. However, those with larger binoculars can easily make it out amongst the background stars of Aquarius and even a relatively small telescope will show its rather vibrant blue colour. In the middle of the month, Neptune transits at around astronomical dusk (a little past 6pm GMT), at which point the planet stands just over 34 1/2° above the horizon (from 51° north).

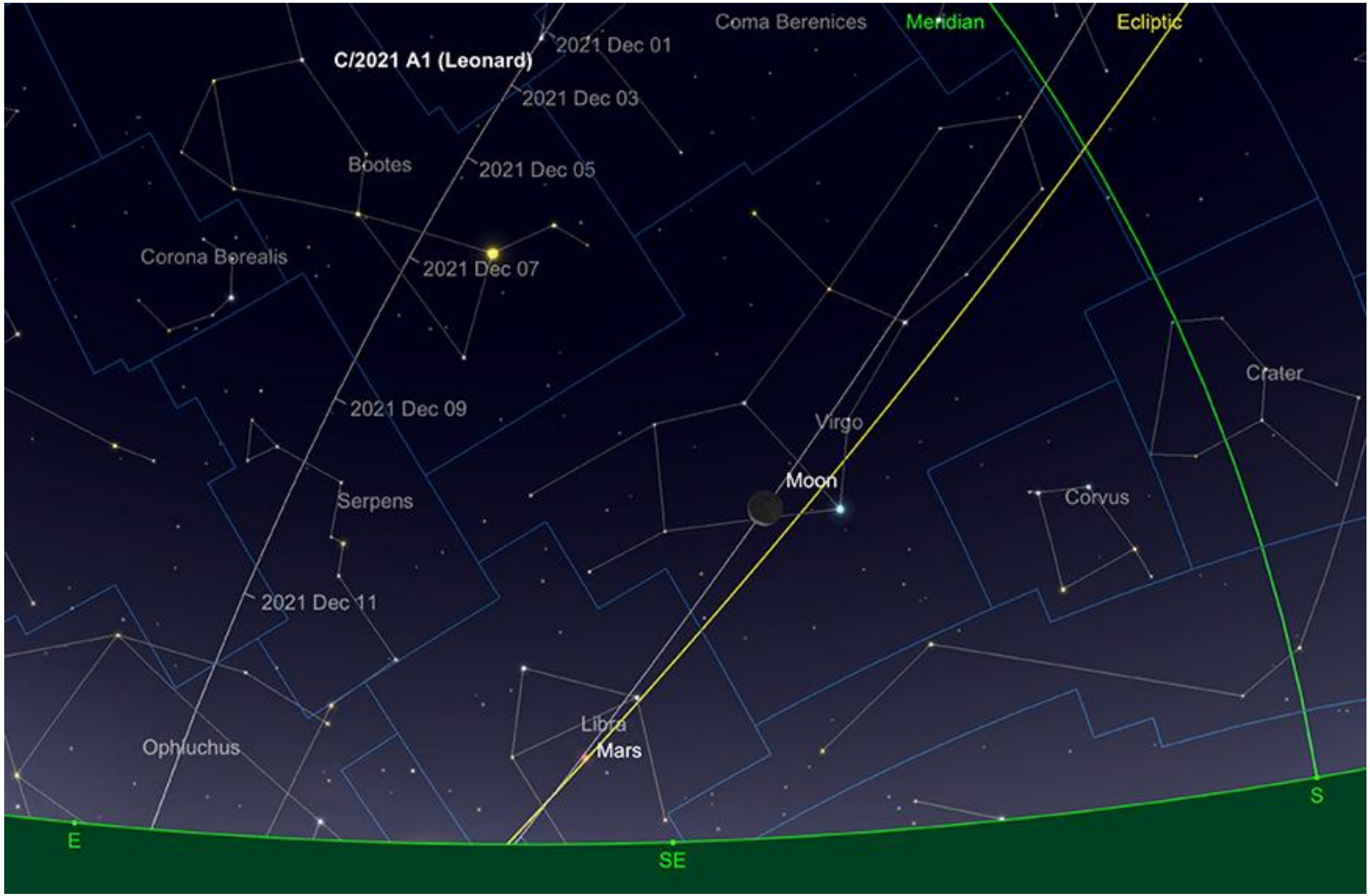

Meridian
Triangulum
Aries
Pegasus
Moon
Uranus
Pisces
Neptune
Cetus
Aquarius
Jupite

Uranus and Neptune relative positions 15th December.  Image created with SkySafari 5 for Mac OS X, ©2010-2016 Simulation Curriculum Corp., skysafariastronomy.com.

Further east in the ecliptic in the constellation of Aries, Uranus at +5.7 magnitude and 3.7 arc seconds diameter, is a much easier target. Technically, a naked eye object for those with good eyesight and exceptional sky conditions, Uranus can be found readily with binoculars and a small telescope will easily show its tiny green-grey disc. Around mid month Uranus transits at a little after 9 pm. At transit point, the planet will stand just over 54° in the altitude (from 51° north).

**Comets**

Comet C/2021 A1 (Leonard) continues to show some progress though at time of writing is still some significant margin below naked eye visibility. The comet is to be found in the eastern part of Canes Venatici at the months beginning though swiftly makes the transition over the border into the constellation of Bootes, the herdsman, passing its principal star, the bright Arcturus, on the 6th December. It will be best seen in the morning sky in the early part of the month, but rapidly heads Sunward, significantly decreasing its separation from the horizon as it does. This should go hand-in-hand with a steady increase in brightness as the comments is predicted to reach a peak in mid December. However, as it reaches peak brightness the comet will be very close to the Sun from our perspective here on Earth and the latter part of the month will see it skirt the horizon during the night making it a difficult target to observe. The comet's closest approach to the Sun as seen from our perspective here on Earth occurs on the 14th to the 15th of December at which point the comment will be just under 15° from the Sun. This will make observation of it more difficult, even if brightness is significant at this point.


Coma Berenices
Meridian
Ecliptic
C/2021 A1 (Leonard)
2021 Dec 01
2021 Dec 03
2021 Dec 05
2021 Dec 07
2021 Dec 09
2021 Dec 11
Bootes
Corona Borealis
Serpens
Ophiuchus
Crater
Virgo
Moon
Corvus
Libra
Mars
E
SE
S

Comet Leonard's path during the first part of December. Image created with SkySafari 5 for Mac OS X, ©2010-2016 Simulation Curriculum Corp., skysafariastronomy.com.

Maximum brightness estimates for C/2021 A1 vary from around +5 magnitude to +3.5 magnitude. Emphatically, this will not be a show-stopper, like the recent Comet Neowise was - but should hopefully be able to be located in binoculars, at its best. Though during the latter part of the month it will be interesting to see how the comet appears in the evening sky, especially as it passes close (5 1/2° south) of the planet Venus on the 17th and 18th of December, making its location relatively easy to find on these dates.

The comet is predicted to fade quite rapidly during late December, which means the window for “easy” observational opportunities is reasonably narrow. C/2021 A1 will appear to loop back on itself in early January before diving south, disappearing from view from the northern hemisphere, by which time it will have faded even further.

As ever, as far as comets go, we always remind people not to get too overexcited - but it will certainly be interesting to see what sort of a show C/2021 A1 puts on in December. While we never know what’s really around the corner for us, cometary-wise, C/2021 A1 seems to be our best hope for some time to come.

**Meteors**

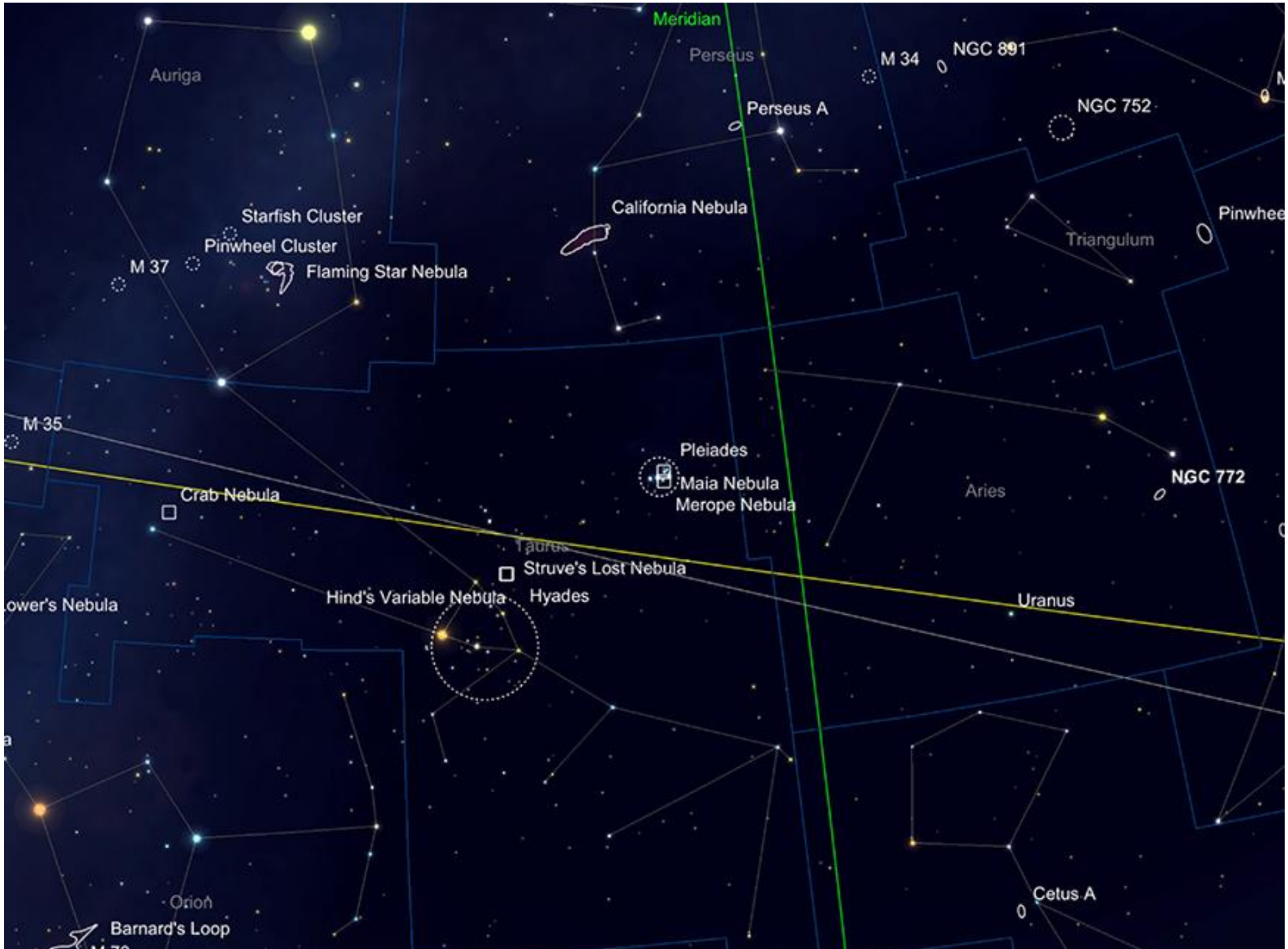
The annual spectacle of the Geminid Meteors, which peak on the night of the 13th-14th December, are always worth looking forward to. Peaking at anything up to 100 meteors per hours (not all of which will be visible from any given location), the Geminids are arguably the most reliable shower of the year, fed by the mysterious "rock comet" asteroid 3200 Phaethon. The shower is expected to be visible from 4th/5th to the 17th December this year.

A Geminid meteor captured over SW London.  Image credit: Kerin Smith

The Geminids radiate from an area inside the constellation of Gemini and are usually very well seen from the northern hemisphere.  2021's shower is not a best case scenario in terms of the influence of moonlight, with the 10 day old Waxing Gibbous Moon lurking in Pisces. However, those who are willing to brave the small hours, post-moonset (just after 3am GMT on the morning of the 14th) will be presented with a much darker sky and significantly better conditions for observing and photography of the shower. The Geminids present great opportunities for astrophotographic record - all you need is a solidly mounted camera, capable of timed exposures, with a reasonably wide field lens. Once set up - even in a fairly light polluted environment - you will be unlucky not to capture a couple of brighter meteors, given an hour-or-so's multiple exposures.  The brightest of the Geminids will cut through even the worst influence of light pollution.

# Deep Sky Delights in Taurus and Aries

This month we shall examine the spectacular Taurus and its distinctly less-spectacular neighbour, Aries.


Meridian
Perseus
M 34
NGC 891
Auriga
Perseus A
NGC 752
California Nebula
Starfish Cluster
Pinwheel Cluster
M 37
Flaming Star Nebula
Triangulum
Pinwhee
M 35
Pleiades
Maia Nebula
Merope Nebula
NGC 772
Aries
Crab Nebula
Taurus
Struve's Lost Nebula
Hind's Variable Nebula
Hyades
Uranus
Orion
Barnard's Loop
Cetus A

Taurus and Aries.  Image created with SkySafari 5 for Mac OS X, ©2010-2016 Simulation Curriculum Corp., skysafariastronomy.com.

The zodiacal constellation of Taurus, The Bull, is home to some of the most outstanding deep sky objects in the sky, the most notable of these is perhaps M45, the Pleiades, or the Seven Sisters.  At collective magnitude of +1.5, M45 is easily seen with the naked eye and has been recorded by numerous cultures throughout the world.  The ancients knew the Pleiades by different names: Subaru in Japanese, Krittika in Hindi, Soraya in Persian amongst many others.  The Pleiades are mentioned in Homer's Odyssey and Iliad, the Bible and the Quran.  It is known that cultures as far apart as the Maori and Aborigines and the Native Plains Tribes of North America had knowledge of this star cluster - which makes it pretty well-known worldwide!


M45 Pleiades Cluster
©2010 Mark L Blundell

The Pleiades, M45. Image credit: Mark Blundell. Image used with kind permission.

M45 presents its nine major members, (named after siblings from classical Greek mythology), the "sister" stars of Merope, Sterope, Electra, Maia, Tygeta, Celaeno and Alcyone - along with the "parent" stars Altas and Pleione - to the naked eye from a very dark location, but most people with reasonable eyesight can split six under average skies. Telescopes and binoculars reveal many more of the 1000-or so members of the cluster and larger instruments and photography can pick up blue-hued reflection nebulosity surrounding the cluster - particularly around Maia and Merope. This nebulosity is caused by illumination of left-over material from the cluster's formation. The view of M45 with a widefield, low power eyepiece is one of the most glorious sights in any telescope, though at 2 degrees in diameter, one has to be careful about eyepiece choice in order to get the outlying members in a useable field of view.

The Pleiades are thought to be around 100 million years old and lie between 430 and 440 light years away.

Next door - though not cosmically speaking - to the Pleiades is the older and more spread-out Hyades cluster. Its major naked eye members are arranged in a V-shape which marks the head of Taurus. Again, similarly to M45, the Hyades have been known since antiquity and were traditionally seen by the Ancient Greeks as being the sisters of the Pleiades - via their shared father Atlas.

The distinct "V"shape of the Hyades, peeking through high cloud, shown in wide field.  Image credit: Kerin Smith

The Hyades lie 152 light years away, and as such are nearest star cluster to us on Earth (though arguably the stars in the Plough or Big Dipper in Ursa Major can actually be thought of as a cluster and are closer).  The Hyades consist of over 300 individual stars and modern estimates put its age at around the 600+ million year mark - making it markedly older than the Pleiades.  The Hyades share a galactic trajectory with M44, the Beehive in nearby Cancer, again suggesting a common origin point in space.  However, the Beehive appears to be slightly older at 600-730 million years.

Line of sight puts Taurus' principle Alpha star Aldebaran - the eye of the Bull - within the boundaries of the Hyades, though this Red Giant is unrelated and distinctly closer to us at 65 light years.

Reaching East down the Southerly "horn" of the Bull, we come to the +3 mag star Zeta Tauri.  This star is a convenient location point for another jewel of the night sky - the Crab Nebula, M1 on Messier's List.

The Crab Nebula is the remnant of a star which went Supernova in the year 1054 (to us here on Earth).  This event was recorded throughout the world, from New Mexico to China.  It would have been a dazzling sight, peaking at -6 mag, brighter than the planet Venus and visible in daylight.  After it faded, the event receded from popular consciousness and it was nearly 700 years later, in 1731, that the object than would become known as the Crab was discovered by Astronomer John Bevis.  Messier rediscovered it when searching for the return of Halley's Comet 27 years later in 1758.  First thinking the object was a comet, it was the Crab that prompted Messier to compile his list, so other comet-hunters would not be confused by these static, cloud-like objects when searching the heavens.

Lord Rosse, observing the Crab with what was then the largest telescope in the world at his Birr Castle Observatory in Ireland, in 1844, made a sketch that showed claw-like protrusions - presumably the filament structure of the outer lying regions.  The object was nicknamed the Crab - and the moniker stuck.

Early both Century photographic observations of M1 showed that the object was expanding rapidly. This expansion was extrapolated backwards and it was noted that the object should have started its expansion around 900 years previously. A little bit of astronomical detective work ensued and the events of 1054 and the Crab were tied together.

Although a hardly dazzling +8.39 mag, the Crab's is quite well condensed and as such its surface brightness is fairly high. It can be found as a misty patch with ordinary binoculars, though larger binoculars reveal it as a definite elongated, round-edged feature. Telescopically, the texture of the Crab becomes evident in refractors of 4-inches aperture or reflectors of the 6-8-inch class. Reflectors of 16+ inches in aperture and dark skies are needed to glimpse the filament structures of M1's outlying regions and real striation in its core. Filtration will help with this object, especially in small instruments where it can sometimes be difficult to isolate the nebulosity of the object from the rich background of the Milky Way.

Photographically, the Crab Nebula is a rewarding target, with the "Hubble Palette" of H-Alpha, OIII and SII being particularly useful in bringing out the tangled, chaotic structure of the object's core. Though it can be very effectively recorded with single shot colour cameras, as displayed by Mark Blundel's picture below.


M1 Crab Nebula
© 2018 Mark L Blundell

The Crab Nebula, M1.  Image credit: Mark Blundell.  Image used with kind permission.

No-one with any form of optical equipment should ignore the Crab Nebula. While not as spectacular is the neighbouring Orion Nebula, it is the only easily-observed remnant of a Supernova that humans have actually observed in relatively recent history.  Given the dearth of Supernovae in our galaxy in recent times, the Crab remains a special object to us.

Where Taurus is rich with bright stars and interesting objects, Aries is much less so. However, it is not without interest. Aries has been known as a constellation since Egyptian and Mesopotamian times, but is now generally recognised to represent the Ram Chrysomallos, who was sent by Hermes (later the Roman equivalent, Mercury), to rescue Phrixus and Helle, the son and daughter of King Athamas and his Queen Nephele. Helle fell from the back of the Ram during the rescue, drowning in the Straits of Gallipoli, also known as the Hellespont (the sea of Helle).  No sooner than Phrixus had made it to the safety of Colchis (now the Georgian Black Sea coast), he sacrificed the unfortunate Chrysomallos to give thanks for his rescue. Chrysomallos was placed in the sky as the constellation of Aries and his Golden Fleece (later to be the focus of the quest of Jason and the Argonauts) was placed in a sacred grove, guarded by a dragon.

Aries itself consists of only four bright stars, the principle of which is known as Hamal (Alpha Arietis). Hamal is second magnitude and is found near to Shertan (Beta Arietis: third magnitude) and Mesarthim (Gamma Arietis, fourth mag) with the outlying 41 Arietis (again, fourth magnitude) lying over 10 degrees to the east.

Of the four main stars in Aries, Gamma Arietis is the most interesting for regular telescopic astronomy. This is one of the most famous double stars in the sky, having been first observed as such in the mid 1660s by the English Astronomer Robert Hooke. Separated by just over 6 1/2 orc seconds the two components of gamma Aretis are very similar stars in terms of brightness and spectral type. With an orbital period of greater than 5000 years the two components stars can easily be split in small telescopes, making this a great target for those interested in getting into double star observation. The stars are thought to lie around 165 light years distance, based on the most modern observations made by the Hipparcos satellite.  There are a few other double stars in Aries including Epsilon, Lambda and Pi Aretis - but none are as prominent and easily-observed as Gamma.

Aries is also home to a few galaxies, many of which are in the 13th to 14th magnitude range and subsequently only readily observable for those with larger instruments. The brightest of these is in NGC772, A fascinating spiral galaxy which is thought to be twice the mass of the Milky Way. This galaxy shows extended spiral arms including one large one thought to be drawn out from the central galaxy by the tidal effects of its satellite galaxy NGC770. Although NGC 772 is listed as a 10th magnitude object it is a fairly low surface brightness, so will need a reasonable aperture telescope to observe. There were two notable supernovae observed in quick succession in 2003 within NGC 772 - this was quite a rarity, with both being visible at the same time.

NGC722.  Image credit: Goran Nilsson & The Liverpool Telescope.  Creative Commons

Text: Kerin Smith