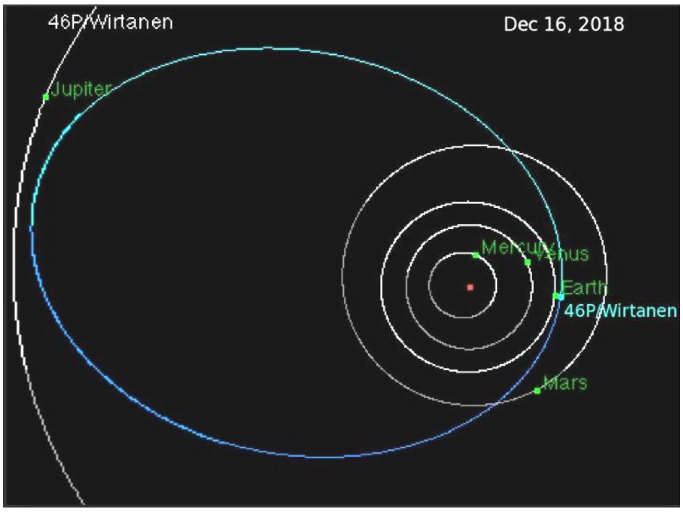
NEWBURY ASTRONOMICAL SOCIETY
MONTHLY MAGAZINE – JANUARY 2019

COMET 46P/WIRTANEN IMAGED BEFORE CHRISTMAS

Comet 46P/Wirtanen imaged by Steve Knight - Newbury Astronomical Society

Throughout December 2018 Comet 46P/Wirtanen tracked its way across our night sky. It travelled up through the constellation of Taurus passing close to Messier 45 (M45) the Seven Sisters star cluster. It was large but rather faint and difficult to find especially in light polluted areas. Newbury Astronomical Society's Steve Knight managed to capture the image above.



The orbit of Comet 46P/Wirtanen around the Sun

46P/Wirtanen is a small comet and one of a group of short-period comets associated with Jupiter. It is about 1.2 kilometres across with an orbital period of 5.4 years.

On 16th December 2018 the comet passed within 11,680,000 km from Earth. It reached an estimated magnitude of +3, making this flyby past Earth the brightest predicted and closest approach for the next 20 years. At its closest approach on the evenings of 15th and 16th December the comet passed between M45 and the bright red star Aldebaran in Taurus.

46P continued up through the constellation of Auriga and passed close to the bright star Capella on 23rd December. It then began to fade as it moved away from Earth and back out to the orbit of Jupiter. It appeared as a 'fuzzy' patch of light but had no visible tail.

NEWBURY ASTRONOMICAL SOCIETY MEETING

4th January — 60 years in Space – Our Members
Website: **www.newburyastro.org.uk**

NEXT NEWBURY BEGINNERS MEETING

16th January — The speed of Light
Website: **www.naasbeginners.co.uk**

EXPLAINING ASTRONOMY – USING 'SETTING CIRCLES'

Setting Circles on a Beginners Equatorial Mounted Telescope

Setting circles are a simple device, fitted to a telescope, to help find an object in the night sky. They are bezels fitted to the 'Up / down' axis and the 'right / left' axis that allow the telescope to be pointed at an object to be observed. Different types of Setting Circles are used for Equatorial Mounted telescopes and Alt Azimuth telescopes. Those used on Alt Azimuth telescopes are generally simpler than those used on Equatorial Mounted telescopes so we will consider these first.

An Alt Azimuth telescope has a horizontal axis 'Altitude' to move the telescope up and down. It also has a vertical rotating axis for left right movement (like a turntable) 'Azimuth'. These two movements allow the telescope tube to be pointed to any point in the sky.

The author's 6" handmade Dobsonian Telescope

The telescope shown above has Setting Circles fitted as indicated by the arrows.

The simple 'Dobsonian' Alt Azimuth mounted, 'Newtonian, reflecting telescope is moved by hand and has no mechanical drive mechanism so objects in the sky have to be located visually. This is made easier by the fitting of a small wide field of view 'Finder Telescope'. However it can still be difficult to locate an object especially for the beginner. So we can have Setting Circles fitted to give some extra help.

The way Setting Circles work is to use coordinates of the night sky to guide the telescope to a selected point in the sky where an object is located. With the aid of a computer Planetarium application, for example 'Solarium (a free download application)' the coordinates of any object can be displayed. To do this we must select a bright star that can be seen in the sky, from the application and select it as a reference object. The coordinates will be displayed in the 'on screen' information. We will use the star Altair as an example.

The selected object will appear to be moving in the sky due to rotation of Earth so the numbers of the coordinates will be continuously changing but by small amounts. We then point the telescope at the selected object. When ready we need to make a quick note of the coordinates. For the telescope shown in the opposite column we must look for the Alt Az coordinates that will be in the form:

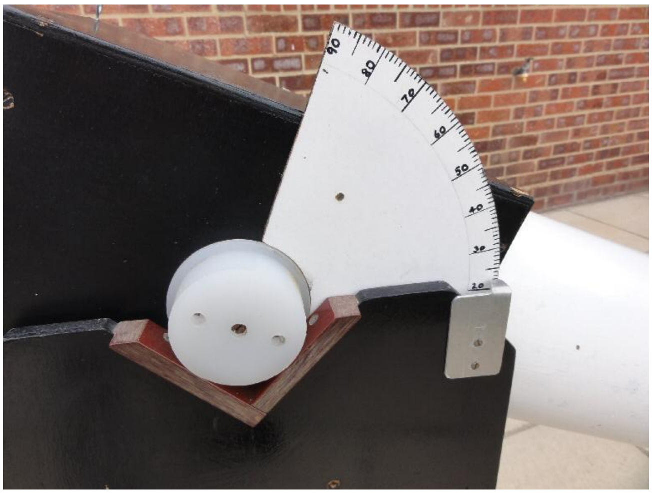
Alt: 47°31.xxx Az 179°9.xxx

Where the xxx will be the fast moving digits (to ignore).

The Alt number will be the altitude we need to raise the telescope to, in degrees from the horizon. The Azimuth number is the coordinate that we must adjust the lower bezel to, as will be shown on the next page.

The Azimuth Bezel is a full circle disc and marked in degrees from 0° to 360°. With the telescope pointing to the selected object (for example the star Altair) rotate the bezel until the Azimuth coordinate given by the computer is aligned to the pointer.

Now we must first turn our attention to the Altitude bezel. The Alt Bezel is attached to the telescope tube and moves with the tube. See the image below.



The Altitude Bezel on the Dobsonian Telescope

We must raise the telescope until it is pointing to the chosen star (Altair). The pointer on the telescope mount should be pointing to approximately 47°3, the coordinate given by the computer. Now we must turn our attention to the Azimuth bezel.

The Azimuth Bezel can be rotated freely to any position we choose. The Azimuth Bezel on the example telescope is shown in detail below.

The Azimuth Bezel on the Dobsonian Telescope

As the telescope has been pointed at our target star (Altair) we rotate the Azimuth Bezel to the coordinate shown by the computer, approximately 179°9. The settings do not need to be super accurate as we are going to use the finder to locate our target to be observed. The telescope has now been aligned to the real sky by aligning to the reference star (Altair). We can now use the setting circles to find other objects.

Before starting to use Setting Circles, both Alt Az and Equatorial mounted telescopes must be set up correctly for observing. It is very important that both types of mount are carefully levelled before starting. If the mounting is not level it will be tilted compared to the sky and it will not align on the object being sought. An equatorial mounted telescope will also need to be correctly aligned to the northern celestial pole.

To find another other object using an Alt Az mount we will need to obtain the coordinates of that object from the computer planetarium application. To do this we must select that object and obtain the Alt Az coordinates from the 'on screen' information.

If we want to find another star we need to move the telescope so that the Azimuth coordinate is aligned to the fixed pointer. (in the image opposite it is set to 20.5°) Then rotate the mounting so the Azimuth coordinate is aligned to the pointer, without moving the Azimuth bezel. (in the image opposite, it is set to 117.0°) The object should now be visible in the finder.

We have seen an example of aligning an Alt Az mounted telescope so now we can transfer this procedure to an Equatorial Mounted telescope. The setting circles on an Equatorial Mounted telescope are shown at the top of the previous page.

With the telescope correctly levelled and aligned, the same procedure used to align the Alt Az telescope is to be followed. A bright alignment reference star must be selected from a computer planetarium programme. Raise the telescope tube until it is pointing to the alignment reference star.

Now the difference, the coordinates marked 'RA' and 'Dec' and are to be used to align an equatorial mounted telescope. 'Dec' is the equivalent to Altitude on the Alt Az but is known as Declination. 'RA' is Right Ascension which is the equivalent to Azimuth. The 'Dec' is measured from the Celestial poles. With Earth's equator being 0° (zero Declination), the South Celestial Pole is -90° and the North Celestial Pole (located near the star Polaris) is +90°.

The axis of Earth's rotation is tilted 23.4° compared to the plane of the Solar System so the north axis of rotation points approximately towards Polaris. This point is therefore 23.4° north of the 'Zenith' (the point in the sky directly overhead). An imaginary line across our southern sky defines the plane of Earth's Equator which is tilted at 23.4°. This means our actual horizon to the south is at -23.4° Declination.

Using the 'Dec' coordinate shown by the computer planetarium programme elevate the telescope tube to the coordinate and check that the target star is visible in the finder. Rotate the 'RA' bezel taking care not to move the telescope tube. Align the 'RA' coordinate to the fixed pointer and check that the target star is still visible in the finder.

To find another star we need to move the telescope to the RA and Dec coordinates of that star (without moving the 'RA' bezel). When they are aligned to the fixed pointers the star (or other object) should now be visible in the finder.

LIGHT - OUR MESSENGER FROM THE STARS

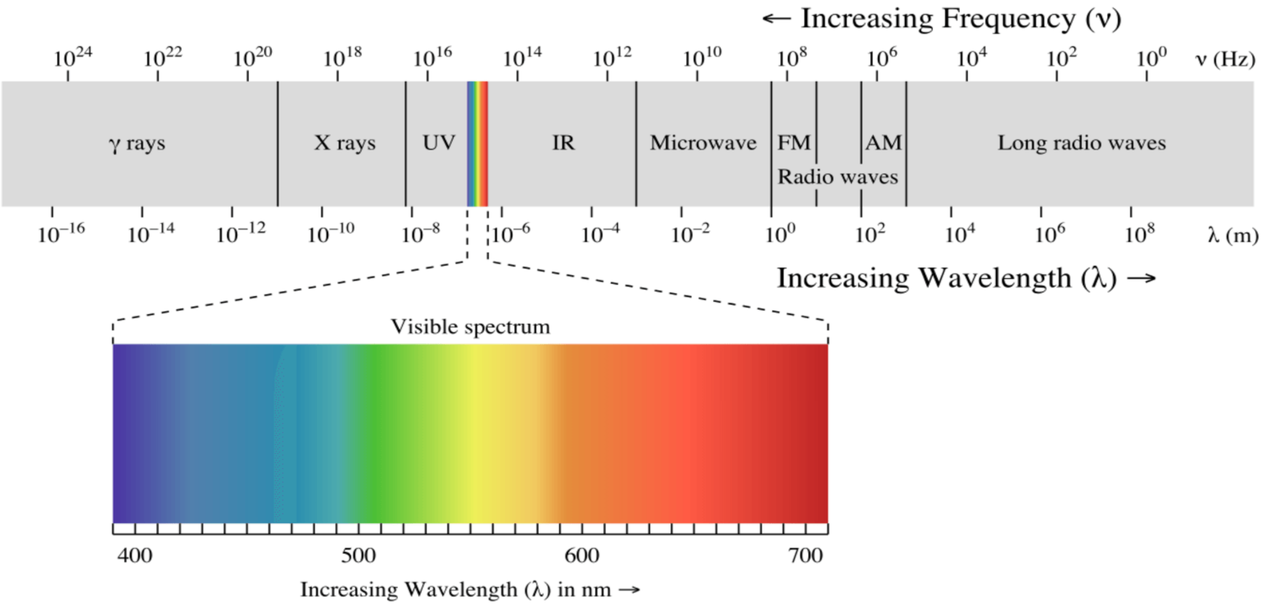


Chart showing the Electromagnetic Spectrum

As astronomers, we are studiers of light because all the information about the objects of the night sky is brought to us by light. When we use the word light we generally mean the wavelengths of the Electromagnetic Spectrum that we can detect with our eyes. However as can be seen from the chart above, visible light is just a small part of the whole Electromagnetic Spectrum.

There are a number of ways to define the type of Electromagnetic Radiation in the spectrum so here are a few of the terms used:

FREQUENCY (written as 'ν')

Frequency refers to the number of the cycles of the Electromagnetic waves per second. This is also referred to by the unit Hertz (Hz)

WAVELENGTH (written as 'λ')

This is the length of the Electromagnetic wave measured from the crest of one wave to the crest of the next, normally measured in metres.

TYPE OF RADIATION

This describes classes of radiation linked by their attributes and the effects experienced in interactions with these types of Electromagnetic waves.

Gamma (γ) are very shortest Electromagnetic waves with a very high frequency and carry very high energies. These are found to the left of the chart above. Gamma rays can have a frequency of from a billion, trillion cycles per second to a million, trillion, trillion cycles per second. They also have the shortest wavelength, carry the most energy and are very dangerous to life.

Radio waves are the longest Electromagnetic waves and can have wavelengths of hundreds of kilometers. These are found at the right hand end of the chart above. Other 'types' of wavelengths, in rising frequency and energy are: Short Wave Radio, Microwave, Inferred, Visible, Ultraviolet, and X Rays.

For non-mathematical readers the expressions above written as 10^2 and 10^{-23} are the method of showing large or small numbers. So 10^2 represents the figure 1 followed by two 0s (zeros) meaning 100. 10^{20} would be 1 followed by twenty '0s' (zeros). The expression 10^{-3} represents the number 1 in the third decimal position and preceded by two decimal places 0.001.

So when we see the number of wave cycles written as 10^{24} we are looking a huge number actually 1 followed by 24 noughts 1,000,000,000,000,000,000,000,000. With a number written as 10^{-16} we are looking at the very small number 0.0000000000000001 this is 1 at the 16th decimal place. Note 'Nanometre' written as 'nm' is 0.000000001m or 10^{-9} = 1 billionth of a metre.

The very narrow band of wavelengths between 400nm (0.4×10^{-6}) and 700nm (0.7×10^{-6}) are the wavelengths we can detect with our eyes. Within this band we see the different wavelengths as different colours. Our Sun produces most light in the green to yellow so our eyes have developed to be most sensitive to green and yellow and overlaps into the blue and red. However our eyes cannot detect any further beyond the red (inferred) or further beyond the blue (ultraviolet).

Up until 2018 the Electromagnetic Waves were our only contact with the stars and everything out in space but now scientists have managed to detect Gravitational Waves. This new branch of astronomy may bring us more valuable information in a form we have never had access to before. This will always be in the domain of the professional astronomers. So light will always be important to us amateur astronomers.

We now have professional telescopes that can allow us see into other wavelengths right into the X-Rays and even into the Gamma range. We also have Radio Telescopes with huge dishes to collect the long radio waves. Radio telescopes around the world are even linked so they can capture the very long radio waves to tease out every bit of information.

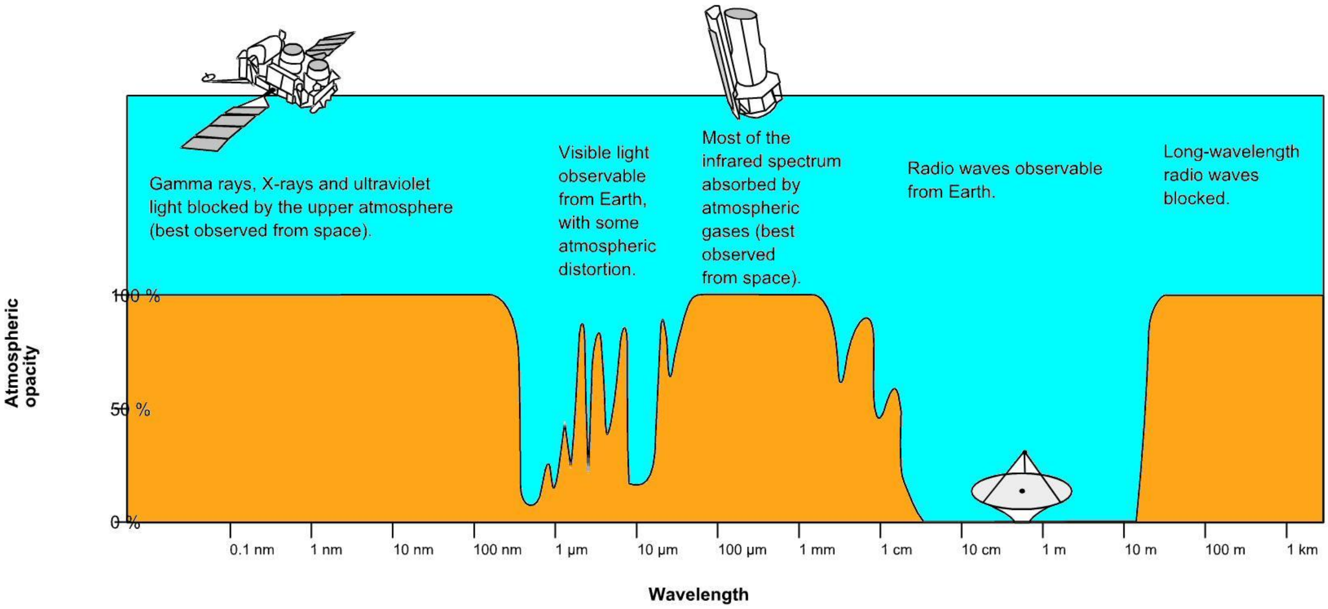


Diagram showing the Electromagnetic waves that can reach the surface of Earth

Earth's atmosphere prevents most of the spectrum of the Electromagnetic waves from reaching the surface. This is very good for us because the short wave types of Electromagnetic radiation are dangerous to life. The higher energies damage the cells of life forms causing illness and death. The shorter the wave length, the higher the energy carried by the wave will be. This means more damage the damage to the cells.

The diagram above shows how far the different wavelengths of radiation can penetrate our atmosphere. Luckily the most energetic Gamma Rays and X-Rays are almost completely blocked. Most of the shorter Ultraviolet waves are blocked but some can reach the surface. Over exposure to Ultraviolet rays can cause Sunburn. Much of the Inferred wavelengths (heat) are absorbed by our atmosphere. A wide range of the Radio waves can and do reach the surface of Earth.

The nature and properties of light are much debated even today and is still thought of as very strange stuff. It can appear to be comprised as particles (photons) and other times appear to be waves. Waves in water and other fluids do not actually move the fluid they simply transmit a wave of energy through the fluid. Light however can and does travel through a vacuum and does not require a medium to transmit it.

One property of light is extremely important to science in general and that is its speed. Albert Einstein theorized that light was the fastest thing in the universe and nothing can travel faster. All modern research and experiments have so far proved this to be true. It is now known that light travels through a vacuum at 300,000 km/sec this in old measure is 186,000 miles/sec. We now use this great speed to measure the distance to the most distant objects in the universe. Our unit of vast distance is the 'Light Year' the distance travelled by light in one year.

Scientists and in particular astronomers have learnt to squeeze every bit of data and information out of all the wavelengths of this our only messenger from the stars.

Where wave lengths are blocked by Earth's atmosphere we need to send telescopes into space above our atmosphere. The Hubble Space Telescope (HST) was primarily designed to observe in the visible wavelengths but can see into the near inferred. The James Webb Telescope (JWT) that will replace HST will observe primarily in inferred but can also see into the visible wave band.

There are also telescopes that can collect Microwaves, X-Rays and Gamma from orbit around Earth. Microwaves can show us the remnants of the flash from the Big Bang. These rays started out as very high energy and ultra short wavelength X-Rays and Gamma Rays that have been stretched by the expansion of the universe and are now detectable as microwaves.

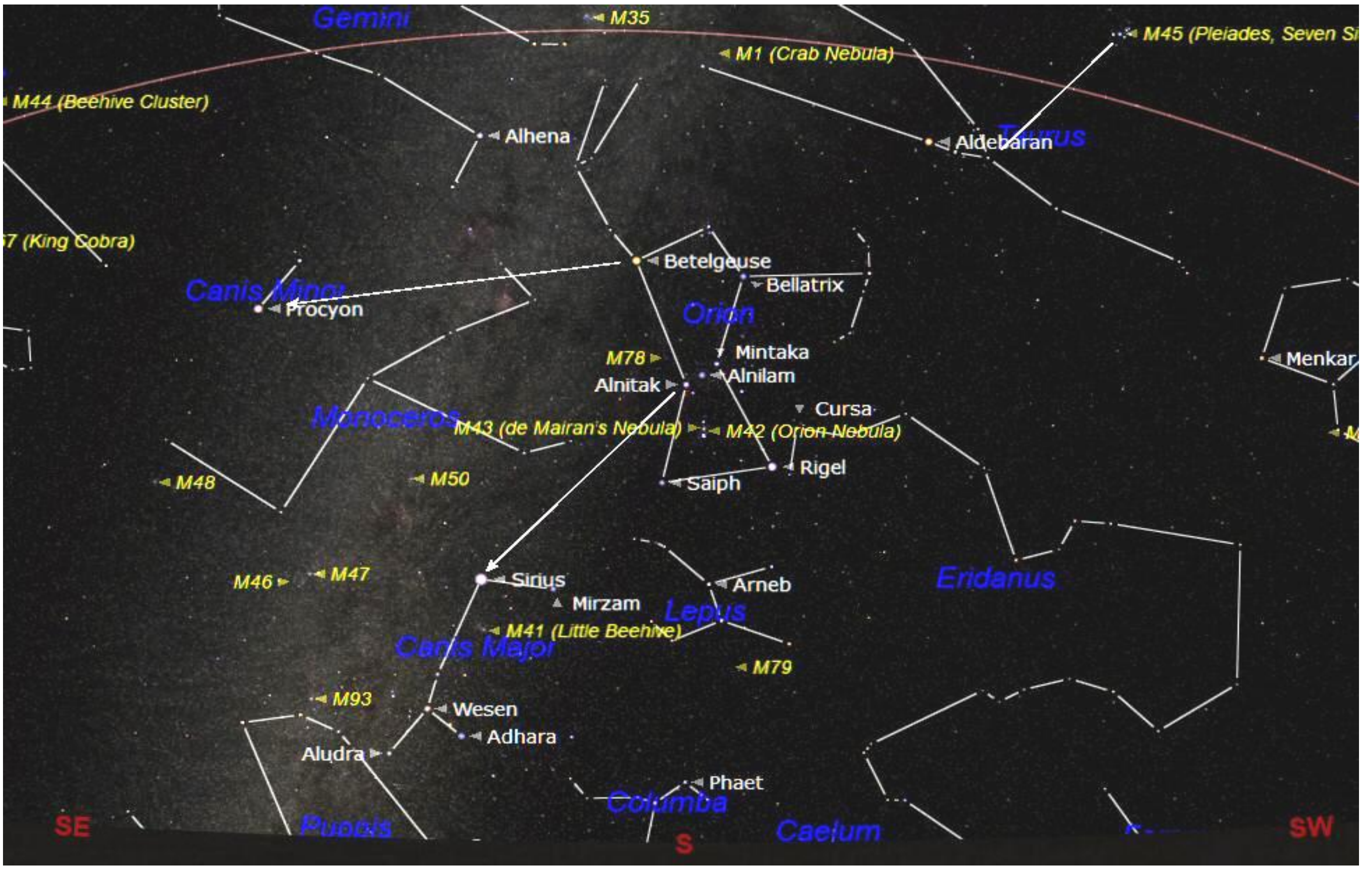
Gamma and X-Rays are produced by the most violent events like exploding stars and the enormous heat produced when material is pulled into Black Holes. So these very 'short' waves allow us to study these extreme and important events.

We can also study many different aspects of visible, inferred and Ultraviolet light. We can examine the light by splitting the light into its component wavelengths and displaying the whole spectrum of light in detail. From this we can reveal many aspects about the source of the light and details of its journey to us as it travelled through vast distances of space.

As light is emitted by a star it has to pass through the atmosphere surrounding the star. Atoms of different elements in the atmosphere absorb discrete wavelengths of the light to leave a pattern of dark bands in the spectrum. By studying these patterns of the bands we can identify all the elements present.

If a star or other object is moving (and things tend to move very fast in space) the dark bands appear to be moved along the overall spectrum. If an object is moving away from us the lines are shifted towards the red. If it is moving towards us it is shifted towards the blue. So we will know how it is moving through space.

CONSTELLATIONS OF THE MONTH – CANIS MAJOR & CANIS MINOR



The constellations of Orion, Canis Major and Canis Minor

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. 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. See the chart above.

If an imaginary line is traced down from Orion's belt for about six belt lengths 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.

Following an imaginary line through the two bright upper stars at Orion's shoulders, Bellatrix and Betelgeuse to Orion's left (east) 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.

The chart above shows the location of Sirius and Procyon, Orion's Hunting Dogs. Although the two stars are associated with Orion through their mythological link with the Hunter and their proximity to Orion in the night sky they are actually much closer to us and not associated with the stars of Orion at all.

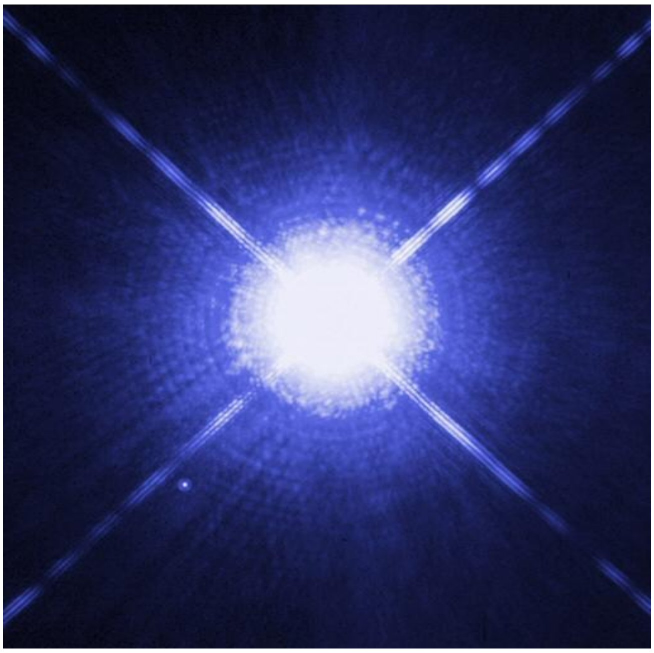
Sirius is in fact a double star but its companion is quite unusual. The bright star Sirius that we see sparkling close to the horizon is the larger and overall brighter of the pair. We call the visible component of the pair Sirius A (the Dog Star) and the companion star Sirius B (It is sometimes called the Pup).

Sirius is in fact the closest star to Earth that we can see from the Northern Hemisphere and is just 8.6 light years away. It is about twice as massive as our Sun but about 25.4 times brighter. Sirius B is a tiny (in diameter) star about the same volume as Earth but with a mass about the same as our Sun.

An artist's impression of Sirius A and B

Sirius B formed about 230 million years ago as the largest star of the original pair. It was about 5 times the mass of our Sun and fused its Hydrogen fuel into Helium very quickly. It lived out its Main Sequence phase (life as a normal star) much faster than its smaller companion. It is thought Sirius B developed into a Red Giant around 120 million years ago. The Red Giant soon collapsed to form the White Dwarf we see today. It is now a super dense sphere of Carbon and Oxygen about 11,600km in diameter.

Sirius B no longer produces heat through nuclear fusion but is very hot due to the compression when it collapsed from its Red Giant phase. It now has a temperature of 25,000°K and shines brilliantly white. The Pup is thought to be spinning very rapidly and orbits around a common centre of gravity with Sirius A every 50 Earth years. The two very different stars are separated by 20 AU (1 AU is the Earth / Sun distance). This is approximately the distance from Earth to Uranus.



Sirius A and B imaged by Hubble.

The picture above was taken by the Hubble Space Telescope with a camera that has a special mask to reduce the glare of Sirius A. Sirius B can be seen to the lower left as a small white dot. Sirius B cannot be seen using any normal amateur's telescope.

An image of Orion and Sirius (lower left)

Sirius is beautiful to look at as it twinkles close to the southern horizon. It can be seen to twinkle to the 'naked eye' but a pair of binoculars or a telescope will show it flashing brilliantly with all the colours of the rainbow. Sirius the star is not twinkling this is due to atmospheric turbulence. Air close to the horizon is misty, dirty and affected by heat from the ground which causes turbulence that makes the light twinkle.

Sirius will be at its best over the Christmas period and into the new year. The dog star is just a star but it is definitely one of the most beautiful to look at.

Sirius is the best known 'Dog Star' but Procyon the Little Hunting Dog is well worth looking out for. Coincidently it is also a double star and the companion is also a White Dwarf. However when the stars are examined more closely they are found to be quite different to the Sirius pair.

Procyon A has a significantly smaller mass than Sirius A (1.5 solar masses compared to 2 for Sirius A) and Procyon A is much further along its life span. Being smaller Procyon A will have a longer active life than the larger and greedier Sirius A. Having said that Procyon A is already a lot older than Sirius A and is already starting its transformation into a Red Giant.

Procyon B is also smaller than Sirius B at just 0.6 Solar masses compared to Sirius B at 1.0 Solar mass. It has a larger diameter than Sirius B at 17,200km compared to 11,600km. This is due the additional super gravity of the more massive Sirius B pulling its material into an even more compact sphere.

The comparative size of Procyon B and Earth

White Dwarfs are created when a star, normally up to about 5 times the mass of our Sun, collapse after completing their Red Giant phase. White Dwarfs can exist up to a mass of 1.44 times the mass of our Sun where further collapse is prevented by a process called **'electron degeneracy pressure'**.

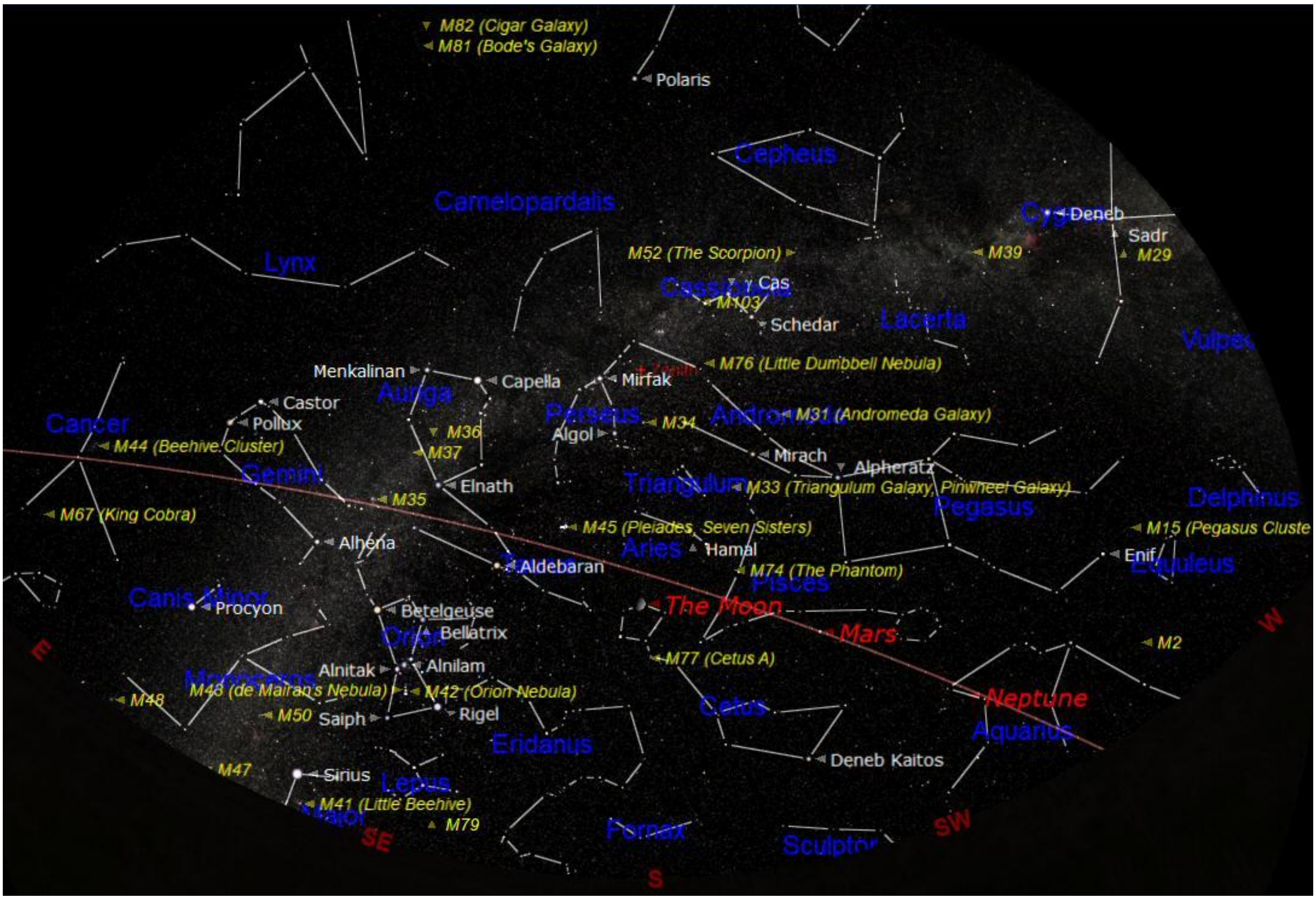
Smaller stars tend to produce a White Dwarf comprised of a core of highly compressed Carbon and Oxygen surrounded by a shallow but extremely dense atmosphere of Hydrogen. Some large White Dwarfs are thought to be composed of Carbon so compressed it has been turned to Diamond.

If a Red Giant star collapses and the resulting White Dwarf has a mass greater than 1.44 Solar masses it will continue to collapse. The 'electron degeneracy pressure' resistance will be overcome and the core will collapse to form an even denser 'Neutron Star'.

A Neutron Star has a diameter of about 25 km but can have a maximum mass up to between 3 and 5 Solar Masses, depending on the chemical composition of the original star. Up to this absolute upper mass limit further collapse can be halted by a process called **'Neutron degeneracy pressure'**.

If this upper mass is exceeded then the star core will overcome the 'Neutron degeneracy pressure' and collapse even further to create a 'Stellar Black Hole'. A Stellar Black hole is a very small object that has such powerful gravity that to escape would require an escape velocity faster that light so nothing can escape.

A TOUR OF THE NIGHT SKY - January 2019



The chart above shows the night sky looking south at about 17:00 GMT on 15th January. 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, now in the constellation of Piscis. 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 'naked eye' Open Star Cluster. This bright Open Cluster with its seven brightest stars is 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 the month, last month. Orion is depicted as a hunter with two hunting dogs called Sirius and Procyon. There are two stars that represent Orion's hunting dogs and they are also called Sirius and Procyon. Sirius and Procyon are the brightest stars in the constellations of Canis Major (the great dog) and Canis Minor (the little dog). These are the constellations of this month, see pages 6 and 7.

Almost overhead this month is the very distinctive 'W' shape of the constellation of Cassiopeia. The central 'Λ' of the 'W' points approximately towards Polaris the 'Pole' or 'North Star' star. There is a distinct line of stars leading up towards Cassiopeia this is the constellation of Perseus. At the top of the line of stars and about half way to the 'W' a 'fuzzy patch can be seen this is the lovely binocular view 'Double Cluster'.

THE SOLAR SYSTEM THIS MONTH

MERCURY is moving back towards the Sun and will be in Superior Conjunction on 30th January. This means it will pass behind the Sun from our point of view. So it is low and still too close to the Sun to be seen this month.

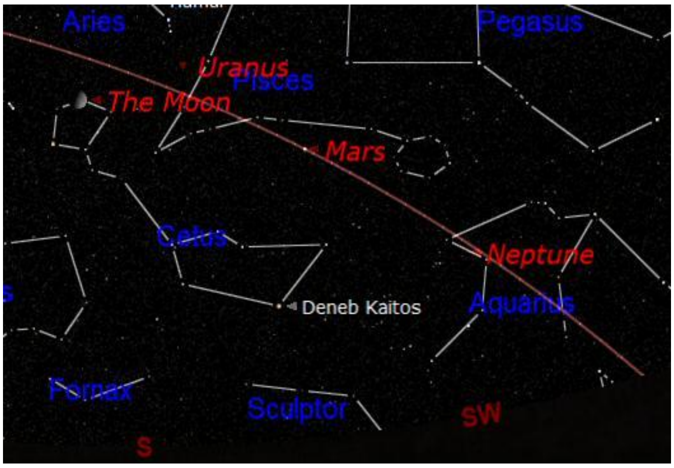
Mercury, Venus, Jupiter and Saturn in the east at 07:45

VENUS was at its point of greatest illumination on 2nd December. It will be at its Furthest Western Elongation from the Sun on 6th January. It rises over the eastern horizon at about 04:15 and will be very bright in the south east even as the sky brightens in the dawn sky.

MARS is still well placed in the early evening. It is low over the southern western horizon in turbulent and smoggy air. The Red Planet is moving away from Earth and looking smaller at 7.0 arc-seconds in diameter but still bright at magnitude +0.7.

JUPITER is moving out from its conjunction with the Sun on 26th November and now rises over the eastern horizon around 05:15 about 2½ hours before sunrise.

SATURN will be in conjunction with the Sun on 2nd January so will not be visible this month.



Uranus, Neptune and Mars at 18:30 on 15th January

URANUS will be in an observable position in the south west in the early evening but is moving towards the south western horizon. 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 view this month but sets in the west at 20:50. 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

The Sun has been very quiet over the last few weeks as can be expected in its inactive phase. There have been no significant sunspots. The Sun rises at 08:04 at the beginning of the month and at 07:50 by the end of the month. It will be setting at 16:05 at the beginning and 16:40 at the end of the month.

THE MOON PHASES IN JANUARY

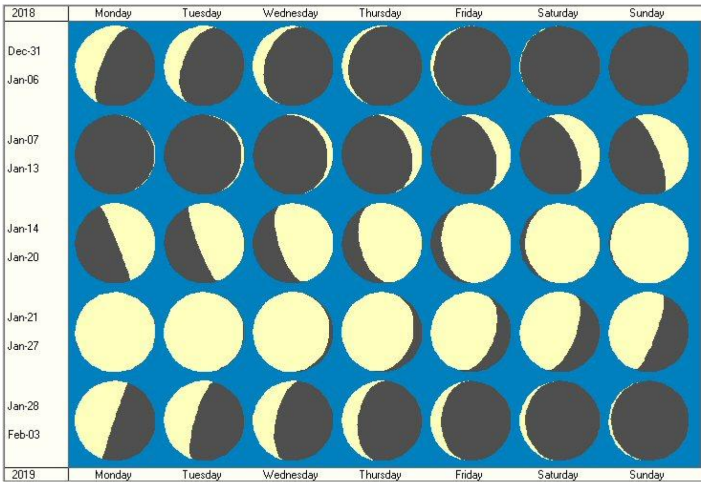
The 'New Moon' will always be seen in the west after the Sun has set over the western horizon. At this phase the Moon will be emerging from conjunction with the Sun (passing between Earth and the Sun). So the far side of the Moon will be illuminated and we will see a small amount of the bright sunlit side on the edge of the Moon. The rest of the Moon will be in darkness.

Seven days after conjunction with the Sun, the Moon will have moved a quarter of the way around its orbit of Earth. As the sky darkens in the evening the Moon will be seen in the south as a 'Half Moon' shape. This period, when the Moon crescent appears to be widening, is called 'Waxing'.

After fourteen days the Moon will have moved half way around its orbit and will be on the opposite side of Earth to the Sun. In other words while the Sun is setting in the west the Moon will be rising over the eastern horizon. Sunlight will shine past Earth and illuminate the whole surface of the Moon so we will see a 'Full Moon' rise over the eastern horizon. After 'Full Moon' the Moon appears to become thinner and this is known as 'Waning'.

After 'Full Moon' the Moon will enter its 'Waning' phase (becoming narrower). Twenty one days after conjunction with the Sun the Moon will have travelled three quarters of the way around its orbit. As the Sun sets over the western horizon the Moon will be around the daylight side of Earth. We will have to wait for six hours for the 'half Moon' to appear over the eastern horizon. At this time of the year the Moon will rise over the eastern horizon at about 22:00 as a 'Waning' 'half Moon' but the opposite side to the 'Waxing' first 'half Moon' will be illuminated by the Sun.

The Moon will finally appear thinner each night and rise over the eastern horizon about one hour later each night.



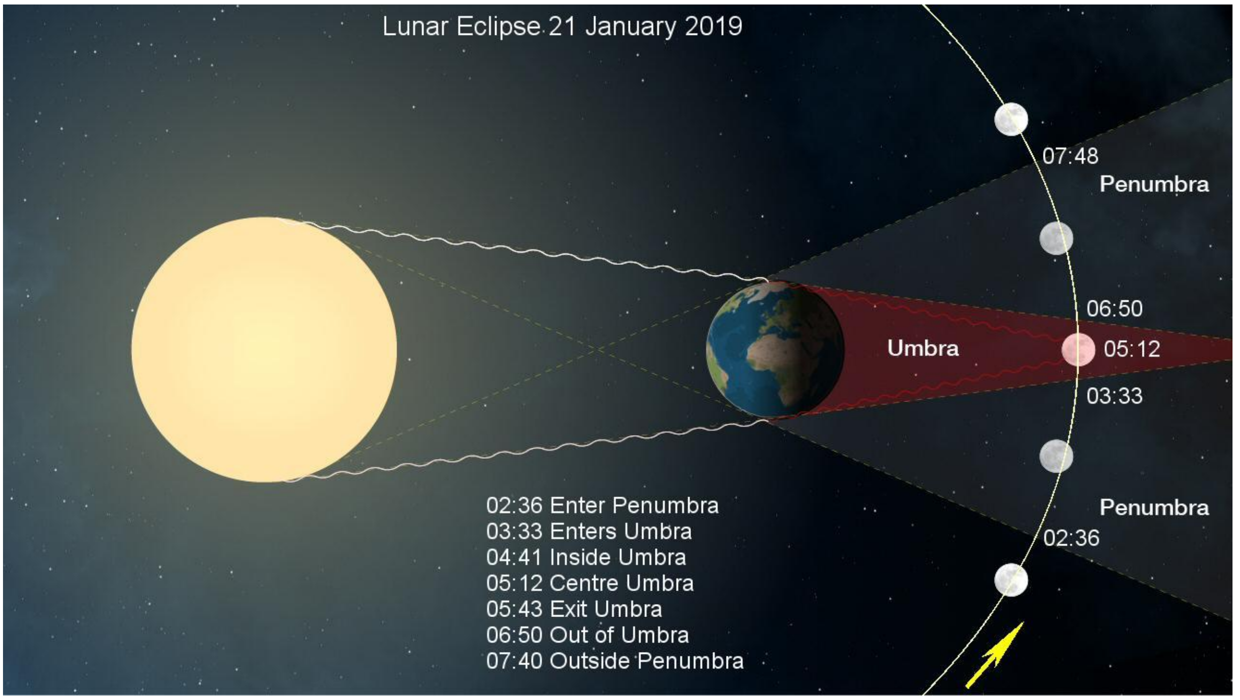
New Moon will be on the 6th January

First Quarter will be on 14th January

Full Moon will be on 21st January

Last Quarter will be on 27th January

TOTAL LUNAR ECLIPSE 21st JANUARY 2019



The Phases of a Lunar Eclipse

In the early morning of Monday 21st January there will be a Total Lunar Eclipse. These events go largely un-noticed by the general public, most of whom are probably not even aware that the Moon is eclipsed by the Earth's shadow.

At about 02:36 on Monday morning the Moon will enter the outer part of Earth's shadow known as the penumbra. The first phase, when the Moon moves through the penumbra, will hardly be noticeable. At about 03:33 the Moon will enter the Umbra, the inner and fully dark part of Earth's shadow. The curve of the edge of Earth will soon become apparent. As the shadow progresses across the Moon the comparative size of the Earth will be seen.

The Moon entering the Umbra on 28th September 2015

At about 04:41 the Moon will be completely inside the umbra of Earth's shadow and will remain completely inside the Umbra until 5:43. During this time the moon may almost disappear from view but this is not always the case; often an amazing effect can be seen.

All the light falling on the Moon from the Sun should be blocked by Earth but some does get past. The thin surface layer of our atmosphere acts rather like a lens and bends some sunlight around the curved surface of Earth and separates out the colours.

As the light is bent the colours are separated in the same way that a prism separates light into the spectrum. The red part of the sunlight is bent more and is able to illuminate the surface of the Moon. Most of the remaining colours of the sunlight are scattered and miss the Moon so the surface becomes bathed in red light.

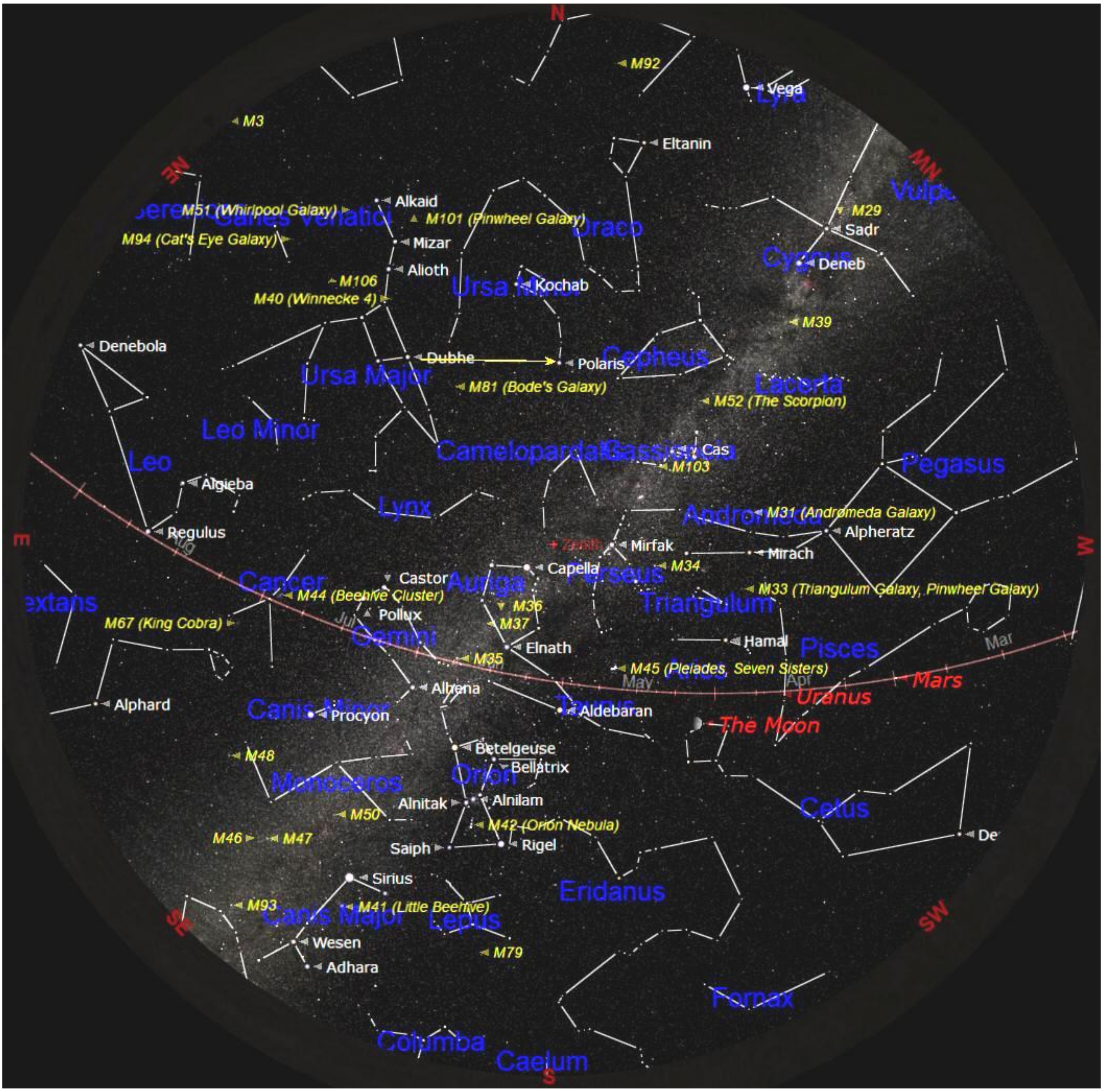
So between 04:41 and 05:43 the moon will be completely inside the central Umbra of Earth's shadow and will appear as an eerie orange globe hovering in the sky.

If we could view the Earth from the Moon at this time, the Sun would be completely blocked out by Earth. As the Moon moves out of the Umbra the Sun will appear as a smaller crescent peeping around the edge of Earth.

The totality on 28th September 2015 image Steve Harris

The effect can be quite spectacular as it was during the 2015 Total Lunar Eclipse. The Moon appeared copper red and seemed to just hover in the clear cloudless evening sky. The effect does depend on the amount of dust and pollution in the atmosphere. Any recent volcanic eruptions can produce a stunning colour as in 2007. An early alarm setting and a clear view to the south west will be required to catch the whole event. It is also a spectacular event to capture for the keen photographer.

THE NIGHT SKY THIS MONTH



The chart above shows the night sky as it appears on 15th January 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 (early evening).