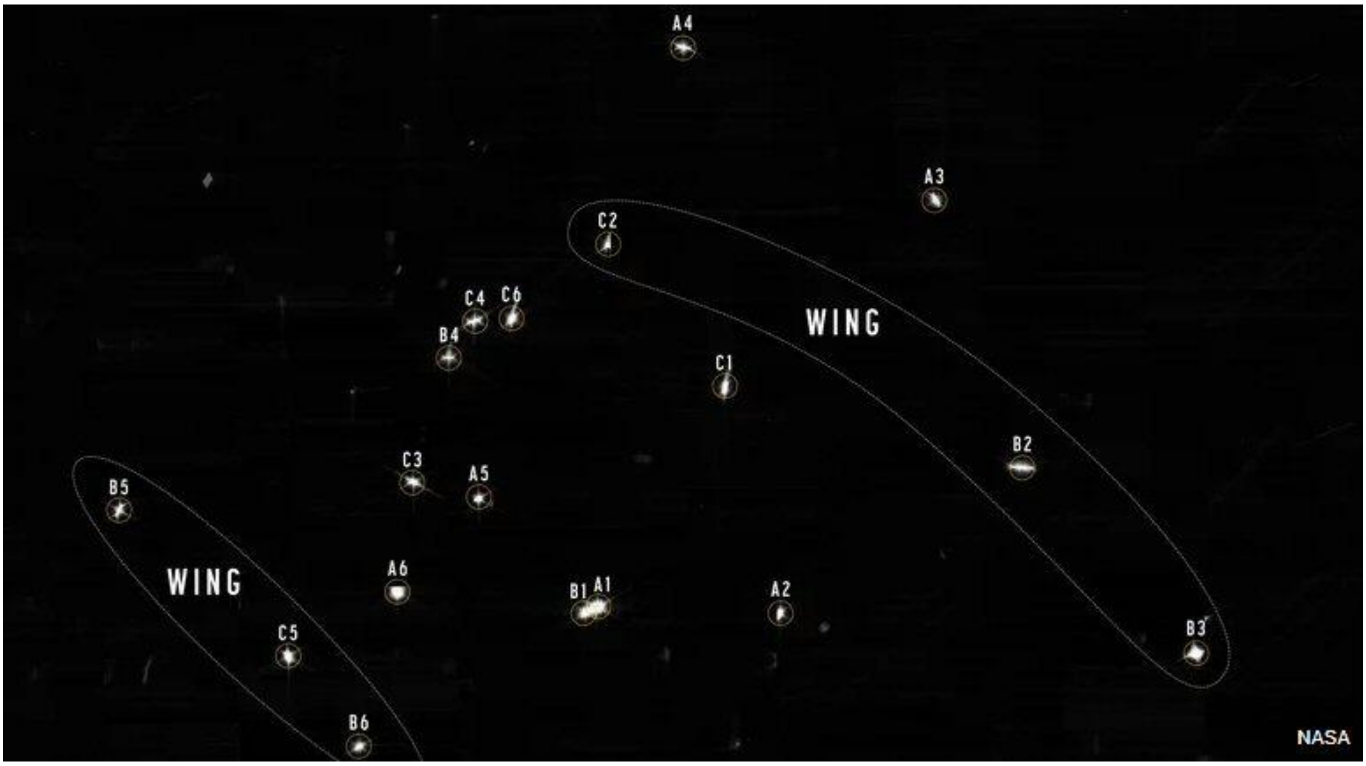
NEWBURY ASTRONOMICAL SOCIETY
MONTHLY MAGAZINE – MARCH 2022

JAMES WEBB SPACE TELESCOPE IS FIRST IMAGE



The first image received from the James Webb Space Telescope (JWST)

NASA's James Webb Space Telescope (JWST) was launched on an Arianespace's Ariane 5 rocket on Saturday 25th December 2021, from the ELA-3 Launch Zone of Europe's Spaceport at the Guiana Space Centre in Kourou, French Guiana. JWST is an infrared telescope with a 6.5 metre primary mirror. The observatory will study every phase of cosmic history from within our solar system to the most distant observable galaxies in the early universe.

It started its mission by unfolding its mirrors and sunshield. It then initiated other onboard systems such as cooling system; aligning; and calibrating systems. The giant telescope mirror had to be folded inside the launch vehicle for the launch. The 18 segments had to be unfolded during its journey and the segments aligned, in space. A huge sunshield the size of a tennis court is needed to keep the instruments cold enough to work and this also had to be unfurled in space.

The image above was a big surprise to everyone who was eagerly waiting for the first image from the JWST because the first image was not expected until around June 2022. The image may look a bit odd but NASA has said all is ok. What we can see is 18 images of the same star which is called HD 84406. There is a separate image from each mirror of the main composite mirror. All this was to prove the whole system was working.

Each of those dots you see on the image is actually the same star called HD 84406 which NASA describes as a "bright, isolated star in the constellation Ursa Major." Each appearance of HD 84406 is how it appears to each one of the 18 different mirror segments on James Webb's primary mirror, reflected into the NIRCam's sensors. NASA, in other words, is capturing the preliminary data it needs to ensure that each mirror segment will be properly aligned ahead of the start of James Webb's scientific mission.

Capturing each of these images wasn't as easy as pointing the telescope at HD 84406 and snapping the shutter 18 times. NASA said that the process of capturing these images involved pointing the James Webb Telescope at "156 different positions around the predicted location of the star." James Webb captured 1,560 images as that was happening which translates to 54 gigabytes of raw data. The images it captured were then stitched into this larger image to help the NASA scientists to align each mirror segment properly.

To enable the mirror to be fitted into the launch rocket the mirror and the important Heat Shield had to fold up and be locked in its transit position. During its journey to its observing location everything was unfolded. Over the next few months the mirrors will be aligned and focused.

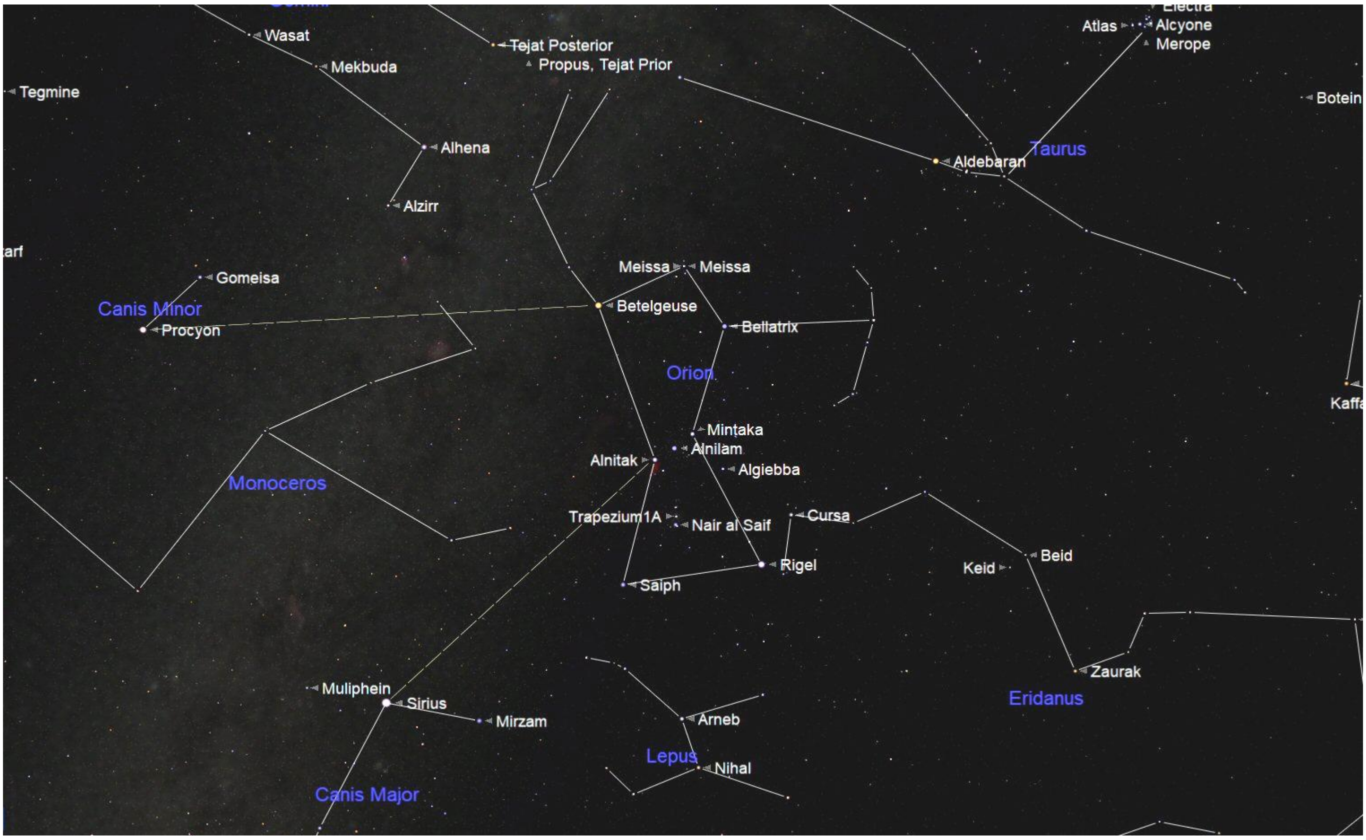
NEWBURY ASTRONOMICAL SOCIETY MEETING

4th March	This will be a Zoom only meeting
Website:	**www.newburyastro.org.uk**

NEXT NEWBURY BEGINNERS MEETING

16th March	Interesting stars in to see in Orion
Website:	**www.naasbeginners.co.uk**

Orion's interesting stars



Orion the Hunter and his Hunting Dogs

Orion (the Hunter) is one of the best known constellations and one of the easiest to recognise and dominates the southern sky at this time of the year. 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.

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 January issue of this magazine 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 Big 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.

We tend to search out Orion to look at the famous object Messier 42 (M42) the Great Nebula. M42 is of great interest and one of the most interesting objects to see. In this article we will be concentrating on some of the very interesting stars in Orion and his Hunting Dogs Sirius and Procyon.

We start with Rigel the bright white star at the lower right of the 'stick' figure depiction shown above. Rigel denotes the bottom right (west) corner of Orion's skirt like tunic. Rigel appears bright to us because it an intrinsically bright giant star. Rigel is a massive, luminous star of the spectral type B8, indicating it is a bright supergiant appearing blue or blue-white in colour.

Rigel has a diameter almost 160 times that of our Sun and has an estimated mass of 21 solar masses. With a temperature of 12,100 K, it shines about 120,000 times brighter than our Sun. It is thought to be about 860 light years away from us.

The Rigel is actually a four star system comprised of the giant star and at least three smaller stars. The Rigel System is referred to as Beta Orionis (β Orionis) and is the second brightest star in Orion after Betelgeuse which is known as Alpha Orionis (α Orionis). Within the Star System the main biggest and brightest star is designated Rigel A (or β Ori) with the smaller stars known as: Rigel Ba, Rigel Bb and Rigel C. There is another star, fainter and at wider separation, that is a suspected component of the Rigel system.

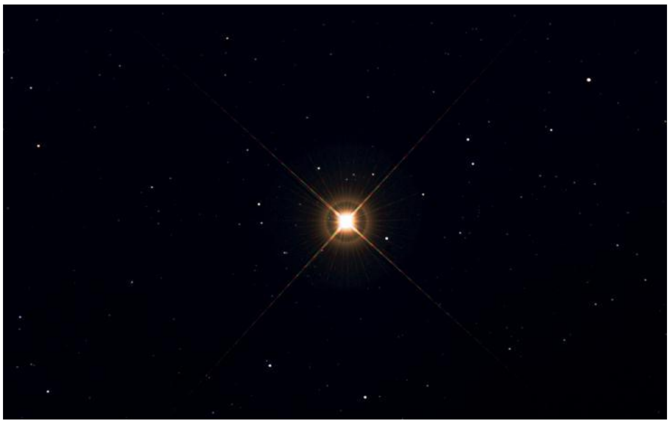
For those with a telescope Rigel (α Orionis) can be seen as a double star. The main and brightest star Rigel A is so bright that Rigel B can be difficult to see. Rigel B has an apparent magnitude of 6.7 which would make the star easily visible in small telescopes if it were not so close to Rigel A. As it is about 440 times fainter than its neighbour, Rigel B is difficult to see in telescopes with apertures smaller than 150mm (6").

Rigel A and Rigel B

The binary system is separated from the primary component by 9.5 arc-seconds that is more than 2,200 astronomical units (Earth – Sun distance). It has a similar proper motion to Rigel A and the pair has an orbital period of at least 18,000 years.

At Orion's left shoulder is the bright orange coloured star Betelgeuse which is much further along its pathway of 'life'. It is approaching the last phases of its existence as a normal star. It has grown into a (really huge) Red Giant with a diameter greater than the orbit of Jupiter in our Solar System.

Betelgeuse is so big and unstable that it pulsates and wobbles rather like a water filled balloon. By carefully observing the brightness of Betelgeuse it can be seen to brighten and fade. At its brightest it can be as bright as magnitude 0.2 and at its dimmest only magnitude 1.2. It is quite difficult to determine the cycle of the pulsations and brightening because there seems to be a number of intertwined cycles. So it appears to vary at different rates of between 150 to 300 days.



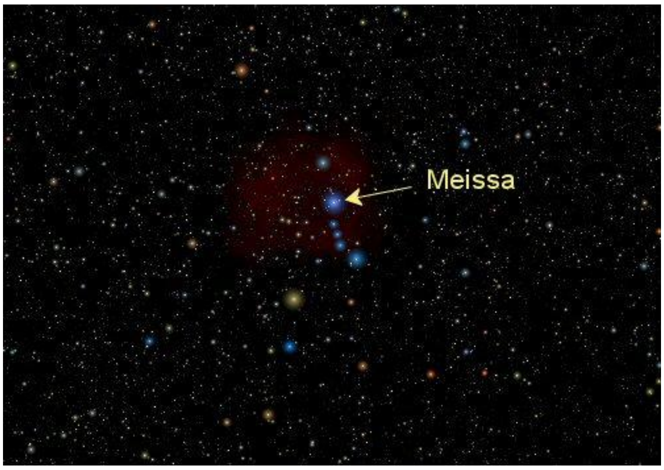
Betelgeuse as seen using a telescope

Betelgeuse appears to be edging towards the end of its life. In fact it is the closest star to us that might explode as a super nova at any time in the near future (astronomically speaking). It could explode and destroy itself sometime in the next million years (maybe as soon as tomorrow). For all we know it may have already exploded but its light will take 650 years to reach us.

These two stars are close enough to us and so bright that we can even see their nature with our naked eyes. Rigel is obviously very white in appearance which is even more obvious using binoculars or a telescope. This is because it is very hot with a surface temperature of about 12,000ºK compared to our Sun at about 6400ºK. This is in contrast to Betelgeuse which is only 3500ºK and is distinctly orange to the naked eye and again even more so when viewed using binoculars or a telescope.

Betelgeuse looks red (orange) because it is more advanced in its life cycle than Rigel and has moved into its Red Giant Phase. The nuclear fusion process is fusing the heaver atoms it has produced into even heavier elements, with each fusion stage contributing additional energy to power the star. All this additional energy pushes out against the force of gravity pulling inwards. The additional energy has forced the outer regions of the star to expand outwards to produce this huge (in volume) bloated and unstable Red Giant.

One of the stars in the small group of stars that define Orion's head is a very hot blue giant. Meissa is a giant star with a stellar classification of O8 III and has an apparent magnitude +3.54. It is actually an enormous star with about 28 times the mass of the Sun. It has an effective temperature of around 35,000 K, giving it a characteristic blue glow of a hot O-type star.



The giant star Meissa

Meissa is actually a double star with a companion. The fainter component has magnitude +5.61 and it has the stellar classification of B0.5 V, making it a B-type main sequence star. There is another outlying component, Meissa C which is an F-type main sequence star with a classification of F8 V. This star in turn may have a very low mass companion that is probably a tiny brown dwarf star associated with this complex star system.

Saiph is located at the lower left (east) Orion's tunic. It is of a similar distance and size to Rigel but appears much fainter. This is because it has a very high surface temperature (26,000°C) that causes it to emit most of its light in the ultraviolet region of the spectrum. Our eyes are not sensitive to ultraviolet wavelengths so it appears fainter than would be expected.

There are many other interesting stars in Orion beside the more well known stars like Rigel and Betelgeuse. It is always interesting to ponder about the true nature of these specks of light that are so far away. The stars of Orion's belt are very easy to see with our naked eyes and the distinctive line of the three stars is one of the most recognised star formations so we should consider what interesting features they may be hiding from us.

The stars of Orion's belt

The star at the east (lower left) of Orion's belt is called Alnitak and is a triple star system. The system is comprised of a pair of stars of magnitude 1.9 and 5.5 orbiting around a common centre of gravity. They appear to be separated by 2.6" (arc-seconds). The third star is a fainter magnitude 10 companion orbiting 57.6" from the pair. This triple star system is thought to be about 820 light years from us.

Alnilam is the middle star of Orion's belt and is the 29th brightest star in the sky (the 4th brightest in Orion). It is a blue-white supergiant with a mass 34.6 times that of the Sun, it has a radius 24 times that of the Sun and 275,000 times more luminous than our Sun. It is estimated to be 2000 light years from us and relatively young with an estimated age of only 5.7 million years. It is expected to develop into a Red Giant within the next million years.

Mintaka is a multiple star system with an overall magnitude of +2.23 but can vary between +2.50 and +3.90. This is because a 7th magnitude star that is currently about 52 arc-seconds away from the main component sometimes eclipses the main star. There is an even fainter star in between these two stars. The main component itself is triple star system comprised of a bright giant and a rare B class main sequence star orbiting every 5.73 days and another B class sub-giant 0.2 arc-seconds away.

There is another 7th magnitude companion that is an unusual B type main sequence star and is itself a spectroscopic binary with a faint A type companion in a 30-day orbit. This 14th magnitude star is thought to be at the same distance but it is not clear whether it is physically bound to the primary star.

Mintaka may be a seven star system but it is also thought to be surrounded by a cluster of faint stars that may be surrounding the whole system. The main star is estimated to be 1200 light years from our Sun. It has a surface temperature of 30,000° K, a luminosity 90,000 times the Sun and a mass of 20 times that of our Sun.

In mythology, Orion the Hunter has two hunting dogs so the constellation of Orion also has two hunting dogs following him in the sky. These are the stars Sirius, in the constellation of Canis Major (the large dog) and Procyon in the constellation of Canis Minor (the little dog). Sirius can be found by following a line down from Orion's belt and Procyon can be found to the left (east) of Betelgeuse.

The chart on page 2 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 the brightest star in the small constellation of Canis Major (Orion's Large Dog) and Procyon is the brightest star in the small constellation of Canis Minor (Orion's Small Dog).

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. It has a companion called 'Sirius B' that 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. It is very close to the brighter component (Sirius A) but is much smaller. Sirius B is considerably smaller and fainter and yet it is one of the more massive white dwarfs ever discovered.

It has a mass slightly more than the Sun's but its radius is only 0.0084 solar radii. In other words, it has the mass of the Sun packed into the size of Earth. The star's estimated surface temperature is about 25,200 K and it will continue to gradually cool over the next 2 billion years. Sirius B is a stronger X-Ray source than Sirius A so appears brighter when using a telescope that is sensitive to X-Rays.

THE SPRING (Vernal) EQUINOX 20th March

Due to a collision with another (smaller) planet as the Solar System was forming, our planet Earth is tilted over at 23.4º. This is the reason that we have the seasons that have had a major effect on the evolution of life on Earth. The presence of our large Moon is another major factor. We need to think about the dynamics of our planet Earth and how it moves around the Sun.

Earth's axis is tilted 23.4º from the axis of rotation of the Solar System. Looking at this from another angle Earth's axis is tilted 66.6º from the plane (or equator) of the Solar System. This gives us on Earth some rather odd views of space around us including the Sun, Moon and the planets. The first thing we need to do is understand how this tilt works.

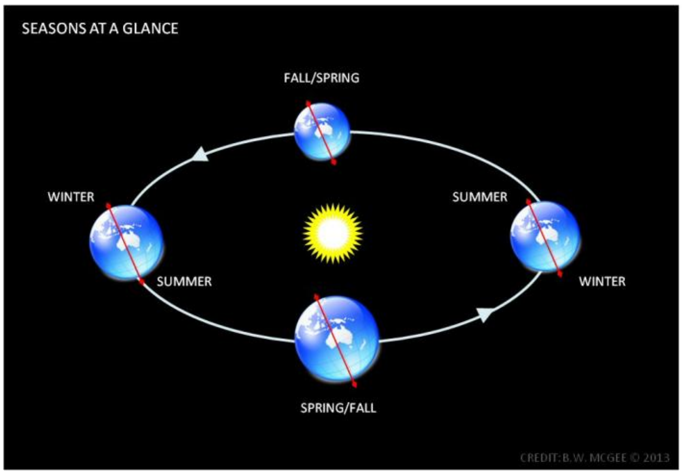


Diagram showing Earth's tilt on its orbit around the Sun

The diagram above shows how Earth orbits the Sun and how Earth's axis is always tilted in the same direction. In fact an imaginary line projected into space, from the north of Earth's axis, points into space at a point in the constellation of Ursa Minor (the Little Bear) very close to the star Polaris. This is why we also call Polaris 'the North Star' or 'the Pole Star'.

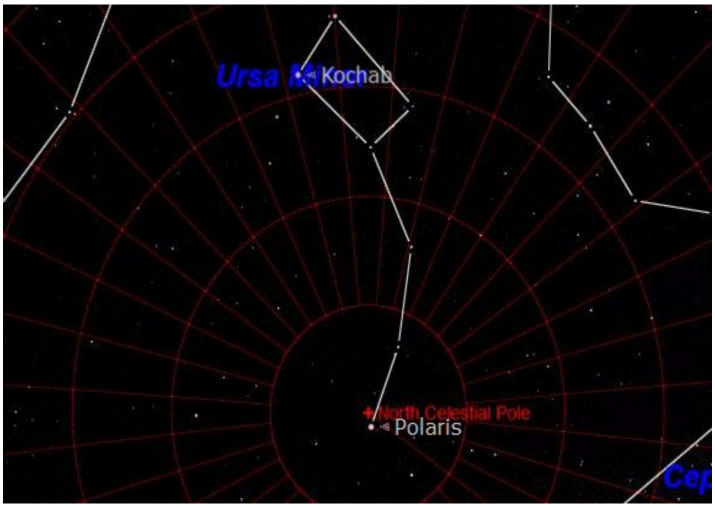
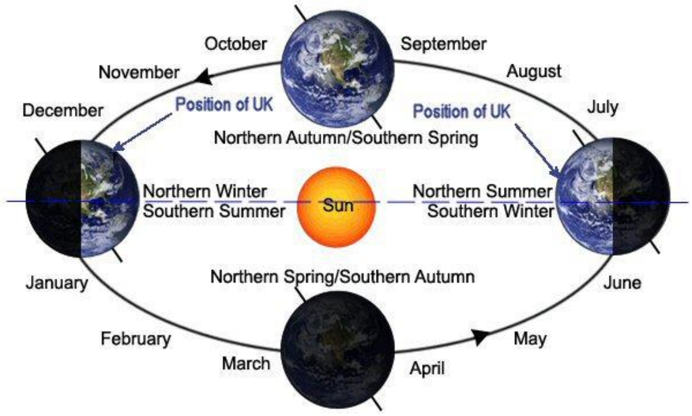


Diagram showing Polaris and the North Celestial Pole

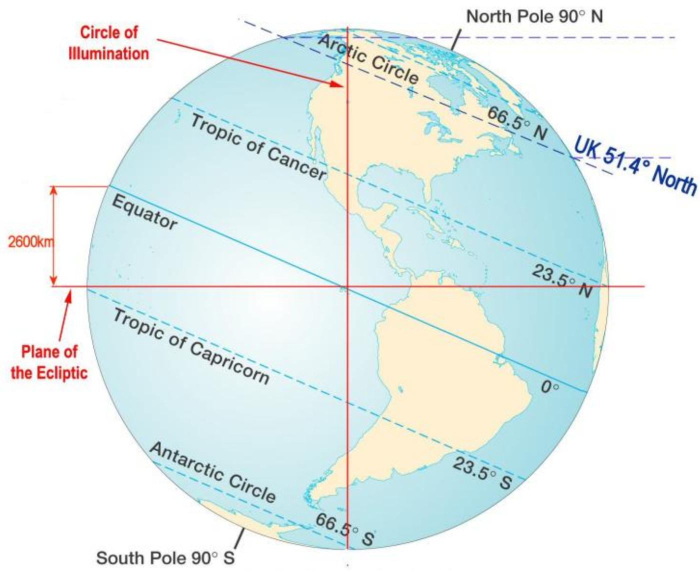
So the tilt of Earth's axis of rotation gives us a rather odd view of our surroundings in space. The first thing to grasp is the way that Earth orbits the Sun. The diagram above shows how the axis of Earth always points in the same direction, in the sky, as Earth moves around the Sun. This has a profound effect on our weather.



Earth's orbit around the Sun

In the diagram above, the representation of Earth on the left shows its position at northern mid-winter. So we in the UK are further above the equator due to the North Pole being tilted away from the Sun. On the right the North Pole is tilted towards the Sun and the UK is positioned closer to the Solar system equator (the Ecliptic) than it was in mid-winter so it is our summer.

What this means is the equator (the position where the Sun appears to be directly overhead at midday) moves south for the northern winter (left) and north for the northern summer. The furthest position that the equator (ecliptic) moves to the north is called the Tropic of Cancer and the furthest south that it reaches is called the Tropic of Capricorn. See the diagram below.



In the diagram above it can be seen that the tropics extend 23.5° north and 23.5° south of Earth's equator. This means that a point on the surface of Earth (for instance the UK) will move 40055km (circumference of Earth) x 23.5°/360° which equals around 2615km from mid winter to the Spring Equinox.

So over one orbit of the Sun (1 year), a point on the equator will move up 2615km and down the surface in six months. It will then move down 2615km and up again in the second half of the year. The UK effectively moves 5230km south from midwinter to midsummer and then back again. This apparent movement of the Sun in our sky and its effect on our view of the sky is explained in more detail on the following pages.

Now we can think about how the tilt of Earth's axis affects us as inhabitants of Earth and us as astronomers. First we can consider how our view of the Solar System and the space around us is affected. Obviously the positions of the Sun (and the Moon) change their elevation in the sky from winter to summer. We all notice that the Sun appears higher in the sky in summer but how does this come about and how does it affect the weather?

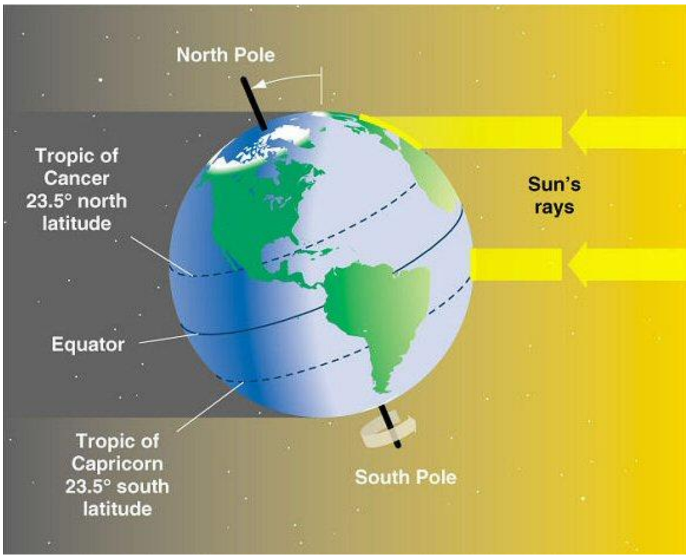


Diagram showing how Earth is illuminated by the Sun

Our summer is noticeably warmer than the winter, this happens for two reasons but both reasons are related to the tilt of Earth. In the diagram above the parallel rays from the Sun are shown coming towards Earth from the right. When Earth's axis is tilted away, as shown, the UK is located high on the sphere. The rays from the Sun are spread over a larger area of the surface due to the curvature, as shown. The yellow arrows indicate the same area of light and heat coming from the Sun but the upper arrow has a larger 'footprint' on the surface. This means the energy from the upper arrow of rays will be distributed over the larger area and have only a half of its energy for each unit of area on the surface compared the energy delivered at the equator.

The other factor affecting the temperature is due to the amount of the atmosphere that the light and heat has to pass through to get to the surface. The higher the latitude the more air it will have to penetrate due to its angle of incidence and more of the energy will be absorbed by the atmosphere before reaching the ground.

Six months later Earth will be on the opposite side of the Sun and the North Pole will be tilted towards the Sun. In the diagram above it can be seen that a country located on the Tropic of Cancer is positioned higher on the side facing the Sun. Six months later when that country is at the lower position during the day it will receive more energy from the Sun and the climate will be warmer. Another diagram showing the northern summer would have Earth positioned as in the diagram above but the Sun would be on the left. See the upper diagram on the previous column.

Another very noticeable effect of Earth's tilt is the change in the length of the day from winter to summer. The reason for this major change is quite easy to see on the next diagram.

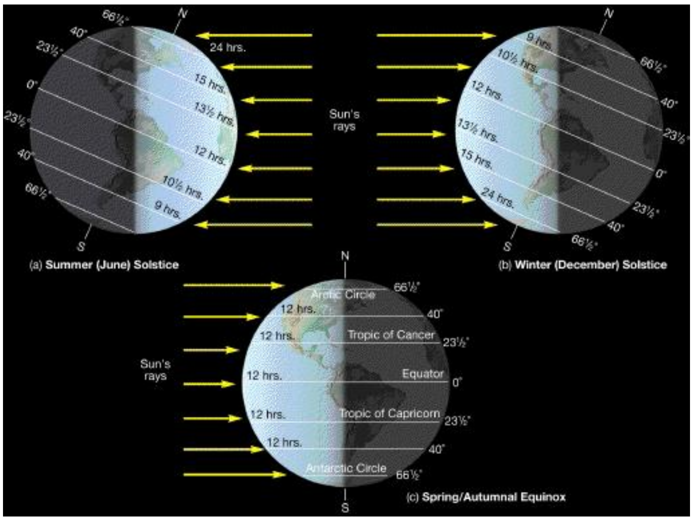


Diagram showing the change in the length of the days

The upper left diagram shows the length of the days in the midsummer period. The upper line is the 40° latitude position we in Newbury in the south of England are at 51.4° north so we would be above the 40° latitude line and approximately where the second from top sunshine arrow is pointing.

Our midsummer day is about sixteen hours long. It can be seen that the tilt increases the time that our location is in sunlight when the pole is tilted towards the Sun. Conversely when the pole is tilted away from the Sun that same location spends less time in the illuminated area and the days are shorter, as in the upper right diagram. Our winter day is just eight hours long.

The lower diagram shows how the day and night are the same length at the Spring and Autumn Equinoxes. The Equinoxes are the exact time when the Sun is moving north or south and reaches the point when it is directly overhead on the Celestial Equator (Earth's Equator).

The diagram below shows the relationship of the Celestial Poles and the Solar Poles and the Celestial Equator and the Solar System Equator (the Ecliptic).

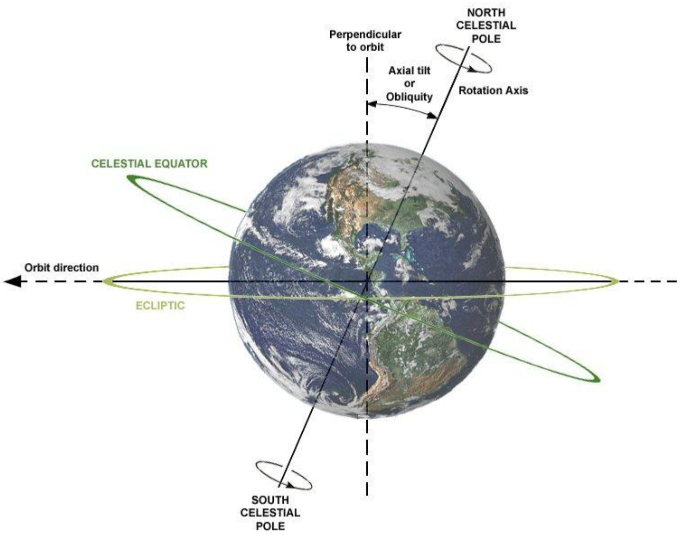
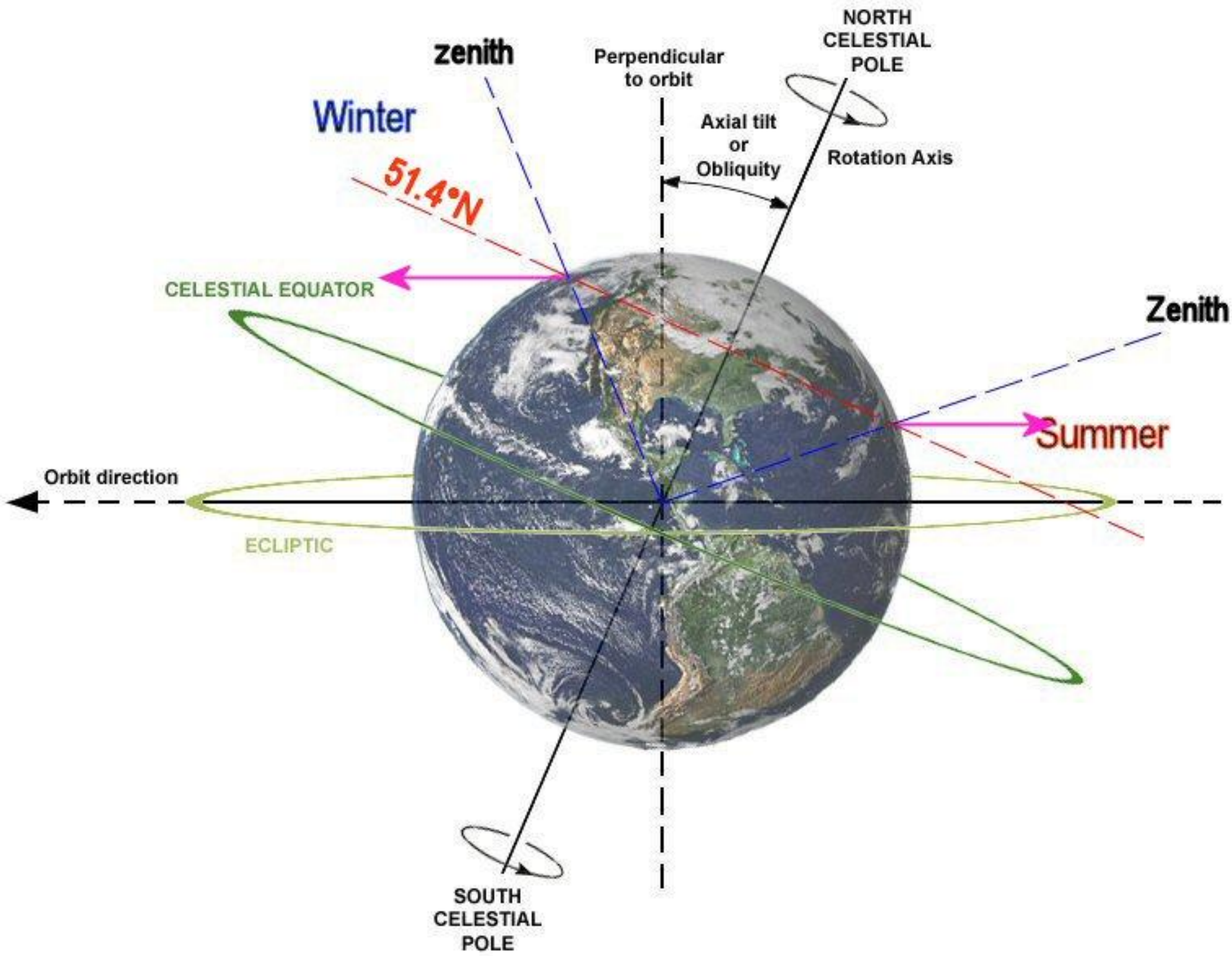


Diagram showing the Pole and Equator terminology

The Ecliptic is actually the imaginary line along which the Sun, Moon and planets appear to move across the sky. It can be thought of as the equatorial plane of the orbits of the planets and tilted at 23.4° to the Celestial Equator.

THE EFFECT OF EARTH'S TILT ON OUR VIEW OF THE SKY



The diagram above shows how Earth's axis of rotation is tilted. The dashed black line marked as 'Perpendicular to orbit' is the axis of rotation of the Solar System around which all the planets, including Earth, orbit the Sun. The solid black line marked as: 'North Celestial Pole' and 'South Celestial Pole' is the tilted axis of rotation of Earth. The angle between Solar System axis and the Celestial Axis (Earth's axis of rotation) marked as: 'Axial tilt or Obliquity' is the 23.4° tilt as discussed on the previous pages. The Ecliptic or Equator of the Solar System is shown as the light green horizontal ellipse with the Celestial Equator (Earth's Equator) also tilted at 23.4°.

The red dashed line towards the top of Earth is the latitude line on which Newbury is located. This is 51.4° north of the Celestial Equator (Earth's Equator) so this is our observing position when we look up into the sky. It can be seen that this line is also tilted at 23.4° to the Ecliptic (the plane of the Solar System).

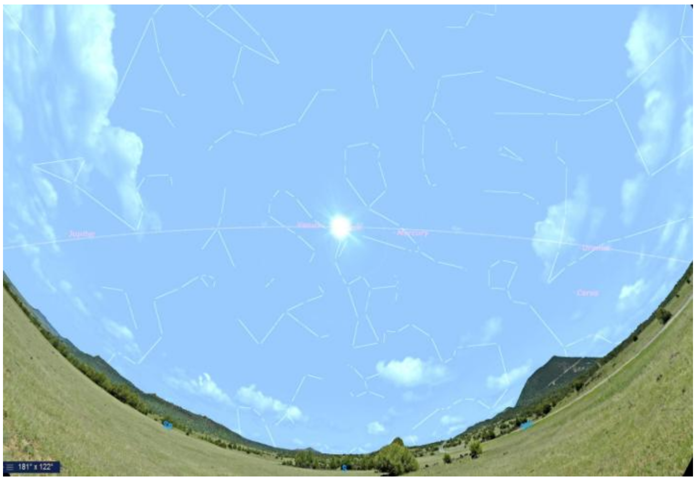
We now have to imagine the diagram has two views to consider. The first is on Midsummer Day when the Sun will be off the diagram to the right and the North Celestial Pole is tilted towards the Sun. So the right side of earth will be facing the Sun and in daylight and the left side will be dark at midnight. Secondly on midwinter day the Sun will be off the diagram to the left and the North Celestial Pole is tilted away from the Sun. So the left side of earth will be facing the Sun at midday and the right side will be dark and it will be midnight.

It will be noticed that the position of Newbury is higher up the surface of Earth and closer to the North Pole of the Solar System marked as 'Axial tilt or Obliquity' on the dashed black line. The direction to the Sun from the winter and summer viewing positions is indicated by the pink arrows. Now if we imagine a person standing at those positions and a line projected from their head to the point in the sky directly above that person, this is called the Zenith. This imaginary line is indicated by the blue dashed lines marked Zenith.

The important thing to notice here is the angle between the Zenith line and the pink arrows pointing towards the Sun. The angle of the pink arrow on the left side (the winter side) is much larger than the angle on the right (the summer side). So this means in the winter the Sun appears further away from the zenith (the point directly overhead) and therefore closer to the Celestial Equator (our horizon). Conversely, in the summer the angle between the Zenith line and the pink arrow pointing towards the Sun is significantly smaller. Therefore the Sun appears closer to the Zenith overhead and much higher in the sky. The Sun consequently appears much higher above the Celestial Equator (our horizon).

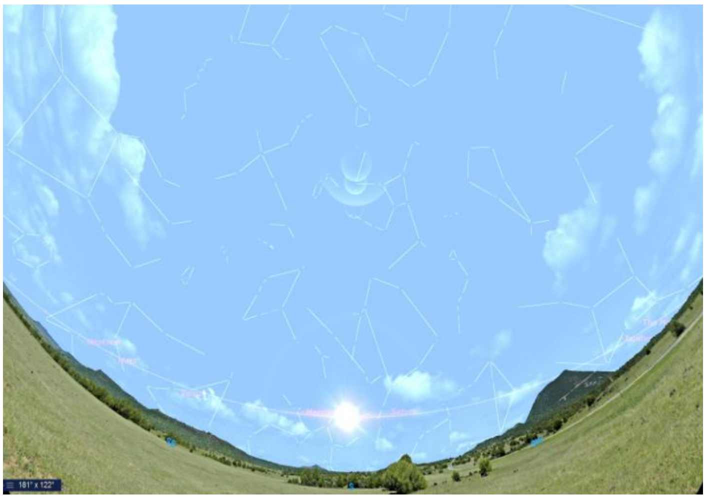
For astronomers the significance is: the planets and the Moon are positioned much higher in the sky during the winter months. This means the light from them has to pass through much less of our atmosphere and the images obtained are much clearer.

As astronomers we have a rather confusing view of the sky around us due to the tilt of Earth's axis. There are some very noticeable effects that we take for granted. The first is: how much the position of the Sun in the sky changes from summer to winter.



The sky at midday on Midsummer Day - 21st June

The computer generated image above shows the sky at midday on Midsummer Day. The Sun is at its maximum elevation above the southern horizon. Any planets in the sky at this time will be located somewhere along the Ecliptic to either side of the Sun and therefore high in the sky as well.

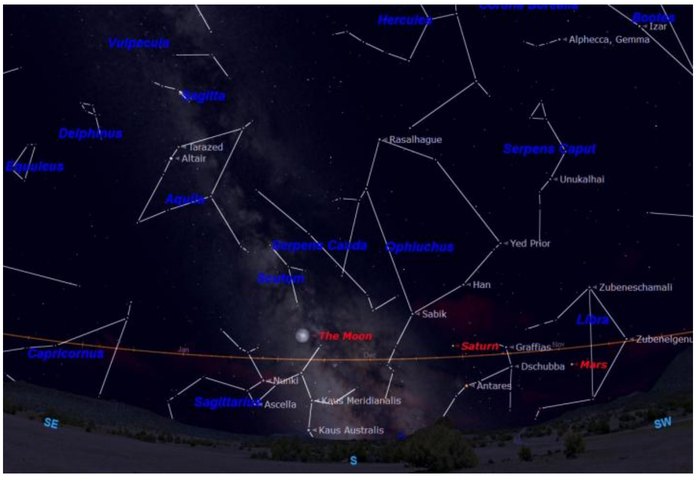


The sky at midday on Midwinter day - 21st December

The image above shows the sky at midday on Midwinter day. When compared to the image at the top, it can be appreciated just how low the Sun appears from the UK in the middle of the winter. The Ecliptic is the imaginary line that represents the equator of the Solar System. The Sun, Moon and planets appear to move along this imaginary line as Earth moves around its orbit about the Sun. As the tilt of Earth's axis always points to the same direction and the same point in the sky, the Ecliptic appears to rise and fall from our point of view as explained on the previous two pages.

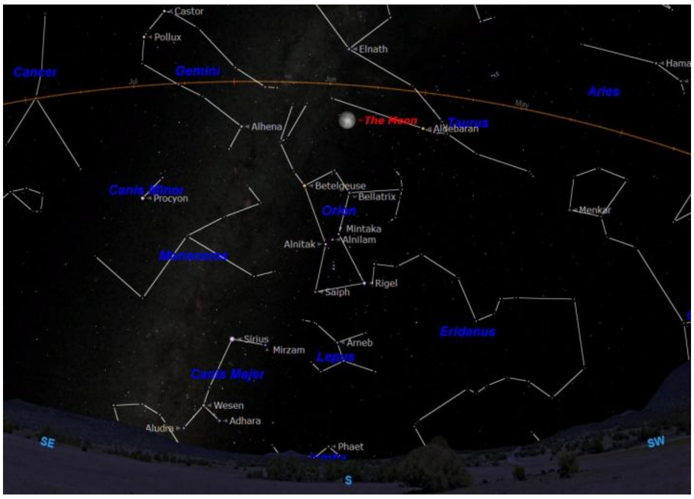
In the northern hemisphere the north pole of Earth's axis is tilted towards the Sun during the summer season. This gives the effect of a point on the surface such as the UK being closer to the equator of the Solar System that we call the Ecliptic. As a consequence the Sun will appear much higher in the sky during the summer.

However as Earth rotates on its axis once every 24 hours (1 day) that point on the surface of Earth (the UK) will rise up due to the tilt. See the red dashed line on the diagram on the previous page. At midnight when the UK is looking away from the Sun it will be at its highest point.



The sky at midnight on Midsummer Day - 21st June

The image above shows the how the Ecliptic appears low in the sky at midnight on Midsummer Day when it had been high in the sky during the day. See the image in the opposite column. The Moon appears low in the sky during the summer nights and appears large as it rises over the horizon giving us the Harvest Moon effect.

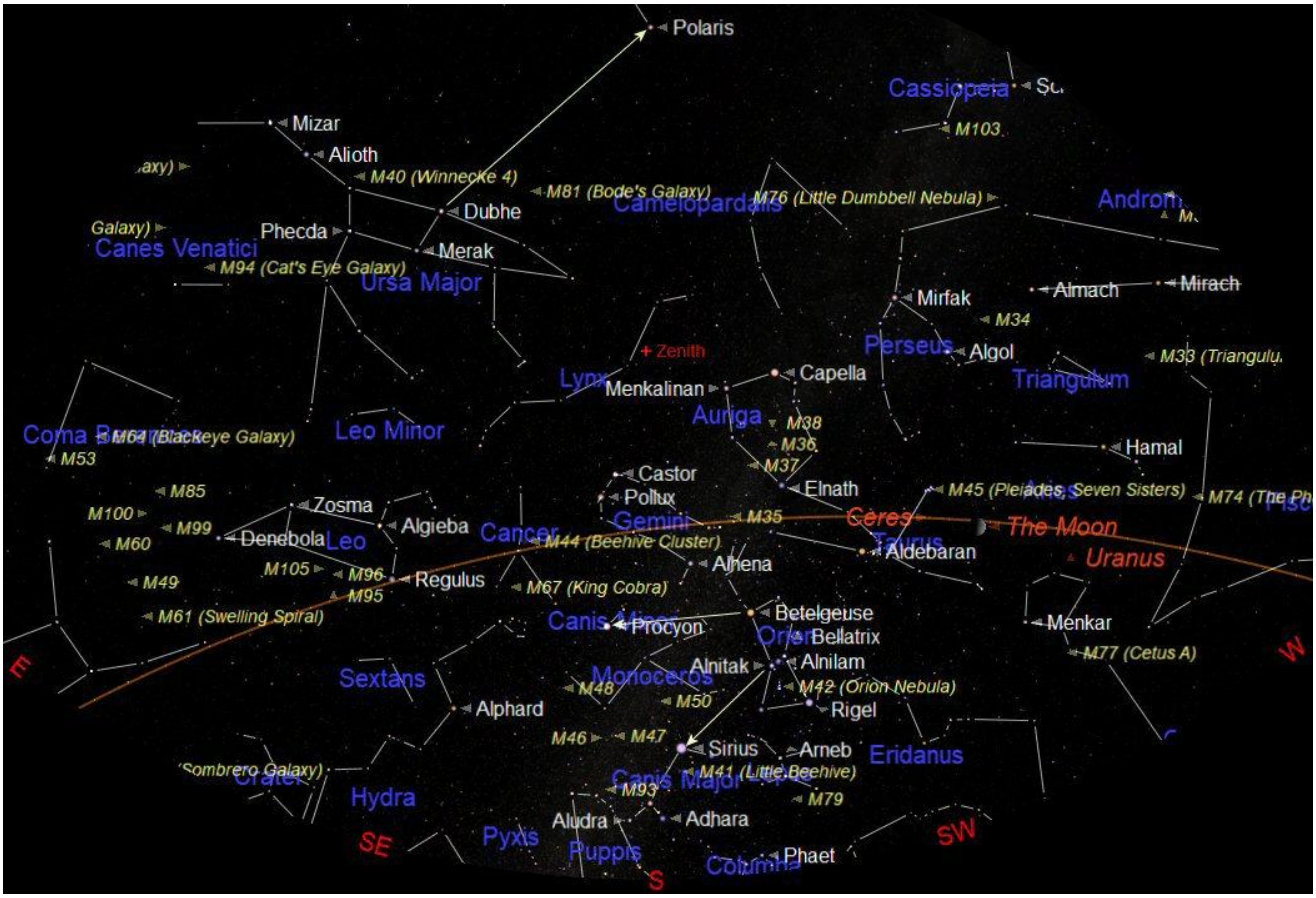


The sky at midnight on Midwinter day - 21st December

During the winter nights the ecliptic appears very high in the night sky as can be seen in the image above. In the northern hemisphere the north pole of Earth's axis is tilted away from the Sun during the winter season. This gives the effect of a point on the surface such as the UK being further away from the equator of the Solar System (the Ecliptic) during the day and closer to the north pole of the axis of the Solar System.

However as Earth rotates on its axis once every 24 hours (1 day) that point on the surface of Earth (the UK) will move down due to the tilt. See the red dashed line on the diagram on the previous page. At midnight when the UK is looking away from the Sun it will be at its lowest point and the Ecliptic will appear high in the sky. The winter is the best time for astronomers because the nights are long and the planets and Moon are high in the sky and away from the thick and turbulent air close to the horizon.

A TOUR OF THE NIGHT SKY - MARCH 2022



The chart above shows the night sky looking south at about 22:00 GMT on 15th March. 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) just off the right of the chart, Pisces (the Fishes), Aries (the Ram), Taurus (the Bull), Gemini (the Twins), Cancer (the Crab), Leo (the Lion) and Virgo (the virgin) just coming 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 called Messier 45 (M45) also known as the Pleiades (or the Seven Sisters). It really does look magnificent using binoculars.

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.

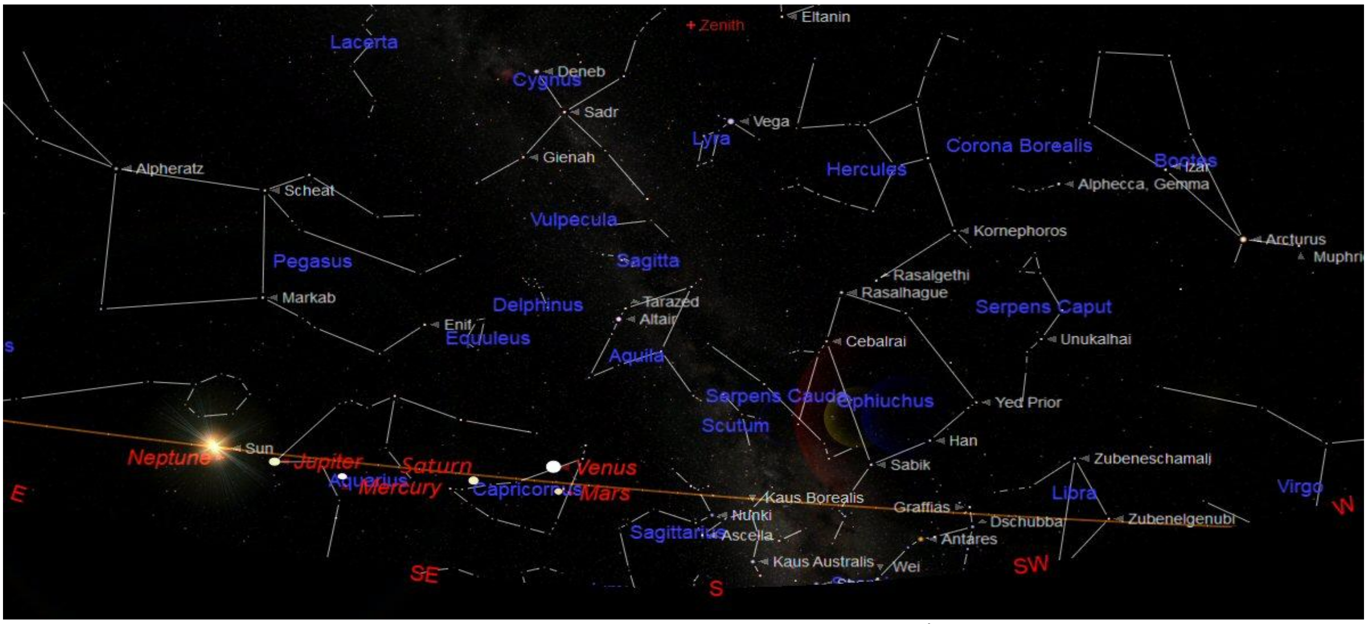
To the south of Taurus is the winter constellation of Orion (the Hunter) that dominates the southern night sky. Orion is easily found by looking for the very obvious three stars of his belt. As he is so easy to find it is a good place to start exploring the sky. Orion has his Hunting Dogs Sirius (the big dog) and Procyon (the little dog) to the east (left) and following him. Orion was featured as 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 constellation of Leo (the Lion) follows Cancer along the Ecliptic and will be the constellation of the month next month. It does actually look a little like a lion or the Sphinx in Egypt. Around and between Leo and the neighboring constellation of Virgo is a cluster of galaxies. Our Milky Way galaxy and our local group of galaxies are members of this larger group of galaxies called the Virgo Cluster. A medium sized telescope (150mm to 200mm) and a dark sky is required to see these faint objects.

The Spring Equinox (also called Venal) occurs on 20th March. This means we are half way to summer. British Summer Time (BST) begins on 27th March.

THE SOLAR SYSTEM - MARCH 2022



The location of the planets at 07:30 GMT on 15th March 2022

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

MERCURY will be very close to Saturn before sunrise in the east but will be difficult to see this month. It will be in the early morning sky throughout March.

VENUS rises about two hours before the Sun climbs over the eastern horizon. It is looking very bright in the east before sunrise. It will show a large diameter but it will be getting smaller and will appear as a widening crescent. It is called the 'Morning Star' at this time.

MARS is on the other side of the Sun (so appears very small) and still appears close to the Sun so will be difficult to see. Mars has moved out of conjunction with the Sun and into the early morning sky but will not appear in the evening sky again until September 2022.

JUPITER will begin to move away from the Sun after its conjunction on 5th March.

SATURN has now moved away from the Sun after its conjunction on 4th February so will be appearing in the morning sky about one hour before sunrise. It will be very low over the eastern horizon in the brightening sky and will be moving into the evening sky later in the year.

URANUS will be observable this month and will be best seen at 19:00 when it will be due south and at its highest point above the horizon but it is small and faint at +5.7.

NEPTUNE will be in conjunction with the Sun on 13th March so will not be visible this month.

THE SUN

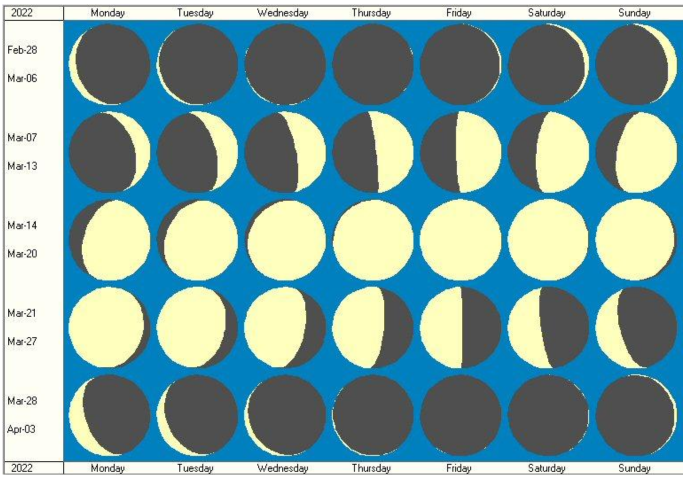
The Sun rises at about 06:40 at the beginning of the month and 05:50 by the end of the month. It sets at 17:45 at the beginning of the month and 18:30 at the end of the month. It will be half way to midsummer on 20th March when it will be the spring (Vernal) equinox. On this date the night and day will be of equal length and exactly 12 hours long.

Midsummer will be on 21st June (Summer Solstice) when it will be the longest day at 16 hours and the shortest night at just 8 hours long. The Sun is starting to climb higher in the sky now. It will be half way between its lowest point (Winter Solstice) on 21st December 2021 and its highest on 21st June 2022 (Summer Solstice).

There have been a few nice Sunspots recently. Sunspots and other activity on the Sun can be followed live and day to day by visiting the SOHO website at: http://sohowww.nascom.nasa.gov/.

Sunspots are caused by the magnetic field of the Sun. Magnetic lines of force cause a depression on the surface that can expose a cooler and darker layer below the very bright visible surface (Photosphere).

THE MOON PHASES DURING MARCH



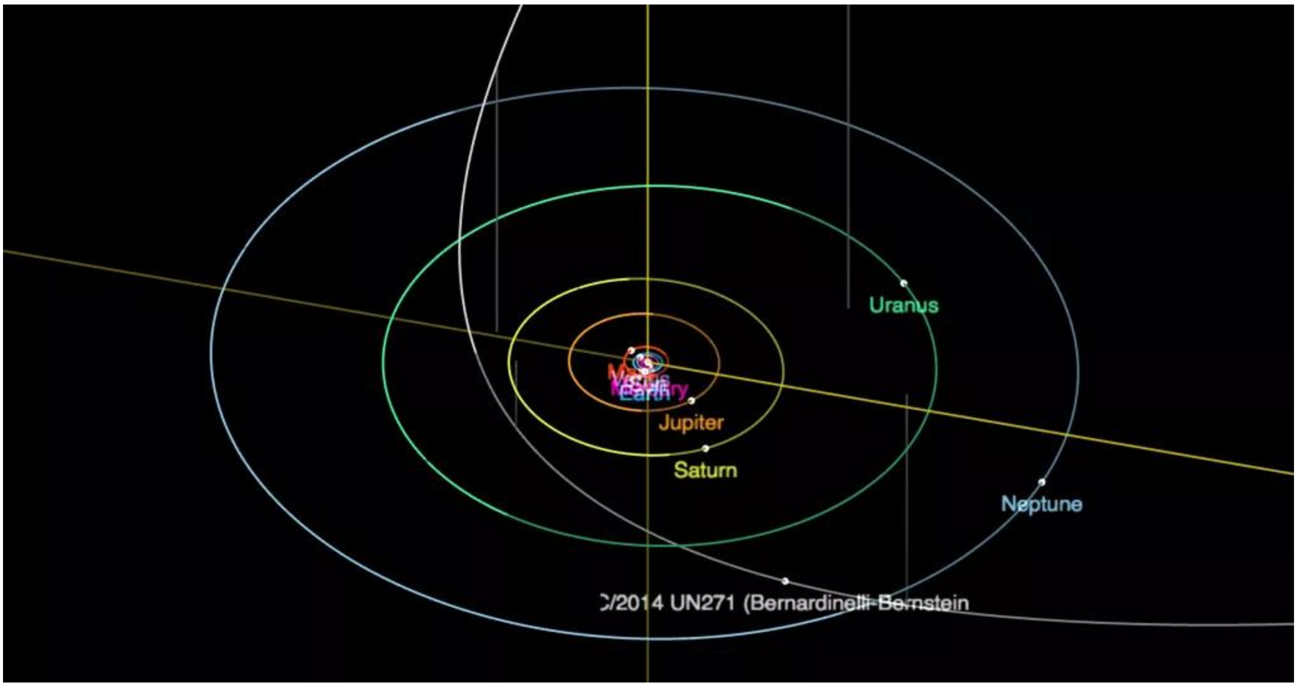
New Moon will be on 2nd March

First Quarter will be on 10th March

Full Moon will be on 18th March

Last Quarter will be on 25th March

Comet Bernardinelli - Bernstein



The path of Comet Bernardinelli - Bernstein

A new visitor is swinging by the solar system is a never-before-observed comet that came from the Oort Cloud.

This alien object was designated as a comet Wednesday (23rd June 2014), only a week after astronomers first observed it. A tiny moving dot was seen on archive images from the Dark Energy Camera at the Cerro Tololo Inter-American Observatory in Chile. The comet is now known as Comet C/2014 UN271 or Bernardinelli-Bernstein after its discoverers, University of Pennsylvania graduate student Pedro Bernardinelli and astronomer Gary Bernstein.

The comet is large and thought to be about 130 kilometres in diameter. It is currently about 20 AU's (Astronomical Unit - the distance from Earth to the Sun) away. It will reach its closest point to the Sun on its orbit on 23rd January 2031, when it will be just beyond the orbit of Saturn, or about 10.95 AUs from us.

Astronomers will have practically 20 years to study it said Peter Vereš, who is an astronomer at the Centre for Astrophysics Harvard & Smithsonian and at the Minor Planet Centre. This is the authority that identifies and computes orbits for new comets, minor planets and other distant rocky bodies. This is an exciting opportunity to observe a comet that is a nearly pristine object from the Oort Cloud. This is halo of icy, rocky debris that is thought to surround the Solar System like an icy shell.

Comet Bernardinelli-Bernstein first made its appearance in the 2014 archives of the Dark Energy Camera. Bernardinelli and Bernstein soon realized that the object which looked like nothing more than a dot was moving over the time that they traced it through 2015, 2016, 2017 and 2018.

The astronomers sent their observations to the Minor Planet Centre which at first classified the object as an asteroid or minor planet since its surface appeared to be chemically inert. The report of the new object triggered amateur astronomers to point their telescopes skyward and some soon noticed a 'coma' or haze of vapours and dust, emanating from the object.

Comets are active because the heat of the Sun and solar wind cause gas to be released from the surface. It is likely that the surface has become more active over the past few years as the comet became closer to the sun, making the activity easier to spot.

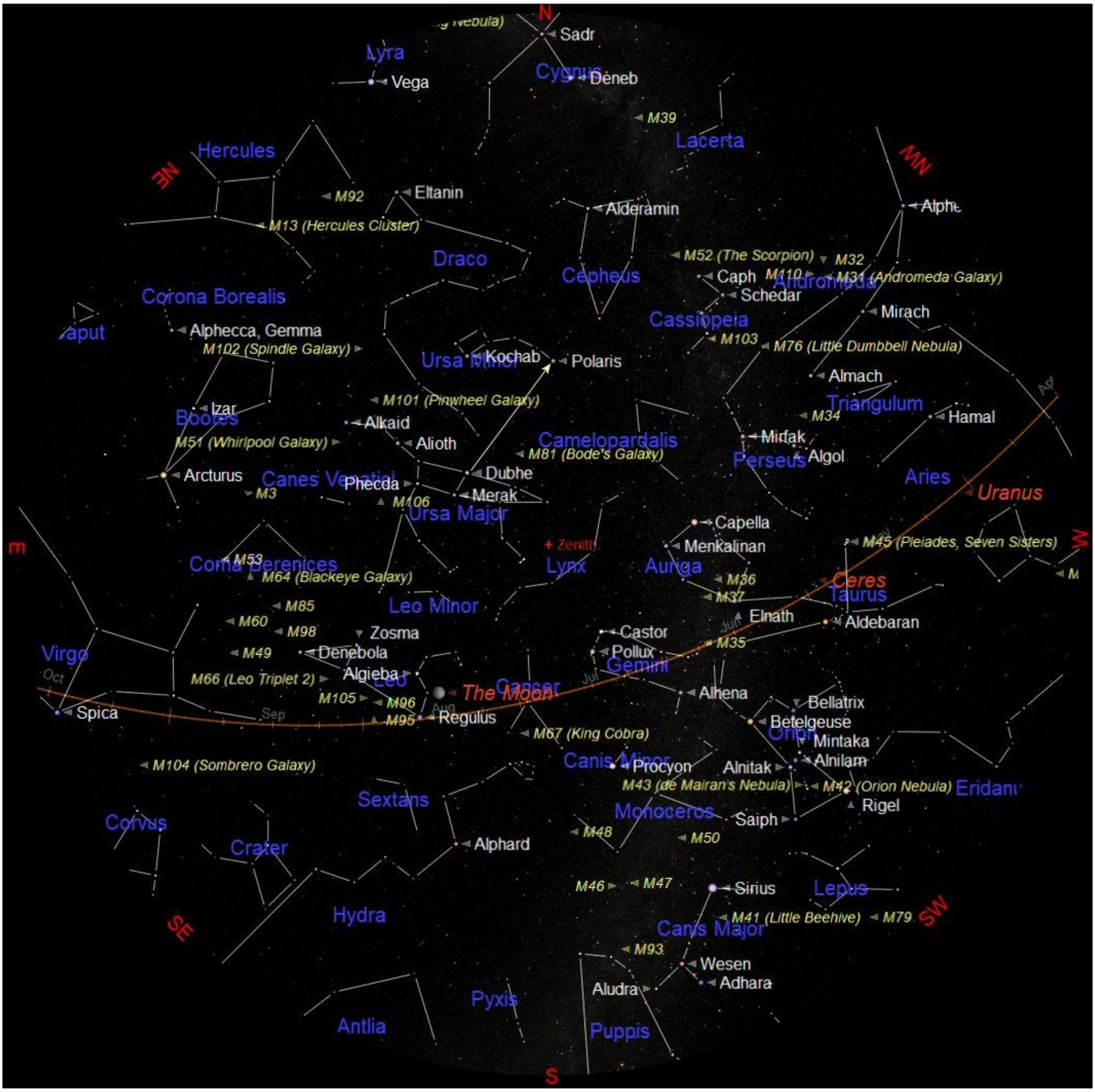
The comet takes approximately 5.5 million years to complete its orbit which is vertical to the plane of the planets. The Minor Planet Centre researchers have calculated that at its farthest point it is approximately a light-year from the Sun. Based on its orbit, the comet is likely to have originated from the ice-cold region beyond the solar system known as the Oort Cloud.

Objects like the Bernardinelli-Bernstein comet were probably once part of the solar system but they were cast out by gravitational interactions with large planets like Jupiter, Saturn, Uranus and Neptune.

Although the comet's history isn't certain, this newfound journey towards the Sun may be its first foray back into the solar system since its initial expulsion. This is exciting because the short-periodicity comets that circle within the solar system are significantly altered from their original form by many rotations around the Sun. Long-periodicity comets like Bernardinelli-Bernstein that stay in the outer parts of the solar system do not change very much. This means they are like a time capsule of conditions and materials present at their formation in the early days of the solar system.

More and more observations are made every day. To the naked eye, the comet still looks like a tiny and faint fuzzy dot and will probably never be visually impressive. However the very sensitive instruments on the large telescopes available today may soon be able to detect variations in the light coming from the comet. This may reveal the molecules coming off its surface that could reveal what the comet is made of.

THE NIGHT SKY – MARCH 2022



The chart above shows the whole night sky as it appears on 15th March 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 high 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: Uranus.

British Summer Time (BST) begins on 27th March.