NEWBURY ASTRONOMICAL SOCIETY
MONTHLY MAGAZINE – DECEMBER 2018

THE GEMINID METEOR SHOWER

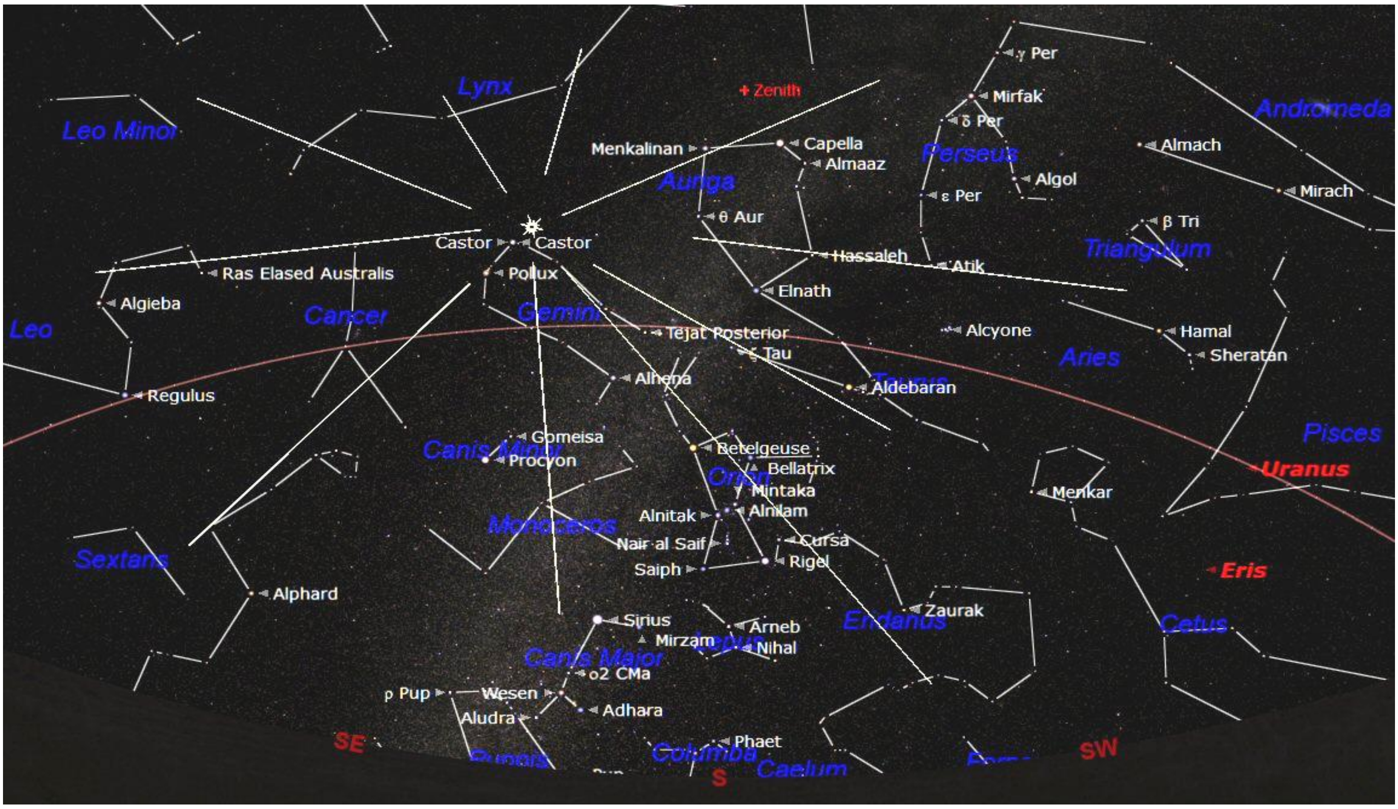


Chart showing the Radiant Point of the Geminid Meteor Shower

In the middle of this month, from 8th to 17th December, there will be a meteor shower known as the Geminid shower. The very best time to watch for the meteors will be during the early morning hours on Thursday 14th.

The Moon does not rise until 03:40 so conditions look very promising and weather permitting, the sky will be dark and moonless for most of the night. The suggested hourly rate is 120 but this would be in a perfect dark clear sky. Even with a perfect sky in the Newbury area we might expect less than that but it could still be well worth waiting for.

The type of meteor that occurs in showers usually originates from a comet and is much more common than the 'Fireballs' that generally 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 often 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 rocky make up, the Geminid meteors may appear brighter and their trails across the sky often last longer.

Geminids appear to radiate from constellation of Gemini which 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 South Western 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 meteor shower. Make yourself comfortable in a garden lounger chair and spend at least an hour looking.

Asteroid 3200 Phaethon is what is known as an Apollo Asteroid. Apollo asteroids are a group of near-Earth asteroids that have orbits around the Sun that extend from the Asteroid Belt (between Mars and Jupiter) into just inside the orbit of Earth. They are generally small but can be up to 8.5 km in diameter with many that cross Earth's orbit. Over 2500 have been identified.

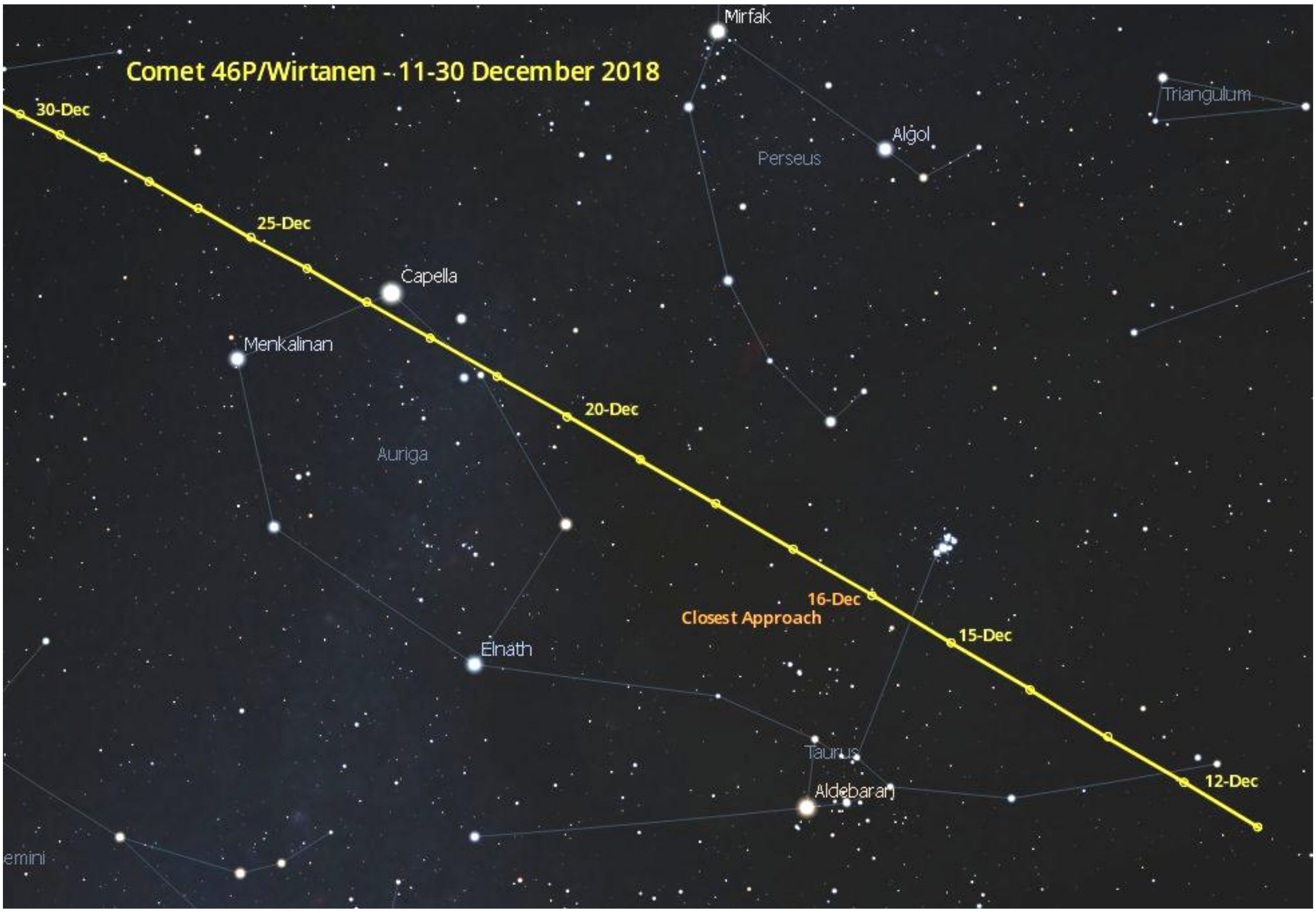
NEWBURY ASTRONOMICAL SOCIETY MEETING

7th December Juno at Jupiter – Mission Results
Website: **www.newburyastro.org.uk**

NEXT NEWBURY BEGINNERS MEETING

19th December Science Fiction and Science Fact
Website: **www.naasbeginners.co.uk**

A Comet for Christmas – 46P could be 'Naked Eye'



The path that Comet 46P/Wirtanen will take through the December sky (see page 3)

There is a good chance that we may have a fairly bright comet gracing our sky this month. This comet is called 46P/Wirtanen and may be bright enough to see with our naked eye. It should almost certainly be bright enough to see using binoculars.

46P/Wirtanen is a small short-period comet with a current orbital period of 5.4 years. It was the original target for close investigation by the *Rosetta* spacecraft, planned by the European Space Agency. However an inability to meet the launch window led to Rosetta being sent to Comet 67P/Churyumov–Gerasimenko instead.

46P/Wirtanen imaged by Yasushi_Aoshima in 2008

Comet 46P/Wirtanen belongs to the Jupiter family of comets, all of which have aphelia between 5 and 6 AU (AU [Astronomical Unit] = Earth / Sun distance). Its diameter is estimated to be about 1.2 kilometres.

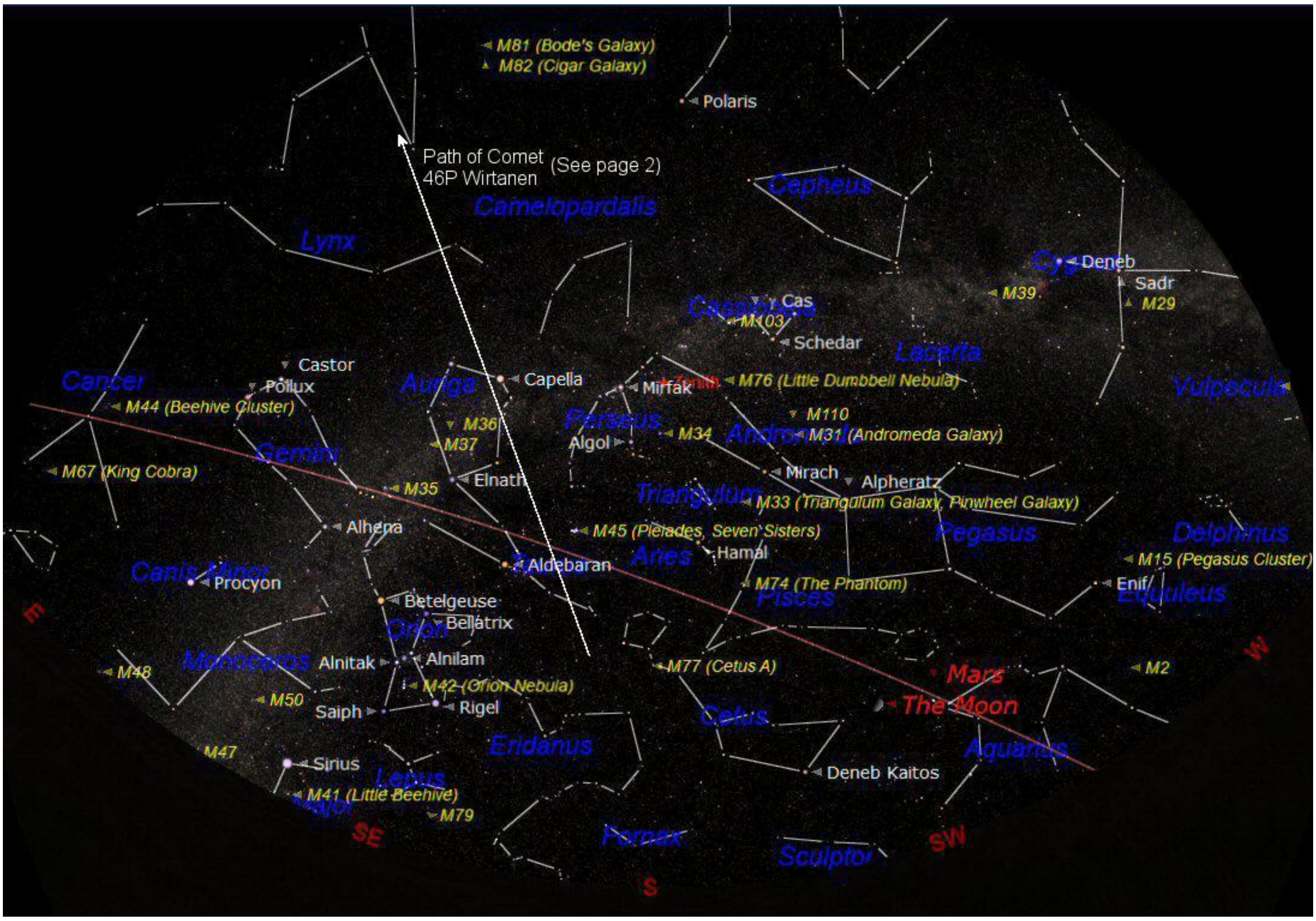
It was discovered photographically on 17th January 1948, by the American astronomer Carl A. Wirtanen. The plate was exposed on 15th January during a stellar proper motion survey for the Lick Observatory. Due to a limited number of initial observations, it took more than a year to recognise this object as a short-period comet.

On 16th December 2018 the comet will pass within 11,680,000 km from Earth. It may reach an estimated magnitude of +3, making this pass the brightest one predicted and the brightest close approach for the next 20 years. Its magnitude could peak as bright as magnitude +3 at its closest approach on 16th December.

It can be seen that the comet will climb through Taurus and pass between the bright star Aldebaran and M45 (the Seven Sisters star cluster) as it makes its closest approach to Earth. It will be at its brightest at this time. It will continue up through the constellation of Auriga and pass close to the bright star Capella on 23rd December. It will then begin to fade as it moves away from us. It will appear as a 'fuzzy' patch of light but probably no tail.

The 2018 close approach, combined with Wirtanen's brightness provides an opportunity to study a potential future spacecraft mission target in detail. A worldwide observing campaign has been organised to capitalise on the favourable circumstances of this apparition.

A TOUR OF THE NIGHT SKY - DECEMBER 2018



The chart above shows the night sky looking south at about 22:00 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 or Nadir and is shown at the 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), Piscis (the Fishes), Aries (the Ram), Taurus (the Bull), Gemini (the Twins), Cancer (the Crab) and Leo (the Lion).

The Milky Way (our Galaxy) flows up from the south eastern horizon through Orion and Gemini. It continues up through Perseus and Cassiopea and on into Cygnus which is now disappearing over the western horizon.

Mars is still in a reasonable position, for observing during the early evening, in the constellation of Aquarius. Above Mars 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.

Joined to the upper left star (Alpheratz) of the Square of Pegasus is the '>' shape of Andromeda. Following the lower line of stars to Mirach and then up to the second star, M31 the Great Galaxy can be found.

Along the Ecliptic is the constellation of Taurus (the Bull). The stick figure representation of Taurus resembles a squashed 'X' with the bright orange coloured Red Giant star Aldebaran at its centre. This is a lovely star to look at especially using binoculars or a telescope and does look noticeably orange in colour.

Following the western (right) and Northern (upper) arm of the 'X' shape of Taurus guides us to the beautiful Pleiades Open Star Cluster. This is the bright Open Cluster of seven bright 'naked eye' stars known as M45 the Pleiades or 'Seven Sisters'.

To the east of Taurus along the Ecliptic is the constellation of Gemini (the Twins). The twin stars Castor and Pollux are easy to identify.

Below Gemini is Orion the constellation of this month.

At the top, centre of the chart above is the fairly faint constellation of Ursa Minor (the Little Bear) also called the Little Dipper by the Americans. Although Ursa Minor may be a little difficult to find in a light polluted sky it is one of the most important constellations. This is because Polaris (the 'Pole' or 'North Star') is located in Ursa Minor. Also see the chart on the last page which provides help to identify Polaris.

Polaris is the star that is located at the approximate position in the sky where an imaginary line projected from Earth's North Pole would point to. As the Earth rotates on its axis, the sky appears to rotate around Polaris once every 24 hours. This means Polaris is the only 'bright' star that appears to remain stationary in the night sky as Earth rotates once every 24 hours.

EXPLAINING ASTRONOMY – 10 EASY TIPS ABOUT TELESCOPES

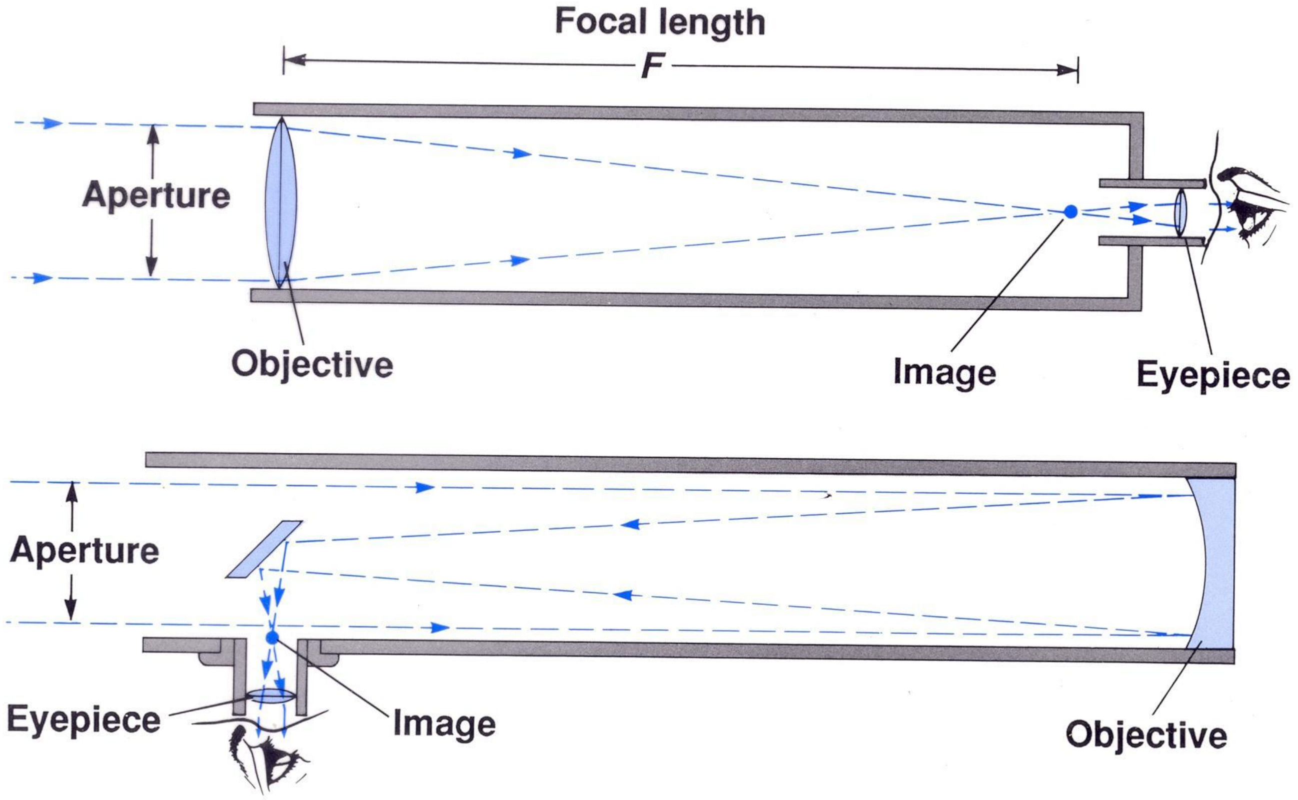


Diagram showing the light paths of the two main types of telescopes

There are two basic types of telescope REFRACTING and REFLECTING. The light path of a refracting telescope is shown at the top of the diagram above and the light path of a reflecting telescope is at the bottom.

THE REFRACTING TELESCOPE

A Refracting telescope uses a glass lens to capture an image carried by light and direct the gathered light into the observer's eye. It can be seen from the diagram above that the larger the lens, the more light it can capture. So a larger lens will provide a brighter image and enable fainter objects to be seen.

The glass lens is shaped so that it refracts (bends) the rays of light progressively more from the centre to the edge. This concentrates all the rays to a common point called the Focal Point where an image is formed.

At the focal point the image (for example the Moon) can be seen if it is allowed to fall on to a piece of card. However the image cannot be seen if the light is allowed to directly enter the eye placed at the position shown. It requires a second lens to modify the light path so the image can be seen directly by the observer's eye. We call this lens the 'Eyepiece'.

An eyepiece has three functions: (1) It changes the light path so the image can be perceived by the observer's eye. (2) The eyepiece is mounted in a movable tube so the image can be focused to the requirements of any individual's optical requirements. (Our eyes are all different.) (3) By changing the curvature of the eyepiece lens, the eyepiece can be used to magnify the image. The shorter the focal length of the eyepiece lens the more it will magnify the image.

THE REFLECTING TELESCOPE

The Reflecting telescope uses a 'concave' mirror to capture an image carried by light and reflect the gathered light into the observer's eye. It can be seen from the lower diagram above that a larger mirror, will capture more light and reflect it towards the observer's eye. So a larger mirror will provide a brighter image and enable fainter objects to be seen.

The reflective Aluminum surface is on the front of the curved glass Mirror, unlike a looking glass mirror where the reflective surface is on the back surface. The glass substrate has a curved surface in the form of a parabola. This is like a spherical surface but with the centre of the mirror very slightly deeper than the edge. So it acts like a headlight reflector in reverse. A headlight has a point source of light (bulb filament) and reflects a parallel beam of light. A parabolic mirror collects parallel rays of light and reflects them to converge into a focal point, where the image is formed.

In the diagram above the eyepiece is mounted on the side of the tube. A second mirror (secondary) is set at 45° to direct the converging light rays out through a hole in the tube to the eyepiece. This prevents the observer's head blocking the open end of the tube. The secondary mirror cannot be seen by the observer and has only a minor effect on the image quality.

A reflecting telescope has main two advantages over a refracting telescope. Having only one polished surface it is cheaper to make and it suffers less from the effect of dew on a cold damp night. There are a number of variations of the reflecting type of telescope.

TELESCOPE ATTRIBUTES AND ACCESSORIES

We shall now consider some common attributes of these telescopes and the accessories used on them.

FOCAL LENGTH

The Focal Length is the measurement from the centre of the Main Objective (lens or mirror) to the image formed. Focal Length dictates the size of the image produced. A long focal length produces a larger image than a short focal length. This means (in general) a long focal length is good for seeing detail on the planets and a short focal length is better for looking at larger structures like star clusters.

A term used to classify a main objective is its Focal Ratio (*f*). The focal ratio is defined by the Focal Length divided by the diameter of the Objective. So an objective with a 1000mm focal length and an aperture of 100mm would have a focal ratio of 1000 ÷ 100 = 10 and written as *f*10.

FOCUSERS

A focuser has two main purposes these are to support the eyepiece and to provide positional adjustment of the eyepiece.

A typical Focuser for a reflector

The example focuser shown above has a rack and pinion adjuster with a knob for right or left hand operation. Eyepieces have a standard 1¼" (31.75mm) mounting tube that is held in the Focuser Mounting Tube and secured using one or two Thumb Screws. Turning the knob moves the Eyepiece Mounting Tube in or out to adjust the focus of the eyepiece for the observer.

EYEPIECES

An eyepiece is really a small microscope used to magnify the image produced by the Main Objective of a telescope. It has a tube like fitting to locate it into the Focuser Mounting Tube. There are two standard sizes of mounting for eyepieces these are: 1¼" (31.75mm) and 2" (50.8mm). Most beginner telescopes are produced with a 1¼" Focuser and supplied with 1¼" eyepieces.

The quality of an eyepiece really does dictate how good the view through a telescope will be. Modern telescopes generally have good optics but the eyepieces supplied are not always so good. However they can be upgraded.

Eyepieces are available with a range of focal lengths. A typical manufacture's range may comprise of the following focal lengths: 40, 32, 25, 20, 15, 12.5, 10, and 6mm. As mentioned earlier this will provide a range of magnifications when used with any specific telescope. A new telescope will normally be supplied with a 25mm and a 10mm eyepiece. The first upgrade for a new telescope should be to at least the 25mm and 10 mm eyepieces supplied with the telescope.

The method of calculating the magnification of a telescope / eyepiece combination is to divide the focal length of the telescope by the focal length of the eyepiece. For example using a 10mm eyepiece with a 1000mm focal length telescope would produce a magnification of: 1000 ÷ 10 = 100 (written 100x). This would be regarded as a high magnification whereas using a 40mm would produce 1000 ÷ 40 = 25x that would be regarded as a low power magnification.

A low power magnification will deliver a wide view of the sky with any objects in the field of view looking small. A high power magnification will produce a narrow field of view with any objects appearing larger.

The Meade set of eight eyepieces and a 2x Barlow

BARLOW LENS

A Barlow is a single lens mounted in a simple tube that can be used with any eyepiece to increase the magnification of that eyepiece. The Barlow has a standard 1¼" (31.75mm) mounting tube to fit into the Focuser and a 1¼" (31.75mm) diameter inner diameter at the opposite end to receive the eyepiece. Normal Barlow lenses produce a 2x or 3x increases in the magnification of the eyepiece but can be as high as a 5x increase in magnification.

EYEPIECE FILTERS

A variety of filters can be screwed into the mounting tube of eyepieces to enhance the performance in many ways. A few examples are given below.

MOON FILTER To reduce glare and increase contrast

SKY FILTER Used to reduce sky light pollution

COLOUR FILTER To enhance detail on planets

ULTRA VIOLET To enhance detail in nebulae

HYDROGEN ALPHA To enhance detail in nebulae

OTHER MORE SPECIALISED FILTERS

FINDERS

Telescopes, especially longer focal length telescopes, have a narrow field of view in the sky so it can be very difficult to locate an object to be observed. To help find an object, a finder is fitted to the main telescope tube. Finders come in two types namely Red Dot Finders and Finder Telescopes.

A red dot finder is fitted to many ‘First’ (beginners) telescopes. These are good for finding bright objects such as the Moon and the brighter planets. They are basically a small LED light that projects a red dot on to a small glass screen. The observer has to simply move the telescope until the red dot is seen to align on the object to be found. They are easy to use but can only be used to find objects that are quite easy to be seen with the naked eye.

A Red Dot Finder

A Finder Telescope (also called finderscope) is a small telescope of 30mm or 50mm aperture and with a magnification of 5x to 10x. It will have cross hairs to aid centralizing the object in the field of view.

50mm and 30mm Finder Telescopes

It is usually easy to fit a finder telescope as an upgrade for a Red Dot Finder. The Red Dot Finder may be attached using a standard Dove Tail Mount so the finders shown above will fit into the Dovetail Shoe. A Dovetail Shoe can be bought from a telescope shop and fitted using just two screws but will require drilling two holes in the telescope tube.

A Finder Telescope is a very useful upgrade to a telescope and makes it much easier to find objects to observe. It is essential for finding objects below naked eye visibility especially in light polluted skies.

FOCUSER DIAGONAL

A Diagonal is a small mirror mounted into a small body at 45° to direct the image through 90° so it can be viewed from a more comfortable position.

A diagonal Mirror Assembly (see the telescope below)

A diagonal is used on refracting telescopes and those telescopes that have the focuser mounted at the rear (bottom) of the telescope assembly. It is especially needed when observing objects at a high elevation.

EQUATORIAL MOUNTING

When observing the night sky the 23.4° tilt of Earth’s axis of rotation presents a problem. All the objects in the sky except Polaris appear to move across the sky in an arc. When looking towards the south, the stars, planets, our Moon and the Sun rise in the east, cross the sky in an arc and set in the west. This means: for a telescope to track these objects the telescope mount has to be moved in two directions at the same time. Up or down and east to west.

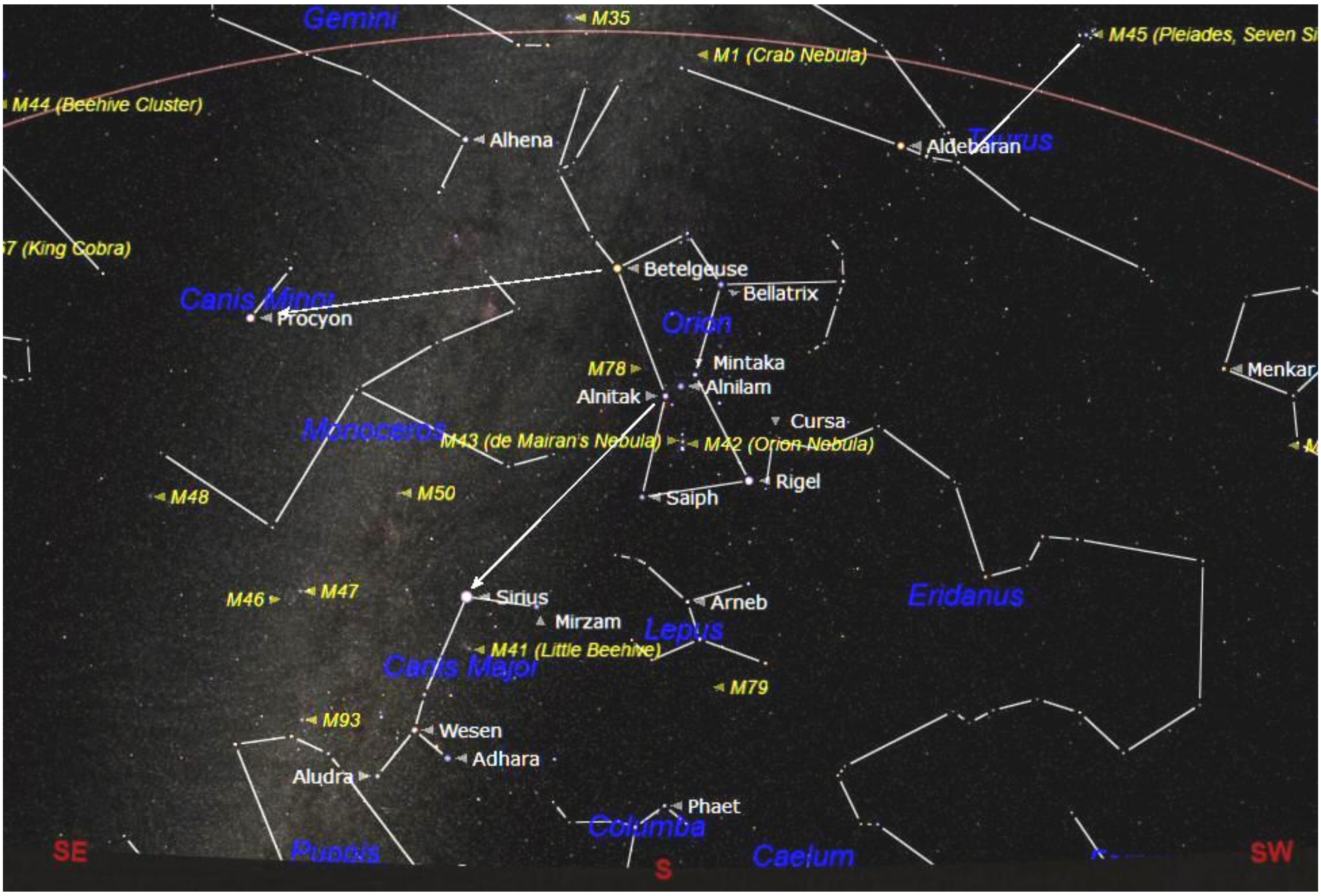
To solve this problem we can tilt the right / left movement to the same axis as Earth’s axis, this is called Right Ascension (also known as R.A.). We need to point the RA axis so that it points towards the star Polaris. The telescope will then be able to track any object that the telescope is pointed at, across the sky by moving just the RA axis. This is called an Equatorial Mounting (EQ).

The author using his 90mm EQ mounted refractor

THE FINAL TIP

To enjoy astronomy it is important to be comfortable. This first of all means to keep warm, even summer evenings can get cold so wrap up warm. If possible try to sit down to use the telescope. This makes our position more relaxed and steady. If it is not possible to sit try to use something to lean on or hold to give extra support to provide a more comfortable and steady posture.

CONSTELLATION OF THE MONTH – ORION



Orion is one of the easiest constellations to recognise and dominates the southern sky at this time of the year. There are many depictions of Orion shown on many different star charts. Some old pictures of Orion are very beautifully drawn in fact some are so beautiful that the artists even moved the positions of some of the stars so they would fit the image they had drawn.

Orion the Hunter appears in the winter sky, with his club held over his head and his shield (sometimes shown as a lion's skin) held out in front of him. His hunting dogs, Canis Major (the star Sirius) and Canis Minor (the star Procyon) following behind him.

Greek mythology tells us that Orion was known as a great hunter. He boasted that he could rid the earth of all the wild animals however this angered the Earth goddess Gaia. She sent a scorpion to defeat Orion. Orion tried to battle the scorpion but he quickly realised that he could not shoot his arrow through the creature's armour. To avoid the scorpion he jumped into the sea.

It was then that Apollo (the Greek god of the Sun) decided to take action. He pointed out to his twin sister Artemis a small black object in the sea. Claiming it was a horrible villain and he dared her to shoot it with her bow and arrow. Artemis easily hit the target. However when she swam out to retrieve her victim she discovered that the villain was in fact her friend Orion.

Artemis begged the gods to bring Orion back to life but they refused. Instead she put Orion's picture in the sky so she could always see him.

Orion is one of the few constellations that does look (with a little imagination) like what it is named after. The most obvious feature is the line of three stars, called Alnitak, Alnilam and Mintaka that make up Orion's belt. From his belt we can see two bright stars called Saiph and Rigel below. These define the bottom of his 'skirt like' tunic. Above the belt are two stars Betelgeuse and Bellatrix that denote the position of his shoulders. Above and between his shoulders is a little group of stars that mark out the head. From his right shoulder (Bellatrix) he holds out a shield. From his left shoulder (Betelgeuse) a club is held above his head. It almost looks as if Orion is fending off the charge of the great bull Taurus who is located above and to the west (right) of Orion.

Down from Orion's very distinctive belt there is a line of stars, ending at the star Nair al Saif that looks very much like a sword attached to his belt. Here can be found the main interest in Orion, the Great Nebula, see the next page for details.

If an imaginary line is traced down from the belt for about six belt length towards the south eastern horizon, a bright twinkling star will be seen. This is Sirius, Orion's Large Hunting Dog in the constellation of Canis Major. It is the brightest and closest star to be seen from the UK at just 8.6 light years from us. To Orion's left (east) of Betelgeuse a quite bright star in a rather large empty area of sky can be seen. This is Procyon in Canis Minor, Orion's Small Hunting Dog. Coincidentally both of these 'dog stars' are double stars that have an invisible companion, more about them in the January issue of this magazine.

M42 THE GREAT NEBULA IN ORION

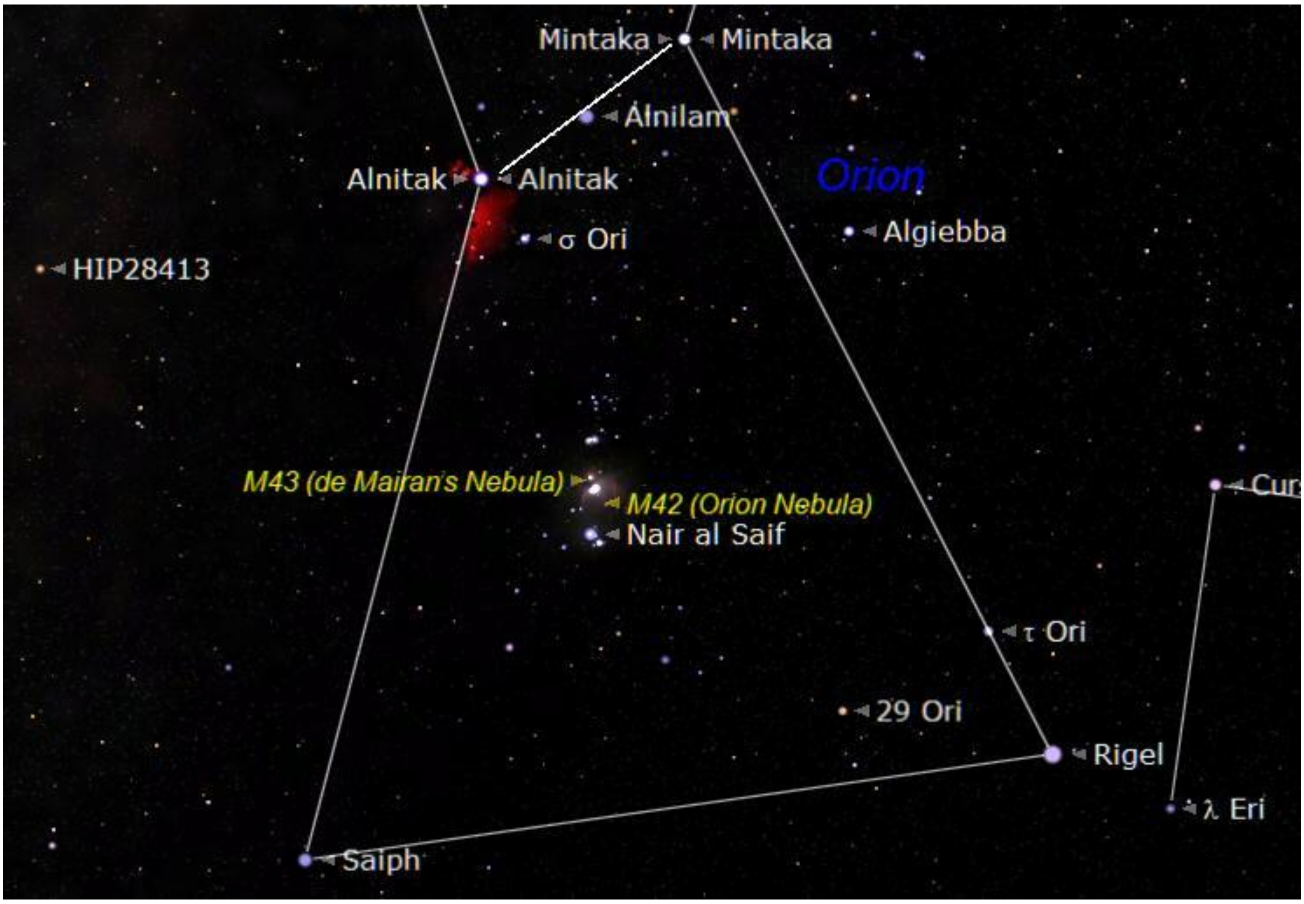
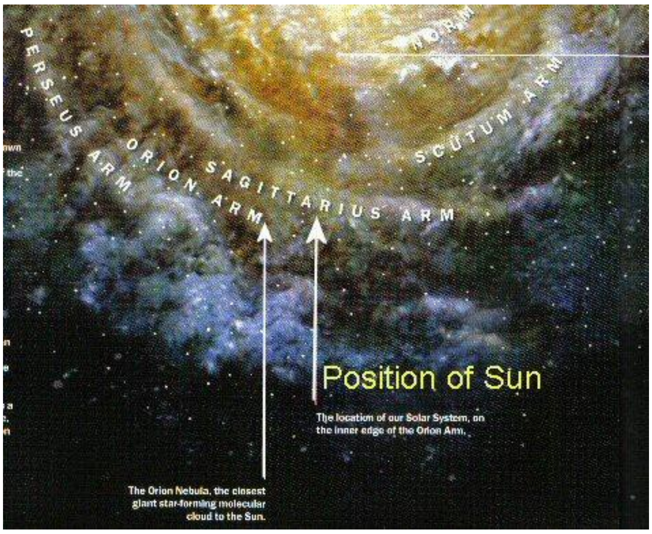


Chart showing M42 the Great Nebula in Orion

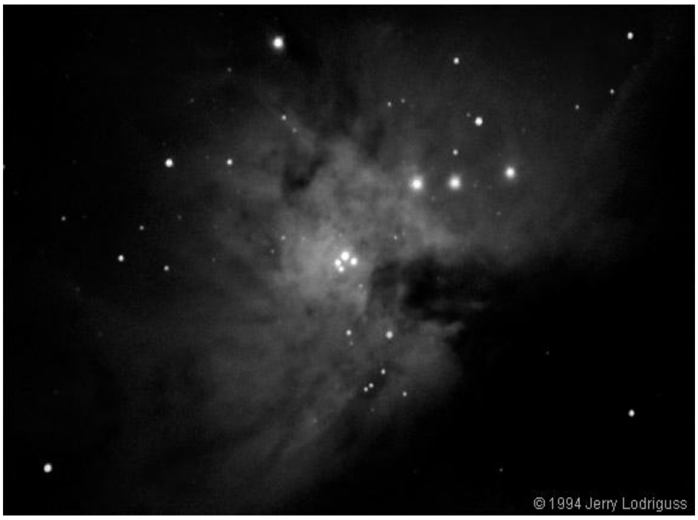
When we look towards Orion we are looking into one of the nearest spiral arms of our galaxy the Milky Way. Our Sun appears to be located in the area between two spiral arms. Towards the centre of the galaxy from our point of view is the Sagittarius Arm and looking away from the centre is the Orion Arm.



An artist impression of our position in the Galaxy

Most of the stars in Orion are located about 900 light years away from us including Rigel but Betelgeuse is much closer at only 310 light years distant. Because the stars of Orion are in a spiral arm there is a lot of gas and dust around the whole area of the constellation. Huge numbers of stars are hidden by the gas and dust.

Below the line of three stars of Orion's belt there is a vertical line of stars forming his sword (hanging below his belt). In the line of stars making up Orion's sword a hazy patch can be seen using binoculars or even with just the naked eye on a clear night. The hazy patch is known as M42 (Messier 42), the Great Orion Nebula. This Nebula is a gigantic cloud of Hydrogen gas mixed with other gases and dust from which new stars are being formed. Through a pair of binoculars the nebula looks like a small fuzzy patch in the line of stars.



The Trapezium cluster superimposed on M42

When seen through a telescope the cloud like structure can been made out. Swirls of gas and dust can be seen, some are lit up but some are dark and silhouetted against the illuminated clouds behind.

The cloud is actually illuminated by the young stars forming in it. Most of the energy illuminating this nebula comes from a group of 4 stars known as the Trapezium. These stars have formed out of the gas and dust in the nebula; they are young, hot and very active. The Trapezium can be seen easily using a small telescope. The four stars of the trapezium (there is a fifth fainter star) are just the brightest of what is an Open Cluster in the process of forming. The Orion Nebula actually contains many more very young stars that are still hidden by the gas and dust of the nebula.

Special telescopes that can detect ultraviolet and inferred radiation can be used to penetrate the gas and dust to see the stars forming inside the nebula. The image below shows most of the stars that are normally hidden by the gas and dust clouds.

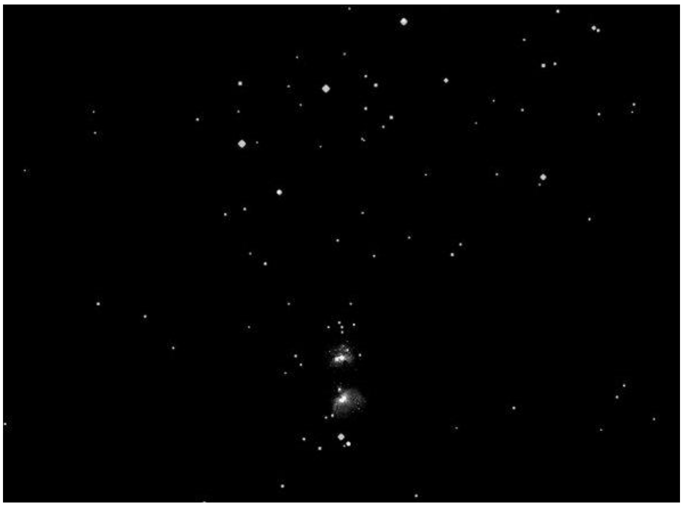
Stars forming in M42

Gravity draws the atoms of the gas together and as the gas becomes denser it pulls in even more until huge spheres of gas are formed. As the pressure in the core of a sphere increases the temperature rises to tens of millions of degrees and the Hydrogen atoms begin to fuse together to form atoms of Helium. In this process known as Nuclear Fusion a small amount of mass is lost and converted into energy in the form of a powerful flash of X-Rays. This heats the mass of gas of the sphere and it begins to shine as a bright new star.

Much of the gas and dust in the nebula shines by reflecting light from the very young stars of the Trapezium in the centre of the nebula. Some gas also produces its own light because the ultraviolet radiation energy from the powerful young stars excites the gas atoms. This causes them to glow somewhat like a fluorescent light or the Aurora (Northern Lights).

When a photon of ultraviolet light from the powerful young stars hits a gas atom it causes an electron to jump from its normal orbit to a higher orbit. After a very short time the electron jumps back to its original orbit and emits a flash of light. The colour of this light is unique to the type of atom that has emitted it. For example Hydrogen always emits red light. See the image opposite. →

The Orion Nebula can be seen with the naked eye from a dark location on a clear moonless night. It is easily seen using a pair of binoculars. The image below shows the sort of view seen using a pair of 8 x 50 binoculars.



Binocular view of M42 with Orion's belt at the top

A small telescope will show a larger view and some detail in M42. Structure in the nebula can be seen with parts of the nebula illuminated and other parts appearing dark.

The sort of view seen using a small telescope

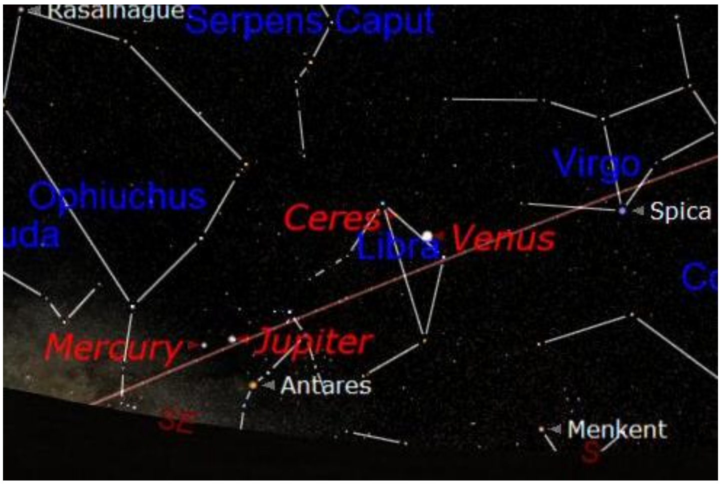
A larger telescope will show more detail in the structure with the nebula made up of wisps of gas appearing. Photographic images show much more detail including colour in the clouds of gas and dust. The red in the image below is typical of the emissions from Hydrogen gas.

A photographic image of M42

THE SOLAR SYSTEM THIS MONTH

MERCURY passed through Inferior Conjunction with the Sun on 27th November. This means it passed in front of the Sun (not across the face of the Sun but just above). So it is low and still too close to the Sun to be seen.

VENUS was in Inferior conjunction (passing in front of the Sun) on 26th October. It is now emerging from the glare of the Sun. It rises over the eastern horizon at about 05:00 but will be difficult to see low in the brightening dawn sky.

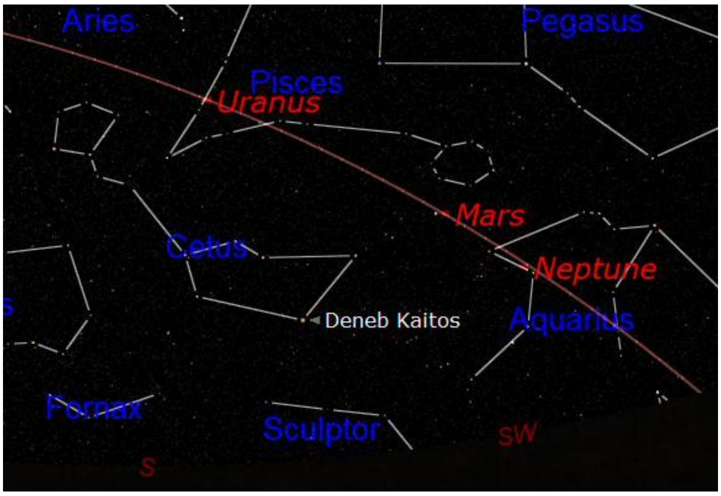


Venus in the east at 07:00 GMT

MARS will still be well placed this month for observing but is very low over the southern horizon in turbulent and smoggy air. The Red Planet passed through 'Opposition' on 27th July so is still relatively close to Earth. It is 8.0 arc-seconds in diameter and is still quite bright at magnitude +0.3.

JUPITER is moving out from its conjunction with the Sun on 26th November so it will not be visible this month.

SATURN is too close to the Sun to be seen this month and will be lost in the glare of sunset.



Uranus, Neptune and Mars at 20:00 GMT

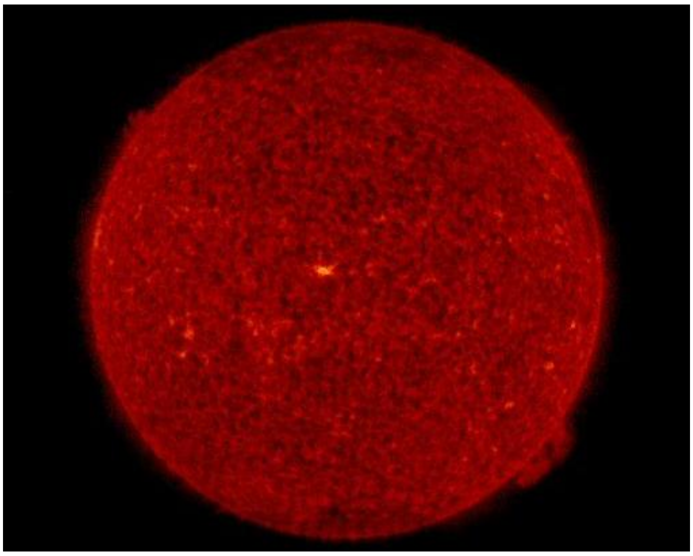
URANUS will be in a good observable position in the south in the early evening and will also be quite high in the south east as soon as the sky is dark. A good pair of 9x50 binoculars will reveal a slightly fuzzy blue, star like, object. A telescope at a magnification of 100x will show it as a small blue/green disc. See the chart above.

NEPTUNE is still in a very good position this month for those who have a telescope. A telescope will be needed to show Neptune as a small blue/green disc using a magnification of 100x but it is small and difficult to find.

THE SUN

There have been a few small sunspots over the past few weeks even though the active phase of the Solar Cycle is now over. The image below was taken by SOHO on 12th November 2018 and shows a small cluster of sunspots (the bright spot in the centre of the image). Some significant Prominences (see below) can also be seen around the edge of the Sun, particularly at the 4 o'clock and 10 o'clock positions.

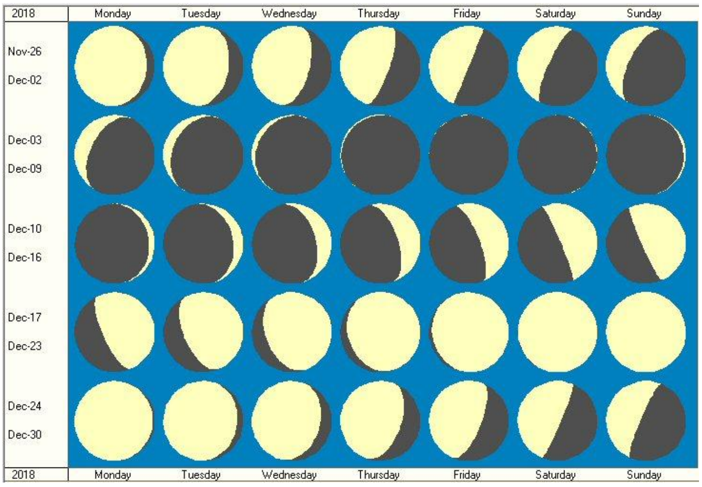
Prominences are caused by magnetic activity on the Sun that can appear as the Sunspots. When lines of magnetic forces break through the upper layers of the Sun and particularly the 'Photosphere' (the visible surface) they can cause Sunspots and associated Flares (Prominences). Sometimes exploding Prominences can drive energetic particles towards Earth and cause Aurora (Northern Lights) as were seen during November this year.



The Sun imaged by SOHO on 12th November

The Sun rises at 07:45 at the beginning of the month and at 08:00 by the end of the month. It will be setting at 15:55 at the beginning and 16:00 at the end of the month.

THE MOON PHASES IN DECEMBER



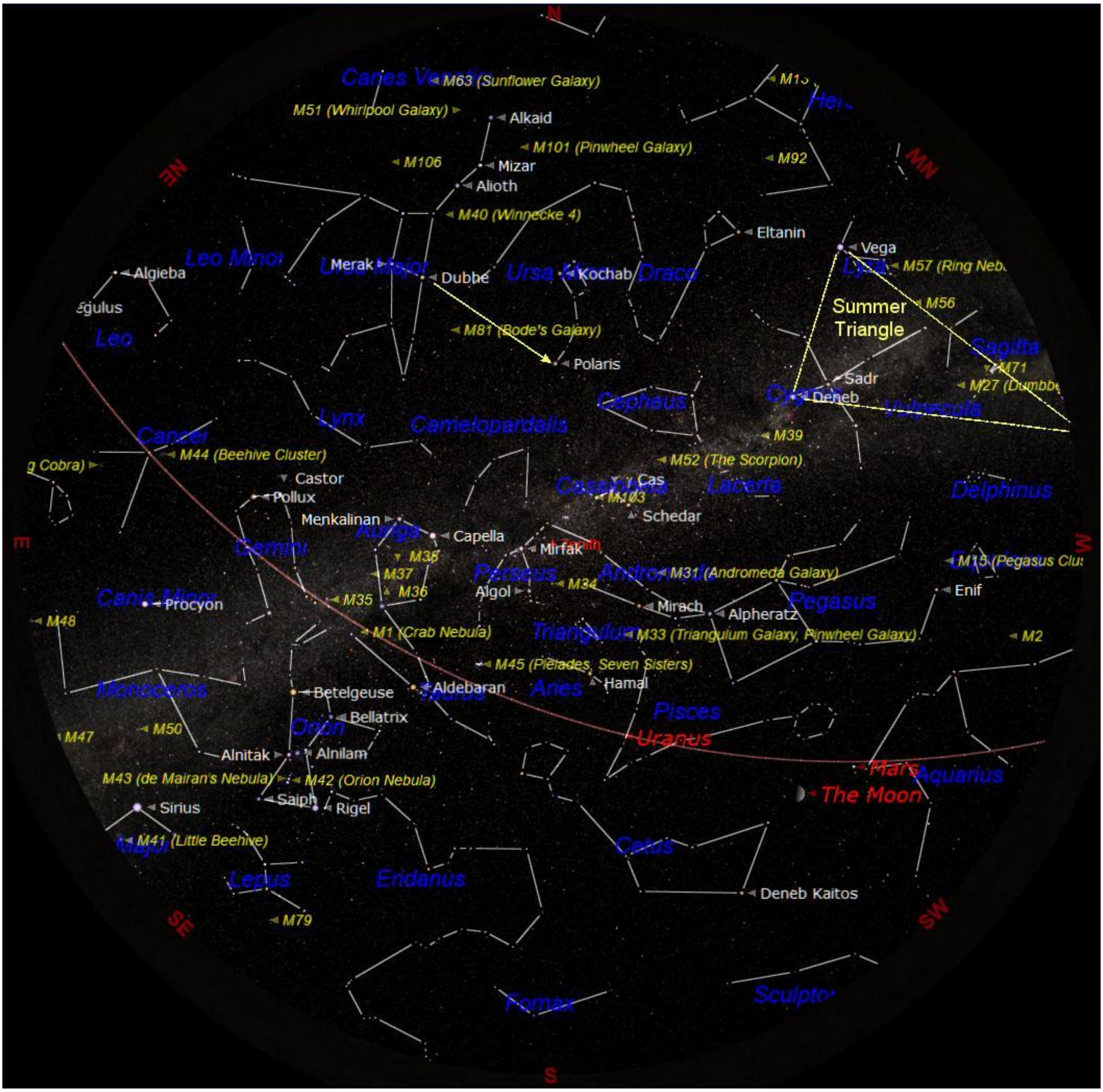
New Moon will be on the 7th December

First Quarter will be on 15th December

Full Moon will be on 23rd December

Last Quarter will be on 30th December

THE NIGHT SKY THIS MONTH



The chart above shows the night sky as it appears on 15th December at 21:00 (9 o'clock) in the evening 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 10 o'clock GMT at the beginning of the month and at 8 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 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 this month: Mars, Uranus and Neptune.