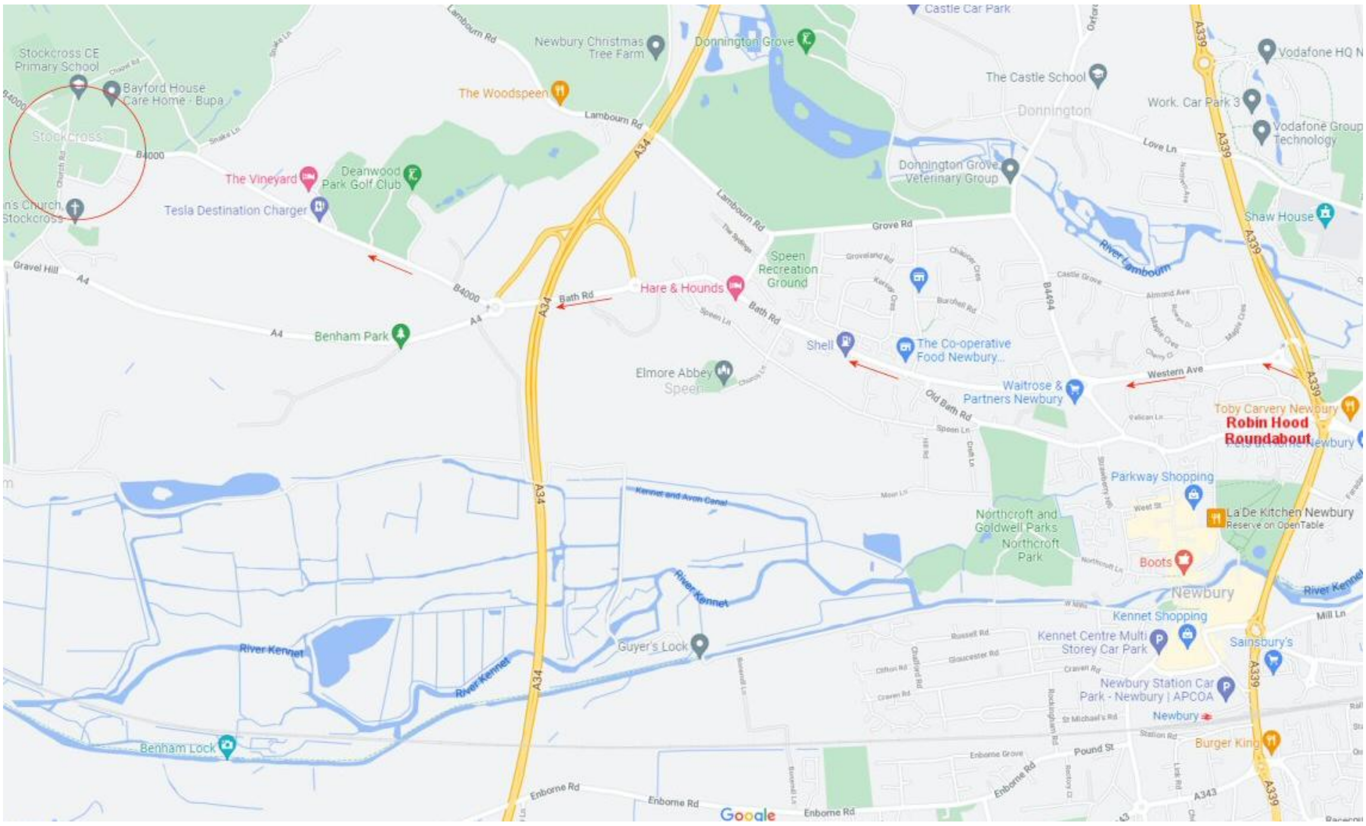
NEWBURY ASTRONOMICAL SOCIETY
MONTHLY MAGAZINE – DECEMBER 2021

NEXT MONTH OUR MEETING WILL BE 'FACE TO FACE'



Directions to Stockcross Village Hall (Sutton Hall)

We will ask visitors to comply with COVID safety guidance at the meetings

Starting with the January 2022 meeting we will, if national arrangements permit, be holding our future meetings 'face to face' in meeting halls where possible. However we will endeavour to maintain a live online Zoom connection for those members who cannot or wish not to join the 'face to face' meetings. The provisional programmes for the Session September 2021 to June 2022 are outlined in the October Magazine but may be changed as things settle down.

There have been developing problems with the venue we have been using for the past few years so with some regret we have decided to change the venue starting in January 2022. The Beginners meetings at St. Mary's Church have been very happy and its facilities have been very good for us. However car parking has been difficult at times and now a new housing development is being built adjacent to the church. This will make our already difficult observing sessions even more difficult.

We will therefore, starting on 19th January, be moving our beginners meetings to the Village Hall at Stockcross. This venue is a little further out of the centre of Newbury but it does have a number of advantages for us. First the larger hall also has excellent facilities with a large car park and can accommodate up to about 100 people. It also has the advantage of dark skies and no street lights. Details and directions can be found on the Beginners website at the website address opposite.

The Main Speaker meetings have also changed venue starting with the November 2021 meeting. After lengthy deliberations it has been decided to move to the Hall at St. Francis de Sale Church at Wash Common in the south end of Newbury. This facility has a good sized hall a large car park and has the benefit of dark sky if we need it. The hall also has some grounds that we can use for any outdoor events and access to a plot where there is a clear and dark view over open fields. There are also some smaller rooms that can be used for committee meetings.

Hopefully these new arrangements for both of our monthly meetings will work out well but we will monitor how suitable these arrangements are and if the members are happy with the new venues. We will be maintaining the Zoom contract for the next year so we can revert to the Zoom meetings if the national guidance for COVID-19 protection is tightened again.

NEWBURY ASTRONOMICAL SOCIETY MEETING

3rd December Our Future on Mars

Website: www.newburyastro.org.uk

NEXT NEWBURY BEGINNERS MEETING

17th December Birth, Life and Death of a Star

Website: www.naasbeginners.co.uk

SHOULD I ASK SANTA FOR A TELESCOPE FOR CHRISTMAS?

A typical Refracting Telescope

A typical Reflecting Telescope

A beginner to the hobby of astronomy is bound to ask the question 'Do I need a telescope for astronomy?' The answer is as with most questions like this is Yes and No. It all depends on how we progress in the hobby and what we want to do in astronomy.

Initially it is useful to start by finding our way around the night sky and to learn from books and magazines what the hobby of astronomy is all about. Another thing is to join your local Astronomical Society where you will find more experienced astronomers who will be willing to give you all the advice you need.

Usually advice will be to start with obtaining a good pair of binoculars. This is sound advice and all astronomers should have a pair. However if we want to see detail on the Moon and planets or see some of the deep sky objects (galaxies and star clusters) we will need a telescope.

Before looking at the range of telescopes that is available, there are two important factors to be considered. First: how much can be afforded to buy the telescope and second what is it primarily going to be used for. The worst possible choice is the one that never gets used. A telescope that is too complicated and expensive or too cumbersome to set up will spend most of its time at the back of a shed or garage and never be used.

The first telescope should be easy to set up, easy to use yet give reasonably impressive views of the sky but do not spend a lot of money on a first telescope. You may not like staying out during the cold winter evenings

Possible uses to be considered are:

General interests in looking at the night sky

Special interest in studying the Moon and the planets

Searching out deep sky objects (clusters, nebulae and galaxies)

Possibly using the telescope for astro-imaging

Does the telescope need to be portable?

Before starting to look at the many instruments on the market there are a few of guidelines to keep in mind:

● First guideline is - do not buy a cheap telescope from a high street shop. The minimum sum required to purchase a new 'first' telescope that is worth having for astronomy must be in the region of £100 to £200 (a second hand telescope will be less). This sounds like a lot of money but it will buy a very useful telescope that will not be a disappointment and will not be confined to the back of the shed or discarded in the garage.

● Second guideline – a first telescope should, ideally, have a minimum aperture of at least 90mm for a refractor or 130mm for a reflector if finances permit. This will ensure that the instrument can capture enough light to enable faint objects to be seen.

● Third guideline – The telescope should have a focal length of about 1,000mm for a general purpose instrument. About 750mm will be best for a more specialised wide field telescope for deep sky objects. A longer focal length may be considered if planetary studies are to be the main purpose for the telescope.

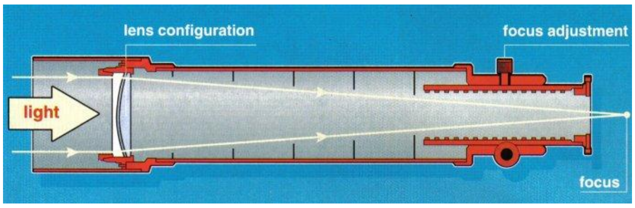
● There is one final point to consider, if the telescope is to be used for astro-photography then it should be mounted on an 'Equatorial Mounting'. This is required if longer exposures are to be taken with a camera fitted in place of the eyepiece.

There are basically two kinds of optics used in the manufacture of telescopes these are REFRACTING telescopes and REFLECTING telescopes. A Refractor uses a lens to gather light from a distant object. A Reflector uses a mirror to gather light from a distant object

The following pages should provide some guidance on how telescopes work and how to operate them. There is an introduction to describe how each kind of telescope is used to gather the light and direct it into our eye. There is also an introduction to the different types of mounting used to support and move the telescope to find an object to be observed.

OPTICS OF REFRACTING TELESCOPES

All refracting telescopes use a glass lens as their primary focusing unit. This lens is normally made up from two or more lens elements to produce a clearer image and reduce colour distortions caused by refraction as explained below.

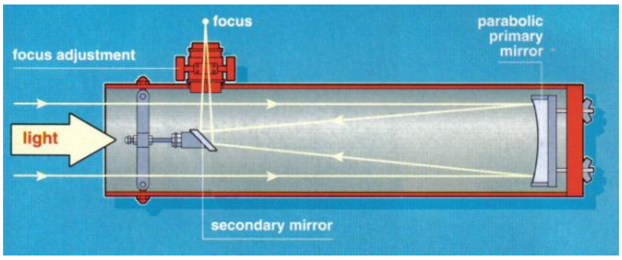


Lenses use the property called REFRACTION to change the direction of rays of light from a distant object and direct them towards a desired focal point. Refraction occurs when light passes between two different transparent materials such as glass, air and water.

When light passes, at an angle, through the surface of a block of glass the angle is changed. As the light re-emerges through the opposite side of this material its angle will be changed again back to its original angle. To utilise this phenomena lenses are produced with a curved surface so when parallel rays of light meet the surface it will present an angled surface to each ray. The paths of all the rays hitting the lens will be bent towards the centre line of the lens. As the light emerges from the back face of the lens it is again bent. If the back surface is convex the same as the front surface then the light will be bent even more towards a Focal Point to form an image.

OPTICS OF REFLECTING TELESCOPES

A Newtonian is the simplest type of reflecting telescope. Below is the layout of the optics of a Newtonian tube assembly. The Newtonian configuration is the simplest layout and therefore generally the cheapest of all the reflecting type telescopes. Used with the simple Dobsonian mounting this type of telescope can make a very useful and cheap option for a first telescope at around £200 for a 150mm (6″) instrument.



Light from a distant object enters the open tube and is reflected back up the tube by a parabolic (concave) mirror. Because the mirror is curved the light is focused into a Focal Point where an image is formed. To enable the observer to study the image without blocking the light entering the tube, a second small 'flat' mirror is mounted at an angle of 45° at the top of the tube. This secondary mirror directs the light out through a hole in the tube. A focusing unit is fitted to the hole in the tube to hold and adjust the eyepiece.

There are other variations of the reflecting telescope such as the Cassegrain. This design replaces the flat angled secondary with a small convex mirror that redirects the light back down the tube and through a hole in the centre of the Primary Mirror where the eyepiece is mounted.

There is a misconception about the term 'Magnification' of a telescope. Strictly speaking magnification is not an attribute of the telescope it mainly depends on the eyepiece being used.

A full set of Meade eyepieces and a Barlow Lens

The telescope is used to collect light from a distant object. It then has to focus the image carried by that light into a Focal Point where the image can be magnified and examined using the eyepiece.

A telescope of a specific focal length will produce an image of a specific size and this cannot be changed. For example a telescope of a certain focal length may produce an image of the full moon 10mm in diameter. A telescope with a longer focal length will produce a larger image and a shorter focal length will produce a smaller image but a wider view. An eyepiece is then used, much like a microscope, to magnify that image. The eyepiece also changes the converging light rays gathered by the main optic (lens or mirror) into parallel rays that the eye can register as an image.

A long focal length 25mm (low power) eyepiece used on a 1000mm telescope will produce a magnification of 1000 ÷ 25 = 40x. A short focal length 10mm (high power) eyepiece used on the same 1000mm telescope will produce a magnification of 1000 ÷ 10 = 100x. However the same eyepieces used on a 1500mm focal length telescope (that naturally produces a larger image) will have magnifications of: 1500 ÷ 25 = 60x and 1500 ÷ 10 = 150x.

The object to be observed should first be selected using the finder and centralised. This may be a small telescope attached to the main telescope or a Red Dot Finder. When starting to observe a low magnification eyepiece (marked 25mm or higher) should be fitted to the main telescope focuser. This will allow a wider view of the sky to be seen.

The object centralised in the finder should appear in the eyepiece of the main telescope where it can be centralised and focused to give the best view of the object. To obtain a closer view, the low power eyepiece can be replaced with a higher magnification eyepiece (perhaps one marked 10mm).

To summarise, if a large Open Cluster (like M45 the Seven Sisters) is to be observed the lowest possible powered eyepiece should be used. If a high power eyepiece is used only a part of the cluster will be seen. The highest magnification eyepiece can be used to increase magnification to obtain a detailed view of Moon craters or detail on the surface of a planet.

Reflecting telescopes are generally cheaper than the equivalent sized refracting telescope. This is because they use a mirror as the main optic and not a more expensive lens. A mirror has only one surface to be ground and polished but the typical refractor, that has two or sometimes three lens elements, has four or up to six surfaces to be ground and polished.

The cheapest and simplest reflecting telescope is a Newtonian tube assembly mounted on a Dobsonian mount. The mount is a simple Alt azimuth with a turntable for rotation and a trunnion mount for up and down movement. These are very easy to set up and simple to use. This type of mount is used by many amateur astronomers who build their own telescopes because it is so simple to make.

Because the Newtonian (invented by Sir Isaac Newton) has a secondary mirror at the top of the tube there is a small loss of light so a 130mm will give a just slightly brighter image than a 100mm refractor.

The Skywatcher Skyliner 150mm FL 1200mm £219

Discontinued but can be obtained second hand.

Skyliner	200mm (8″)	FL 1200mm	£299
Skyliner	250mm (10″)	FL 1200mm	£469
Skyliner	300mm (12″)	FL 1500mm	£699

Other manufacturers may still have a similar range.

A major advantage, beside the cheapness, of the Dobsonian is its simplicity of use. It just needs to be placed down on a flat surface and it is ready to use. A finder scope is attached to the main tube to help find a desired object. Once the object is located in the main telescope it can be tracked by moving the tube gently, up or down (by hand) and around while looking through the eyepiece to keep the object central.

The owner can soon master the technique of moving the telescope manually to track an object as it appears to move across the sky. The usual method is to move the telescope towards the east until the object is at the west side of the field of view. As the image is optically reversed this means the object has to be moved to the right of the field of view. The object is then allowed to drift across the field of view until it is about to disappear. The telescope is then moved again.

The Newtonian tube assembly can also be fitted to an equatorial mounting. This does make the telescope more expensive but can make it easier to track objects across the sky. This combination gives the advantage of a large aperture telescope on a mount that can easily be driven using an electric motor to track objects. Most Dobsonian telescopes use a fairly long focal length tube assembly whereas a shorter focal length is generally favoured for the equatorially mounted Newtonian.

Skywatcher Explorer130 FL 900 EQ2 Newtonian £169

Models in this range:

Explorer 150P EQ3	150mm (6″)	FL 750mm	£319
Explorer 150PL EQ3	150mm (6″)	FL 1200mm	£319

Most of the larger manufacturers have a similar range.

As previously stated the main advantage of an equatorial mounting is in its ability to track an acquired object across the sky using just one drive. The mount has two rotating axes. In the image above the shaft with the optical tube at one end and the counter balance weight at the other is called the Declination (Dec) axis. This is used to elevate the telescope or move it down. The axis that is parallel to the telescope tube is called the Right Ascension (RA) and is used to move the telescope from east to west or west to east.

The object to be observed is first found by pointing the telescope, by eye, in the approximate direction. Most equatorial mounts have a clutch release mechanism that allows the telescope to be slewed freely with the drives disengaged. With the clutches still released the object is located at the centre of the finder scope (the small telescope or Red Dot Finder attached to the main tube). The RA and Dec drive can then be engaged by tightening the clutches. The required object should be visible in the main telescope eyepiece. Using the RA and Dec drives the object can then be centred in the main telescope. Once centred, the object can be tracked by adjusting the RA drive only.

Most basic equatorial mounts are supplied with manual drives on RA and Dec. Electric motor drives can be fitted when purchased for additional cost or can be fitted as upgrades at a later date. An electric drive is not necessary on the Dec axis but a driven RA is very useful to save continual manual tracking of objects being observed. With the mounting set up approximately level and closely aligned on the north polar axis, tracking for in excess of 20 minutes without manual adjustment is easy to achieve.

REFRACTING TELESCOPES

Refracting telescopes are generally more expensive than reflecting telescopes but they do have some advantages over their cheaper cousins. Firstly the main optic (the lens assembly) is mounted in the tube by the manufacturer and should remain there untouched for the life of the telescope. The mirrors of reflecting telescopes do need to be collimated from time to time. Being enclosed in a tube the internal surfaces of the lenses can stay clean for a long time and may never need internal cleaning. The outer surface of the lens assembly may need a gentle clean every few years but this is a relatively easy thing to do.

There is also an optical advantage due to the requirement of a reflecting telescope to have a secondary mirror in the light path to direct the gathered light out of the tube to a viewing position. This secondary mirror is an obstruction in the light path and reduces the amount of light available to the observer. A short focus reflecting telescope needs a larger secondary than a long focal length instrument. The presence of the secondary mirror also slightly reduces the quality of the image compared to a refracting system that does not require a secondary optic and is therefore obstruction free. For these reasons the minimum aperture for a refracting telescope should be 90mm whereas 130mm is recommended for a reflecting telescope.

A Skywatcher Evostar 90 on EQ2 Mount £220

This telescope represents the minimum specification for the perfect first refracting scope for a beginner. It has an aperture of 90mm and a focal length (FL) of 1000mm. It is supplied with a tripod fitted with a basic EQ2 (equatorial mounting), two eyepieces, even a camera adaptor. The current price is £155 from Rother Valley Optics.

Other telescopes in this range are:

Evostar – 90	EQ3	FL 900	£270	A little small but ok
Evostar – 102	EQ3	FL 1000	£370	Perfect
Evostar – 120	EQ3	FL 1000	£450	A bit expensive
Evostar – 150	EQ5	FL 1200	£900	Big and expensive

Most of the larger manufacturers have a similar range. The telescopes in these ranges are typically supplied on a tripod and with an equatorial mounting. They usually have two eyepieces (25mm and 10mm) and sometimes include a Barlow Lens. All are supplied with a 90° Star Diagonal. This is a mirror set at 45° to direct the image into a comfortable position for viewing through the eyepiece.

SO WHAT SHOULD YOU BUY?

A first telescope must be easy to use, portable enough to move around and set up and be within a modest budget. The budget available is important but if possible at least £150 should be spent on a new telescope or the pro-rata amount for a second hand instrument (say £100 for a telescope that costs £200 new). **Avoid models that are sold in high street stores as they may be poor quality**.

Some of the best manufacturers to look out for are:

MEADE, CELESTRON, ORION, SKY WATCHER, TAL, KONUS and BRESSER. Suppliers of these telescopes can be found in the adverts in popular astronomy magazines such as ‘Astronomy Now’ and ‘Sky at Night’.

Modern telescopes bought from reputable manufacturers are all good quality these days so it is difficult to choose from the huge and varied selection available. The choice between reflecting and refracting telescopes is really a matter of choice, bearing in mind the advice given previously regarding comparative aperture size. A reflector should, if finances permit, be over 90mm and a reflector over 130mm. A general purpose telescope should have a focal length of around 1000mm. An equatorial mounting is desirable as it will make tracking an object easier.

Do not spend too much money on a large or complex telescope as a ‘first scope’. Using the telescope on the cold damp winter nights (which are the best for observing) does not suit everyone. So a starter scope will provide a relatively low cost trial for the hobby with not too much lose. Like most equipment bought for a hobby the telescope can always be upgraded later.

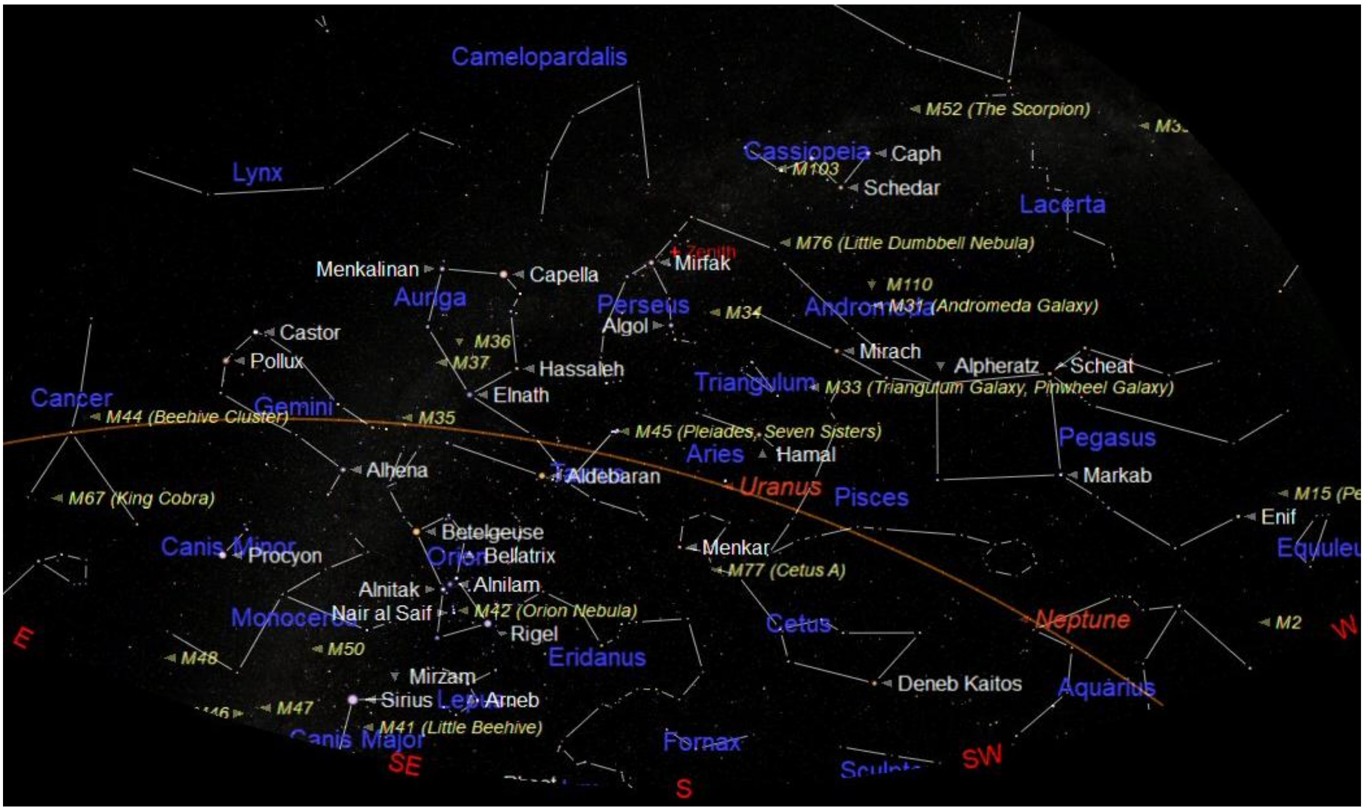
The smaller examples are usually supplied with a Red Dot Finder or a 30mm aperture finder scope whereas a 50mm aperture finder telescope would be better but this can be upgraded later. The cheapest equatorial mountings are usually good enough to start out with. Once the new astronomer becomes more discerning a heavier and more robust mounting (EQ3 or EQ5) can be fitted to make the telescope more stable. This will be required if astro-imaging is to be an interest.

There are other telescopes available with 60mm to 70mm aperture that are not bad if only a small budget is available (£60 to £100). Their capability is however really limited to observing the Moon or the moons of Jupiter. They may also just be able to give a glimpse of Saturn’s ring system or Jupiter’s cloud patterns on a good night.

If anyone is considering buying a telescope for someone as a Christmas present then the best advice is to contact a local Astronomical group. The members will always give advice freely and usually offer a look through their telescope and those of other members so a practical comparison can be made.

Almost any telescope has the ‘wow’ factor when first used, particularly if used to look at the Moon. However if it is too small it may soon become a disappointment if the objects talked about in books and magazines cannot be seen. This is why a minimum aperture is recommended. The extra cost of a worthwhile telescope can be made more acceptable when the instrument is used by the whole family and friends. Almost everyone will want to have a look when it is set up. So £100 to £150 can be used to purchase a telescope which is quite comparable with many other Christmas gifts.

A TOUR OF THE NIGHT SKY - DECEMBER 2021



The chart above shows the night sky looking south at about 21:00 GMT on 15th December. West is to the right and east to the left. The point in the sky directly overhead is known as the Zenith and is shown (in red) at the upper centre of the chart. The curved brown line across the sky at the bottom is the Ecliptic or Zodiac. This is the imaginary line along which the Sun, Moon and planets appear to move across the sky. The brightest stars often appear to form a group or recognisable pattern; we call these 'Constellations'.

Constellations through which the ecliptic passes this month are: Aquarius (the Water Carrier), Pisces (the Fishes), Aries (the Ram), Taurus (the Bull), Gemini (the Twins) and Cancer (the Crab).

The Summer Triangle that dominates the Summer Sky and was described in detail in September issue of this magazine is now moving over the western horizon. The triangle is defined by three obvious bright stars: Deneb in the constellation of Cygnus, Vega in Lyra, and Altair in Aquila.

Prominent is the southern sky is the constellation of Pegasus (the Winged Horse). The main feature of Pegasus is the square formed by the four brightest stars. This asterism (shape) is known as the Great Square of Pegasus. The square is larger than might be expected but once found is easier to find again. There is a very nice Globular cluster in Pegasus it is known as Messier 15 (M15). It is a lovely sight to see in a telescope.

Moving into view in the southern sky is the constellation of Taurus (the Bull). The most obvious star in Taurus is the lovely Red Giant Star called Aldebaran. It appears slightly orange to the 'naked eye' but it is very obviously orange when seen using binoculars or a telescope. Aldebaran is located at the centre of the 'flattened' X shape formed by the brightest stars in Taurus. At the end of the top right (upper west) arm of the 'X' is the beautiful 'naked eye' Open Star Cluster Messier 45 (M45) known as the Pleiades (or the Seven Sisters). It really does look magnificent using binoculars. See pages 7 and 8.

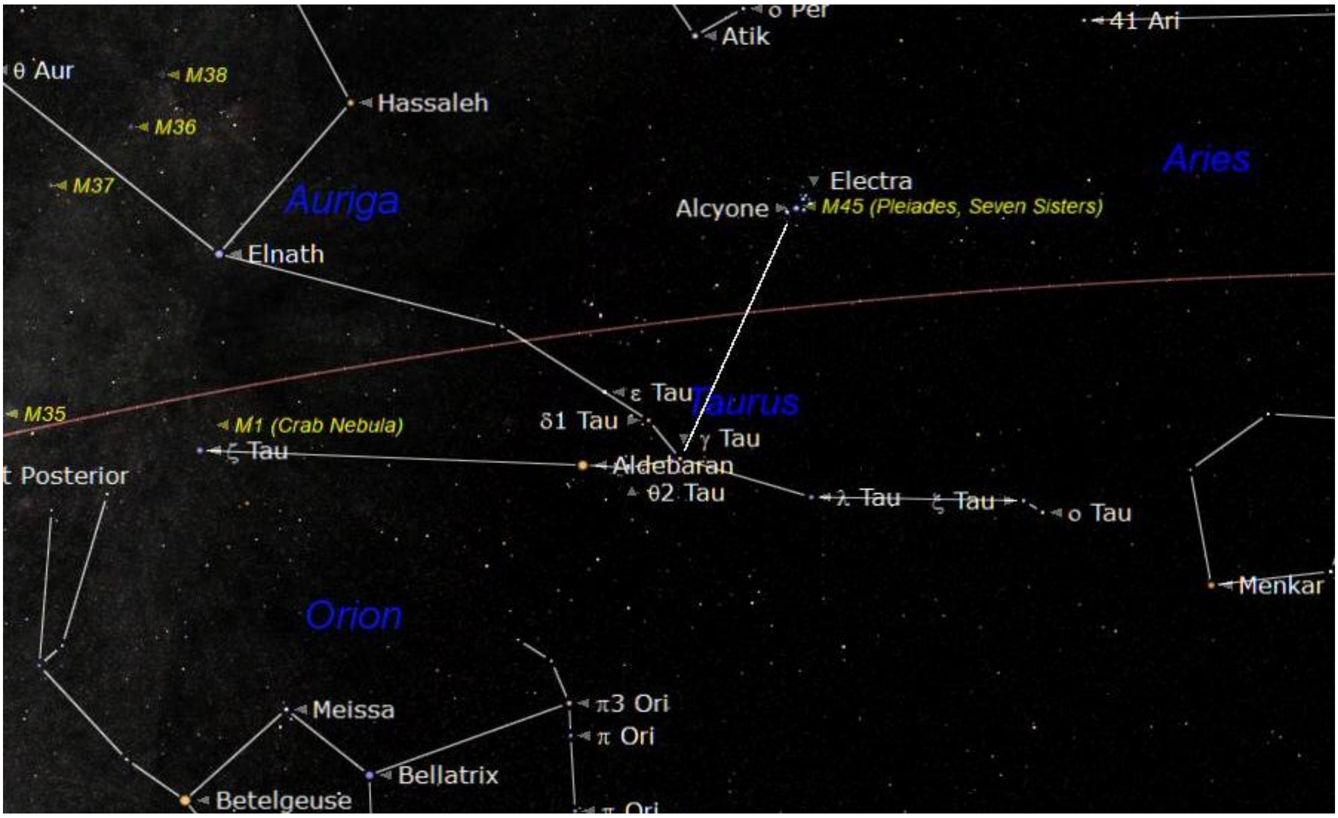
Following Taurus is the constellation of Gemini (the Twins). The two brightest stars in Gemini are Castor and Pollux and they are named after mythological twins. To the north of Taurus is the odd pentagon shape of Auriga (the Charioteer). Dominating Auriga is the brilliant white star Capella which is almost directly overhead. For those with a telescope there is a line of lovely open clusters to search out in Taurus and Auriga. These are M35 in Taurus and M36, M37 and M38 in Auriga.

To the south of Taurus is the winter constellation of Orion (the Hunter). Orion is easily found by looking for his very obvious three stars of his belt. Orion will be the constellation of the month in the January Magazine.

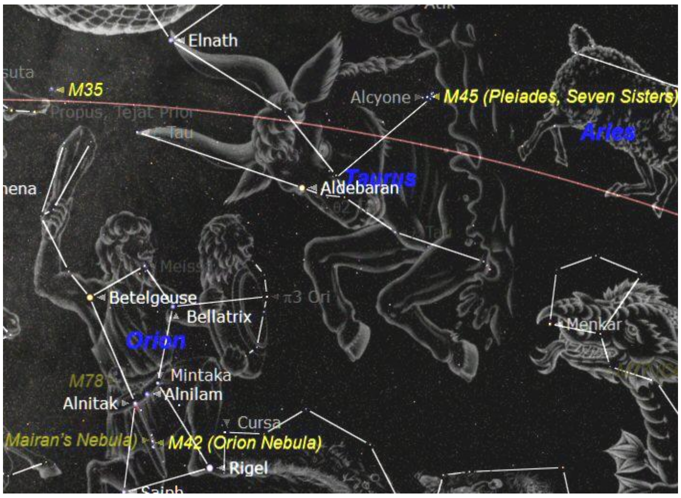
To the east (right) of Taurus is the rather indistinct constellation of Cancer (the Crab). The stars of Cancer are quite faint and can be difficult to discern especially in a light polluted sky. It is really worth searching out Cancer using binoculars or a telescope to see the Open Cluster M44 (the Beehive Cluster). M44 is older and further away than M45 (the Seven Sisters) so is fainter than M45 but still looks lovely. It has a group of stars that resemble an old straw Beehive with bees around it.

The Ecliptic was low in the sky during the summer months so the Moon and planets appeared close to the southern horizon. Saturn and Jupiter are still fairly well placed in the early evening but moving steadily towards the western horizon. The outer 'Ice Giant' planets Neptune and Uranus are well placed in the evening for those who are fortunate enough to have access to a telescope. Due to their low altitude, the planets have not been at their best for observation this year. The thick, murky and turbulent air has caused the planets to appear quite unsteady.

CONSTELLATION OF THE MONTH – TAURUS



The chart above shows the constellation of Taurus the Bull. There are many different representations of Taurus but he is generally shown with his horns tipped by the stars at the end of the obvious '>' shape. The bright red star Aldebaran is normally used to show the bull's eye.

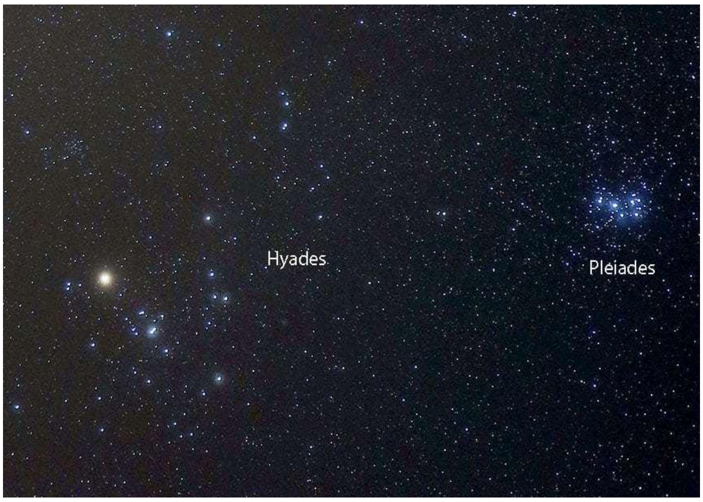


An illustration of the constellation of Taurus

With a little imagination Taurus appears to be charging Orion in the illustration. It sits on the Ecliptic and is one of the star signs of the Zodiac. The asterism (shape) used to identify Taurus resembles a stretched 'X'.

The bright red star Aldebaran is located at the centre of Taurus. It is easy to find and therefore helps to identify the constellation of Taurus. It is in fact a Red Giant Star and that is why it appears distinctly orange. A Red Giant is a star similar to our Sun (perhaps a little larger) that is approaching the end of life as a normal star. It has used up most of its Hydrogen fuel and has swollen into a giant. Its outer layers are now stretched over a larger area so the available heat is also spread over a bigger area so its surface is cooler and appears orange in colour.

Surrounding the bright red star Aldebaran is an Open Cluster of Stars known as the Hyades. It is an older cluster than M45 so its stars have begun to disperse. It is also quite far away from us so the stars appear quite faint. In a dark Moonless sky the cluster can be seen with the naked eye but is best seen using binoculars. The cluster is large, at 3.5° in diameter (about 7 Moon diameters) and well dispersed.

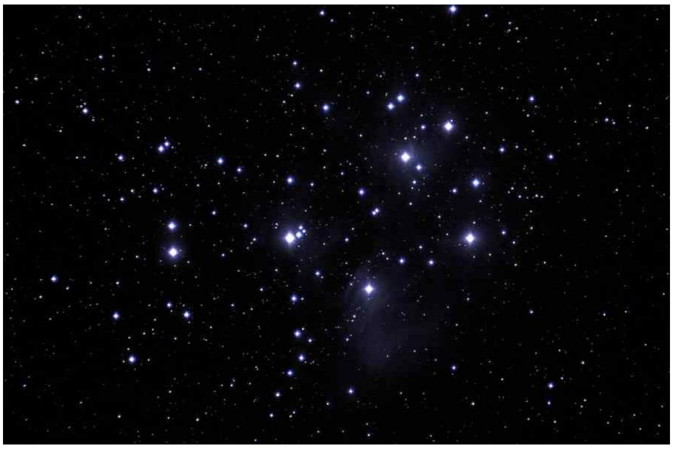


The Open Star Clusters Hyades and Pleiades

The real jewel of Taurus is without doubt the beautiful Open Cluster, Messier 45 (M45) also called the Pleiades or the Seven Sisters. An Open cluster is created as stars form in a giant cloud of gas and dust called a 'Nebula'.

M45 is visible to the naked eye initially looking like a patch of light. Closer observation will reveal a cluster of up to seven stars. Using a good pair of binoculars many more stars will be seen. There are in fact about 300 young stars in the cluster that is estimated to be about 100 million years old. M45 is one of the closest open clusters to us at 400 light years.

The Pleiades look brighter than the stars of the Hyades because they are very bright large young stars and are relatively close to us. The largest and brightest is Alcyone which is 10 times the mass of our Sun and 1000 times brighter. The larger and brighter stars of the Pleiades are also rotating very fast.



Messier 45 (M45) the Pleiades (Seven Sisters)

The stars of the Pleiades cluster would have formed from the gas and dust of a Nebula. Gravity draws the atoms of the Nebula together to form denser clumps of gas that become ever denser. Eventually the gas is squeezed into dense spheres where the pressure and high temperature at the core causes Hydrogen atoms to combine through Nuclear Fusion. As Hydrogen atoms are fused into Helium heat is produced and the sphere becomes a shining star. Any left-over gas and dust is blown away by intense radiation from the young stars and a cluster of new stars is revealed. This type of star cluster is called an 'Open Cluster'.

The biggest and brightest stars of M45 (the Seven Sisters) have been named after seven sisters from Greek Mythology. They were the seven daughters of the Titan god called Atlas and the sea-nymph Pleione. Atlas and Pleione are included as the naked eye stars but the 6th & 7th sisters are actually Sterope (Asterope) and Celaeno.

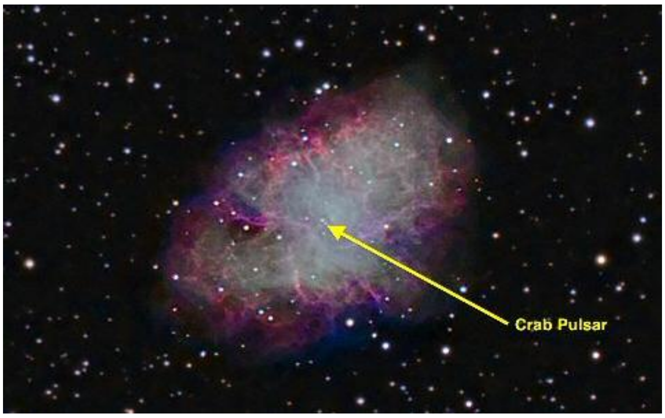
Names of Seven Sisters and Parents (yellow)

Impressive as they are, the Seven Sisters are just the brightest (naked eye) stars in a cluster of around 300 young stars. In the images above the Seven Sisters appear to be surrounded by gas remaining from the original nebula. However it is now thought the cluster is just passing through a cloud of Hydrogen gas in space.

As M45 is so close to us the cluster has a relatively high apparent movement across the sky although it is still too slow for us to perceive. It will take 30,000 years to move a distance equal to the diameter of our Moon.

Although the cluster is moving through space the individual stars all have slightly different trajectories and relative speeds. Gradually over millions of years the stars will move further apart and the cluster will disperse, like the Hyades. Binoculars will reveal around 30 to 50 stars in the cluster and a telescope will reveal about 300 stars in the cluster. However the cluster is too large to fit into the field of view of most telescopes so the outline of the cluster will be lost.

There is another very interesting object in Taurus. At the end of the lower left (eastern) arm of Taurus is Messier 1 (M1) the Crab Nebula. It can be seen using binoculars in a dark clear sky but really needs a telescope. From Aldebaran look east to the star ξ (xi) Tauri. Just above ξ Tauri is a small smudge of light, this is M1.



Messier 1 (M1) the Crab Nebula imaged by Hubble

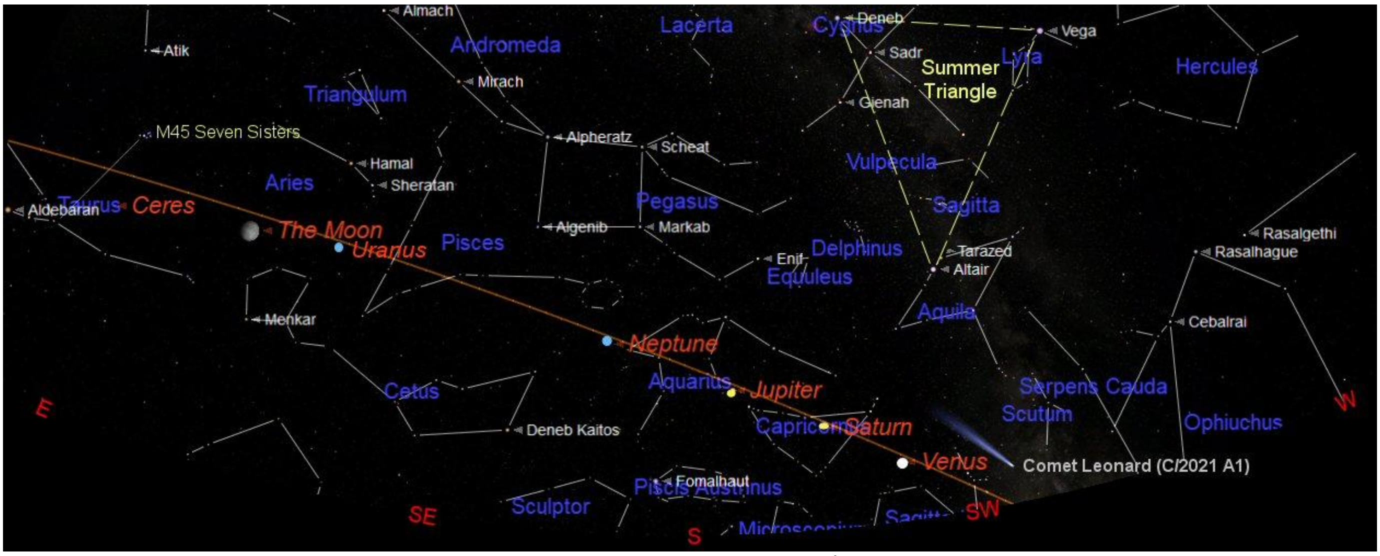
M1 is the remnant of a giant star that exploded as a Supernova about 7000 years ago. Its light took 6000 years to reach Earth and was observed by Chinese astronomers in the year 1054 AD. It can still be seen in a dark clear sky as a 'fuzzy' patch of light using a medium sized telescope.

A Supernova is the 'death' of a star more than three times the mass of our Sun. Giant stars consume their Hydrogen fuel at an experientially faster rate than smaller stars. Consequently bigger stars do not 'live' as long as smaller stars. As stars begin to exhaust their supply of Hydrogen they develop into a Red Giant like Aldebaran. Even larger stars develop into even larger Red Super Giants like Betelgeuse in Orion.

A star like our Sun and those up to about twice the mass of our Sun eventually slowly collapse as their fuel eventually runs out. The outer layers of the Red Giant drift away to form a gas bubble. The core 'gently' collapses to form a White Dwarf Star.

Stars that are over 2½ to 3 times the mass of our Sun come to a more dramatic end. As the fuel of a larger Red Giant Star finally runs out the star suddenly collapses and all the mass of the star falls inwards under the massive force of its own gravity. The collapse reaches a point where the pressure and heat causes a gigantic thermonuclear explosion. The outer regions are blown into space to create a Supernova Remnant like M1 and a dense Neutron Star about 12,000km in diameter. These tiny, super dense stars are also called 'Pulsars'.

THE SOLAR SYSTEM - DECEMBER 2021

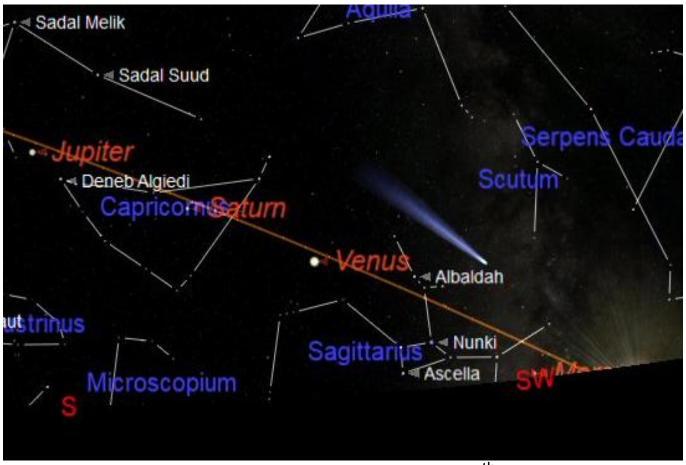


The planets at 17:30 GMT on 15th December

The chart above shows the location of the planets along the Ecliptic. The sky has been darkened to make the planets visible. The visible planets: Venus, Saturn, Jupiter, Neptune and Uranus are visible along the Elliptic from the West (right) to East (left). The planets appear low in the sky and are not well positioned for observing.

MERCURY will be very close the Sun before sunrise in the east and will not be visible this month.

VENUS will be visible in the early evening sky after sunset. It will be easy to find but will it require a clear view to the south western horizon. Venus has emerged from its excursion behind the Sun when it was in 'Conjunction' with the Sun. It appeared at its Greatest Easterly Elongation on 29th October and it is now moving back towards the Sun and appearing bigger in diameter but as a narrowing crescent.



Venus as it appears at sunset on 15th December
Also showing location of Comet Leonard (C/2021 A1)

MARS has now moved out of view and will not appear in the evening sky again until September 2022. It is very close to the Sun this month will be too close to the Sun and too small in diameter to be observable.

JUPITER will be at its best and visible in the south west as the sky darkens. Jupiter was at opposition and its best on 20th August. It will be at its rather poor best in the south at about 17:00 but it will be moving towards the western horizon to set at about 21:15.

SATURN is now bidding us goodbye until next year. It will be difficult to observe in the turbulent air close to the south western horizon. Saturn will be at its best as soon as it is dark and in the south. It will be moving west and will set over the western horizon at about 19:30.

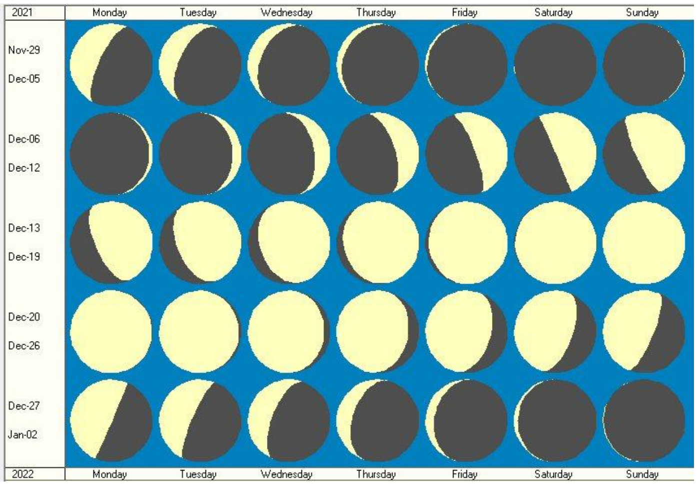
URANUS will be observable this month and will be best at 21:00 when it will be due south and at its highest point above the horizon but is small and faint at +5.7.

NEPTUNE will be just visible to the east of Jupiter and will be at its best at 18.00. It is small a difficult to see at only 2.4 arc-seconds in diameter and at magnitude +7.7.

THE SUN

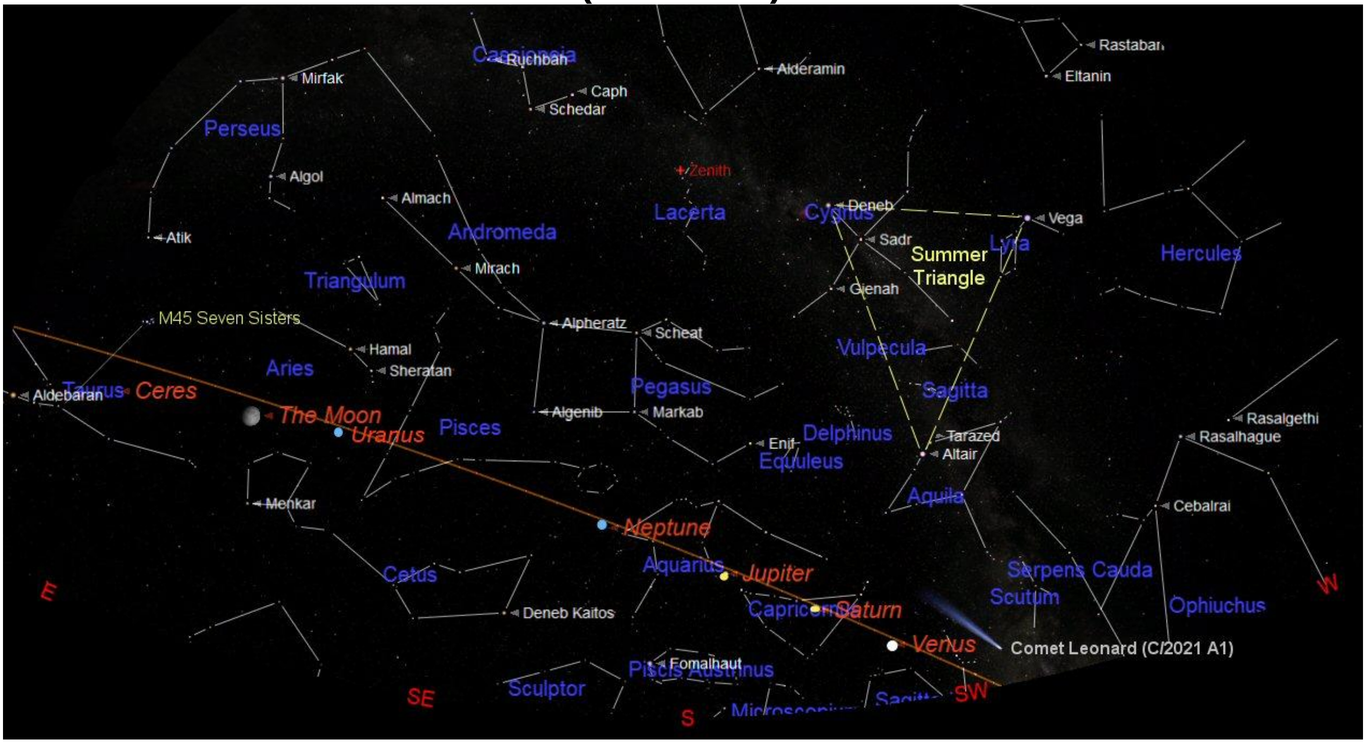
The Sun rises at about 08:00 at the beginning of the month and 07:35 by the end. It sets at 16:30 at the beginning of the month and 16:00 at the end of the month. It will be at its lowest point in the sky on 21st December and at the Summer Solstice. It will be the longest night at 16 hours and shortest day at just 8 hours long. There have been a few nice Sunspots during October and November.

THE MOON PHASES DURING DECEMBER



New Moon will be on 4th December
First Quarter will be on 11th December
Full Moon will be on 20th December
Last Quarter will be on 27th December

COMET LEONARD (C/2021 A1) - DECEMBER 2021

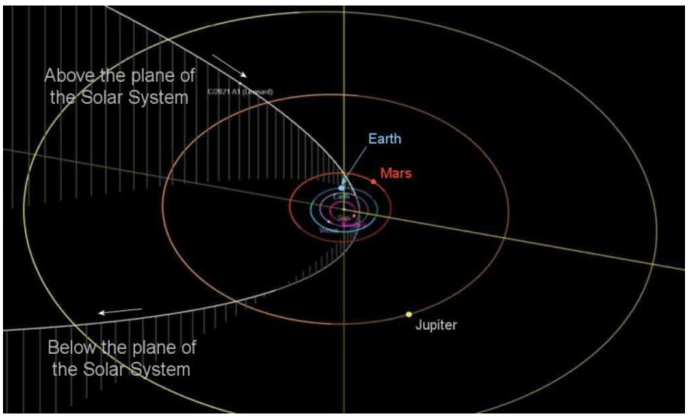


The location of Comet Leonard (C/2021 A1) at 16:15 GMT on 15th December

There is a 'naked eye' Comet visible in the night sky at the moment so that is the good news but unfortunately there is some bad news. The bad news is the comet called Leonard (C/2021 A1) is close to the Sun from our point of view and difficult to see. Its location is shown on the chart above just above the horizon after sunset in the south west and will be very difficult to see.

Comet Leonard (C/2021 A1) is an inbound (approaching the Sun) long period comet discovered by G. J. Leonard at the Mount Lemmon Observatory. It was first spotted on 3rd January 2021 (a year before perihelion) when the comet was 5 AU (750 million km) from the Sun. Jupiter's orbit is (5 AU from the Sun) is at the frost line where methanol (CH_3OH) and water start sublimation into gas. *[1 Astronomical Unit 'AU' is a unit of distance between Earth and the Sun equal to 150 million kilometres.]*

This was the first comet discovered in 2021 and has a retrograde orbit. On 12th December 2021 the comet will be 0.233 AU (34.9 million km) from Earth and on 18th December 2021 will be 0.028 AU (4.2 million km) from Venus. It will make its closest approach to the Sun on 3rd January 2022.



The trajectory of Comet Leonard (C/2021 A1)

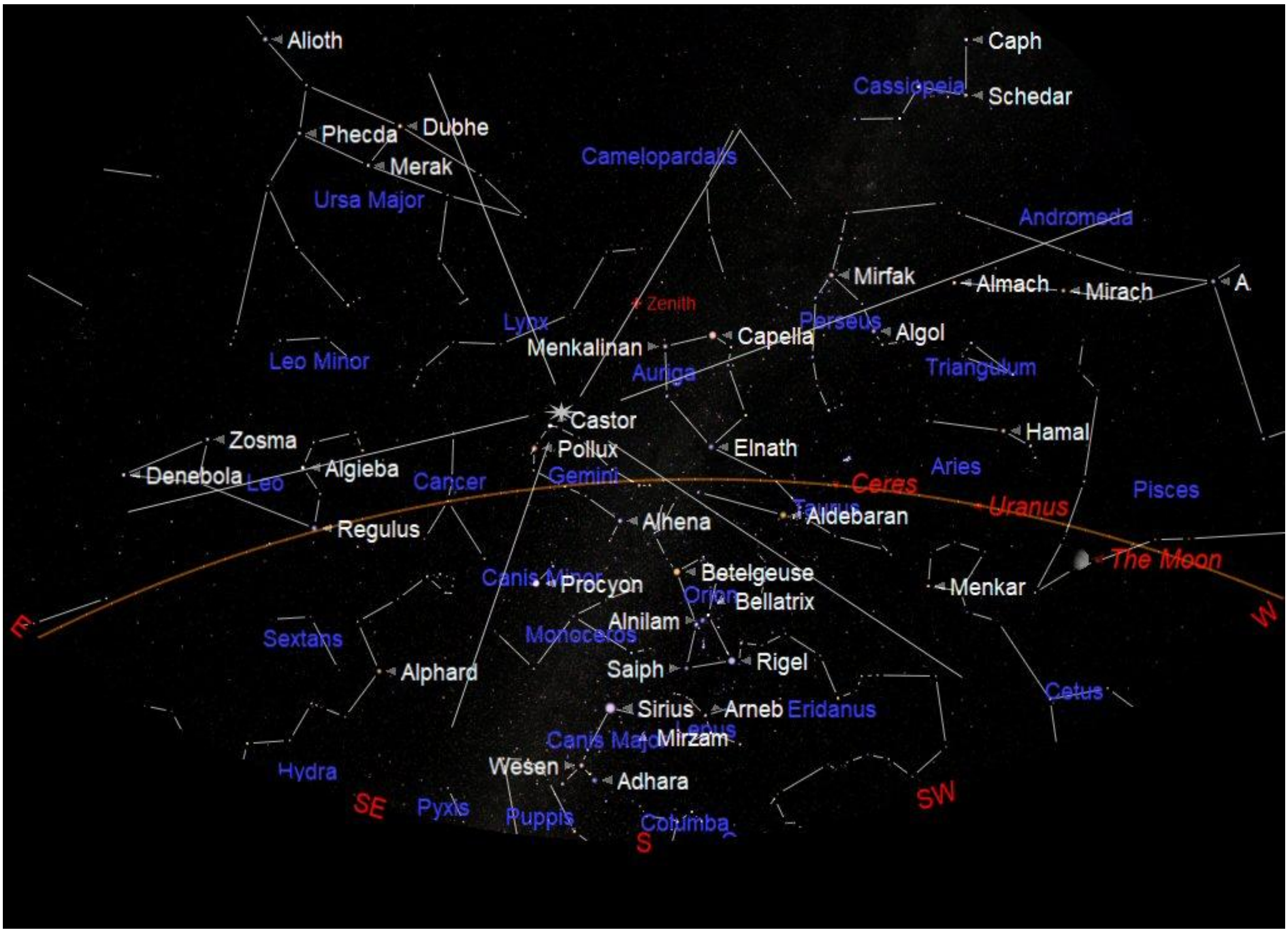
On the morning of 6th December 2021 the comet will be about 5 degrees from the star Arcturus. On 14th December 2021 the comet will be just 14.7 degrees from the Sun and will quickly become southern hemisphere object not visible from the northern hemisphere and the UK. The forward scattering of light could cause the comet to brighten to as much as magnitude 2.

The comet may reach naked eye visibility in December 2021 from the southern hemisphere. At an apparent magnitude of 4, it (in theory) should be a good binocular comet. On 10th October the comet showed a short but dense dust tail. As of mid-November the comet has gained a total magnitude (coma + nucleus) of around 10.

A comet similar to what Leonard may look like

Comet Leonard C/2021 A1 has been inside of the orbit of Neptune since May 2009. Using an epoch of 1950 which is well before the comet entered the planetary region of the Solar System, a barycentre orbit solution suggests the comet had roughly an 80,000 year orbital period. Therefore the comet had spent the last 40 thousand years inbound from approximately 3,700 AU (550 billion km). After perihelion (closest point to the Sun) the comet will be ejected from the Solar System. The barycentric orbit will remain hyperbolic after September 2022.

THE GEMINID METEOR SHOWER



The Geminid Meteor Shower - Radiant at 01:00 14th December

In the middle of this month, around 8th to 17th December, there will be a meteor shower known as the Geminid shower. There will be a peak in activity during the evening of the 13th and morning of 14th December. The very best time to watch for the meteors will be during the early morning hours on 14th December (at 07:00 the shower should be at its maximum as seen from the UK).

The gibbous Moon will be in the south in the early evening of 13th December but will move into the west by midnight and before any serious meteor watching has started. Conditions look promising, weather permitting and the sky will be fairly dark but not moonless.

The type of meteor that occurs in showers usually originates from a comet and is much more common than the 'Fireballs' that originate from asteroids. The Geminid shower for this reason is unusual because it is thought to originate from an asteroid known as 3200 Phaethon. This means that some of the meteoroids (the particles moving through space) may be of a rocky nature so they will often be bright and survive for quite a long time. When they enter Earth's atmosphere about 100km up they might produce a bright and persistent trail.

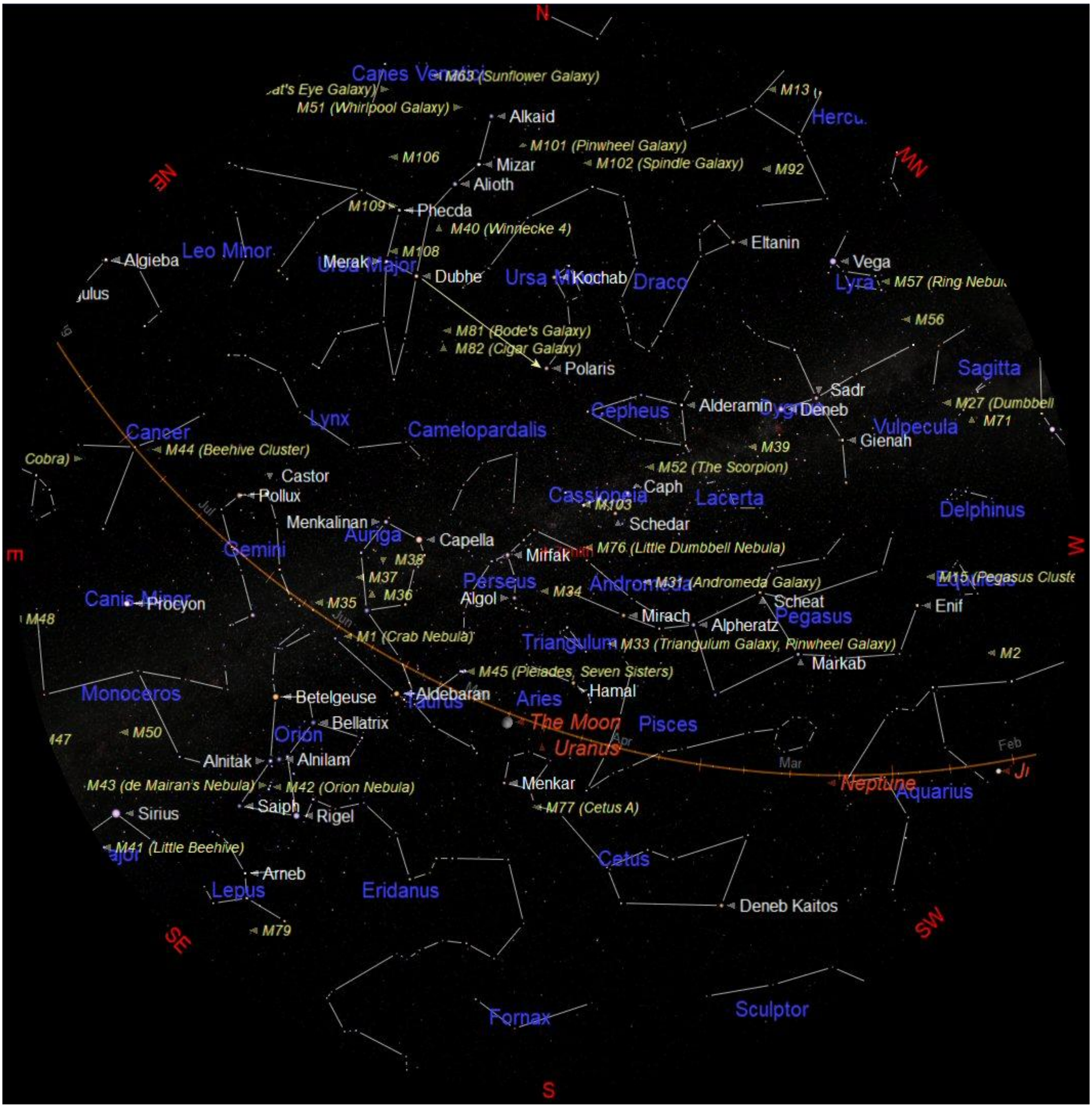
The Geminid meteors also enter the atmosphere comparatively slowly at about 35 km/second compared with other showers that enter at over 75 km/second. As a result of this slower entry and some having a more robust make up, the Geminid meteors may appear brighter and their trails across the sky last longer.

The actual peek of activity is expected to occur at 07:00 around on 14th December so should be visible from the UK before dawn. Observers in the USA will be luckier as they will be able to see it in their darkness.

Because the constellation of Gemini is above the horizon from early evening, the meteors can be seen for most of the night and in almost any part of the sky. By midnight the constellation will be almost due south and high in the sky. If you are intending to have a look remember to wrap up warm before you go out because you will soon feel very cold and that will spoil your enjoyment of the shower. Make yourself comfortable in a garden chair and spend at least an hour looking.

Geminid meteor shower composite by Clint Spencer

THE NIGHT SKY – DECEMBER 2021



The chart above shows the whole night sky as it appears on 15th December at 21:00 (9 o'clock) Greenwich Mean Time (GMT). As the Earth orbits the Sun and we look out into space each night the stars will appear to have moved across the sky by a small amount. Every month Earth moves one twelfth of its circuit around the Sun, this amounts to 30 degrees each month. There are about 30 days in each month so each night the stars appear to move about 1 degree. The sky will therefore appear the same as shown on the chart above at 8 o'clock GMT at the beginning of the month and at 10 o'clock GMT at the end of the month. The stars also appear to move 15º (360º divided by 24) each hour from east to west, due to the Earth rotating once every 24 hours.

The centre of the chart will be the position in the sky directly overhead, called the Zenith. First we need to find some familiar objects so we can get our bearings. The Pole Star **Polaris** can be easily found by first finding the familiar shape of the Great Bear 'Ursa Major' that is also sometimes called the Plough or even the Big Dipper by the Americans. Ursa Major is visible throughout the year from Britain and is always quite easy to find. This month it is in the North East. Look for the distinctive saucepan shape, four stars forming the bowl and three stars forming the handle. Follow an imaginary line, up from the two stars in the bowl furthest from the handle. These will point the way to Polaris which will be to the north of overhead at about 50º above the northern horizon. Polaris is the only moderately bright star in a fairly empty patch of sky. When you have found Polaris turn completely around and you will be facing south. To use this chart, position yourself looking south and hold the chart above your eyes.

Planets observable in the evening sky: Venus, Saturn, Jupiter and Neptune (in the early evening), Uranus later.