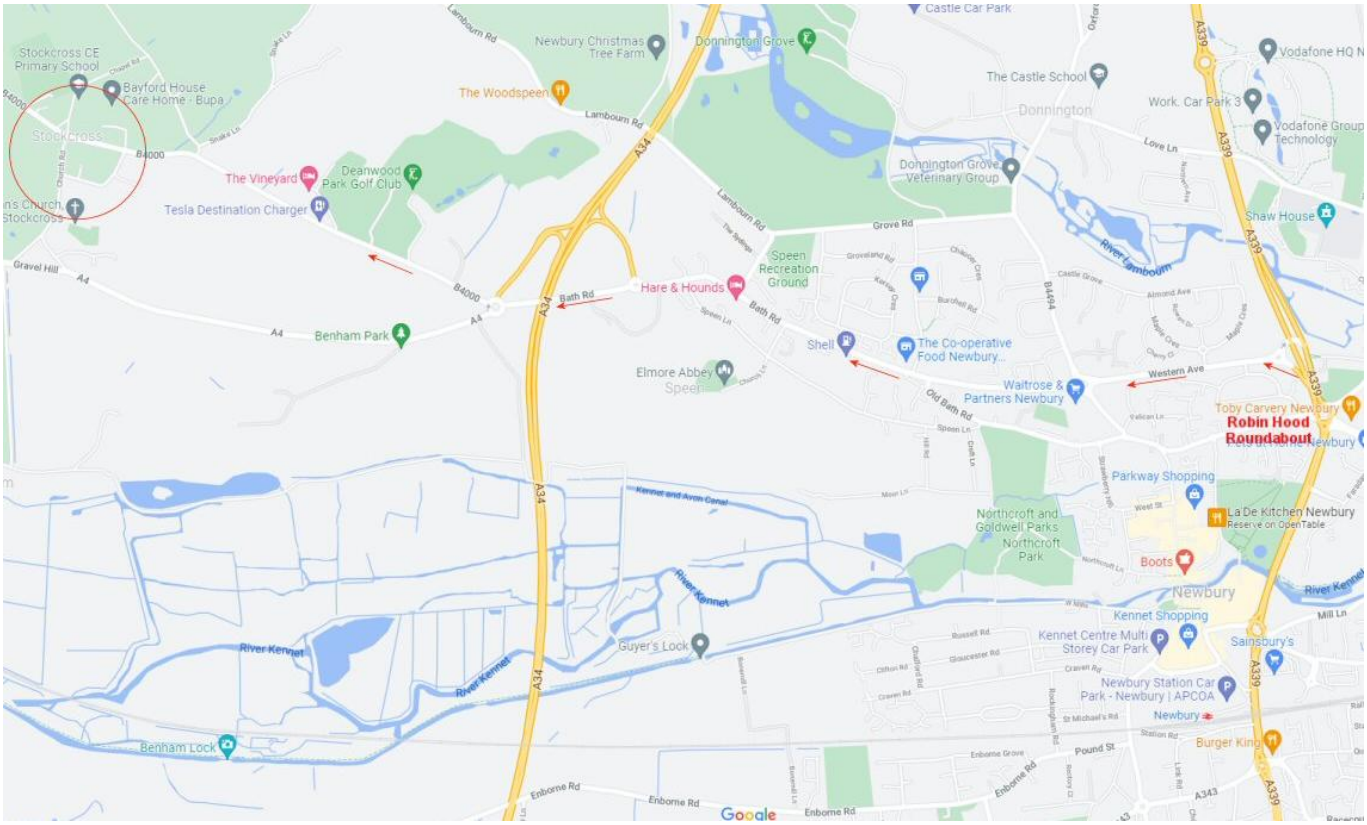
NEWBURY ASTRONOMICAL SOCIETY
MONTHLY MAGAZINE – JANUARY 2022

OUR JANUARY MEETING VENUE WILL BE 'FACE TO FACE'



Directions to Stockcross Village Hall (Sutton Hall)

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

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

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

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

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

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

NEWBURY ASTRONOMICAL SOCIETY MEETING

7th January	Space Traffic Control
Website:	www.newburyastro.org.uk

NEXT NEWBURY BEGINNERS MEETING

19th January	Birth, Life and Death of our Star
Website:	www.naasbeginners.co.uk

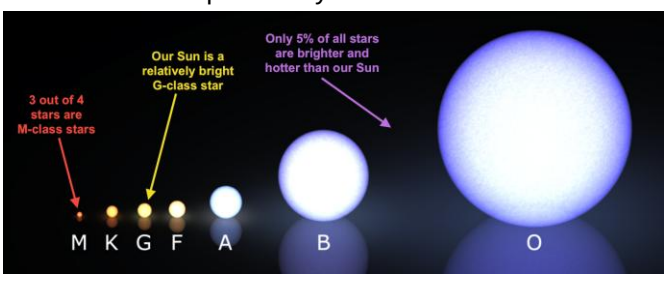
THE BIRTH, LIFE AND DEATH OF OUR STAR

Our star ‘The Sun’ as it appears to us

Most of the time we take our star for granted but it is always there for us even when we can’t see because of the clouds. The Sun provided the heat and energy that was essential for the creation of life on our planet and continues to provide what we need to survive.

So it is interesting to think about our star and consider exactly what it is, how it was formed and how it compares with the other trillions of stars in our universe. Another interesting concept is where does our Sun fit into the vast expanse of our universe?

We know our star is very much ‘middle of the road’ when we compare it to other stars. It is in the middle of the size of stars when comparing their mass. There are stars up to 100 times the mass of our Sun and others that are 100 times smaller. There are two features of our Sun that are a little different to many other stars these are: our Sun is very stable (fortunately for us) and our Sun is a singleton whereas about 60% of stars are in double or multiple star systems.



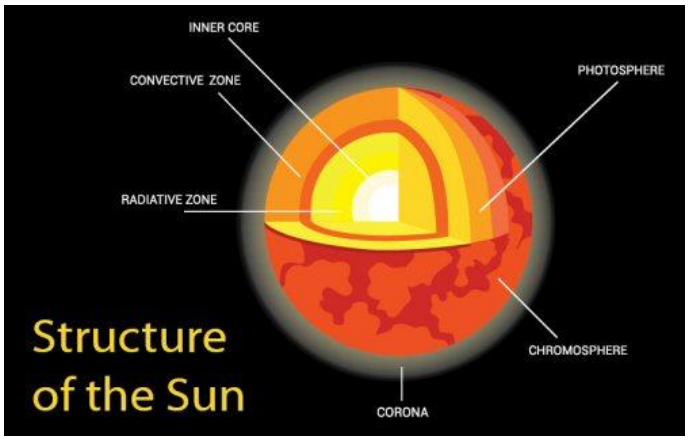
Our Sun is classified as a G7 type star

The most numerous stars are those that are smaller than the Sun. The smallest stars are called Red Dwarfs and they make up about 75% of all stars. Stars that are bigger than our Sun are less common with the biggest being very rare. This is because very massive stars consume their fuel supply (Hydrogen) much faster so they shine for a much shorter time.

Now let us consider what a star is and how it works. So a star is literally just a compressed cloud of gas. The most abundant stuff in the universe is Hydrogen gas that comprises about 89% with Helium gas 10% and all the other elements amounting to about 1%.

Within galaxies there are vast clouds of gas (Hydrogen and Helium) called a Nebula (plural Nebulae). The atoms of gas in the nebulae are drawn together by gravity to form denser areas within the nebula. As the denser areas gain more mass they increase their gravity to pull in ever more gas so they grow in mass and increase their gravitational influence.

Increased gravity compresses the gas and eventually it forms into a sphere. This is the smallest volume that the gas can be squashed into, much like squeezing snow into a snowball.



The structure of our Sun

As gravity continues to compress the sphere, the core pressure and temperature soar until the Hydrogen atoms are fused together to form atoms of Helium. This process produces heat causing the sphere of gas to heat up until it begins to shine and a star is born.

THE ANCESTRY OF THE SUN

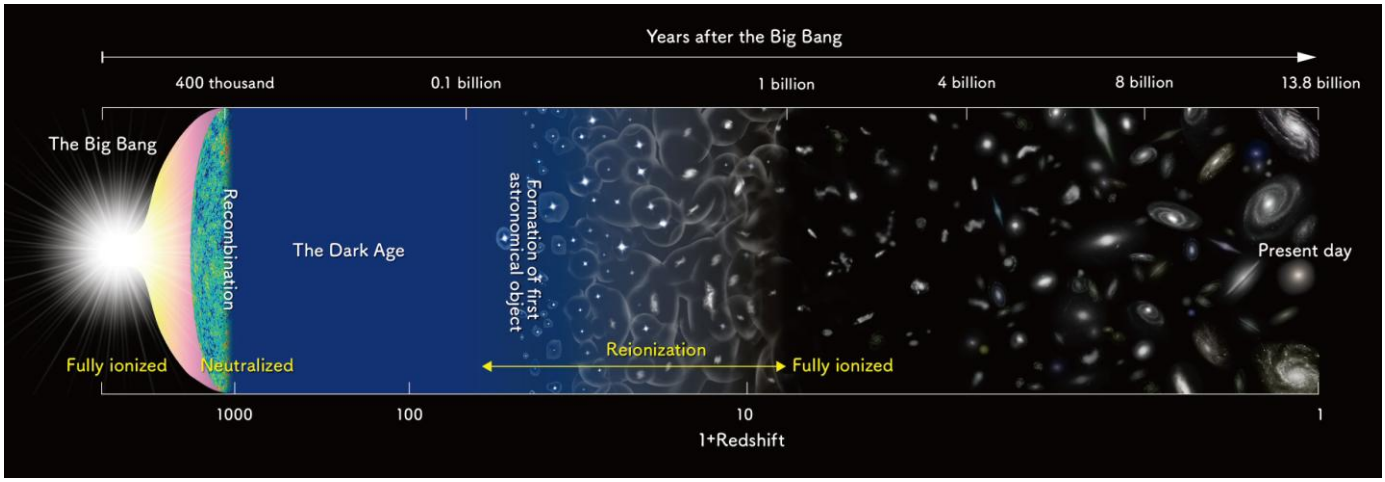


Diagram showing the developement of the Universe

Our Sun is a star and it is very important to us but in reality it is just one star amongst 200 billion stars in our galaxy that we call the Milky Way. If that sounds insignificant then it is even more insignificant when we consider that our galaxy is just one of the billions of galaxies in our Universe. So to consider how our Sun formed we must first think about where the materials that we call Elements (of Matter) came from and when.

The event that we call the 'Big Bang' occurred about 13.8 billion 'Earth' years ago. This is when time began for us and everything in our Universe was created. For us anything that happened or was there before the Big Bang has no meaning to us because we can never see out beyond our Universe, it is now too big and it is too far for us to see to outer the edges.

We cannot know what caused the Big Bang but we can speculate for ourselves as to what happened in the beginning. What we can say is there was an enormous release of energy and it occurred at a very small point.

We can see that the Universe, as we see it today, is expanding. If we look at the light coming from the galaxies around us we can see, by examining the light, that they are all moving away from each other (with a few exceptions). So if we work out the directions that the galaxies are travelling and we project their path back, they all appear to have come from the same place.

This means that in the past the Universe was much smaller and everything was much closer together. If we continue this thought back far enough then the whole universe appears to have started out from the same place. The trajectories of everything show that it all would have been in the same place about 13.8 billion years ago. So the 'Big Bang' could have occurred at an infinitely small point known as a 'Singularity'.

We don't know what caused the Big Bang but we do know that when it formed it was very small, very dense and very hot. In fact it was so dense and hot that it could not exist as any form of matter that we can conceive of today so with think of it being a ball of pure energy. It was too hot and too dense for any kind of what we call matter (atoms) to exist.

In the first second it expanded so fast that light could not escape from it this is called the 'Inflation' period. At this time the laws of physics that we know today did not exist so we think the universe expanded faster than the speed of light during this first phase.

The diagram above shows how the whole process when the Universe was created as a section of the expanding sphere. In this diagram time is marked along the top of the cone shape also see the diagram on the next page.

The term 10^{-18} represents a very small number preceded by a decimal point and 18 decimal places such as: 0.000,000,000,000,000,001 (or a trillionth of a trillionth of a second). The temperature shown as 10^{32} is a huge number represented by a number followed by 32 zeros. This high temperature is beyond our comprehension.

In the first 10^{-100} of a second the Singularity expanded exponentially (this is like growing 2x, 4x, 8x, 16x, 32x, 64x, 128x per unit of time). This caused the universe to inflate at unbelievable speed. After a very short time the super inflation phase stopped but the Universe still carried on expanding and cooling at a very fast rate.

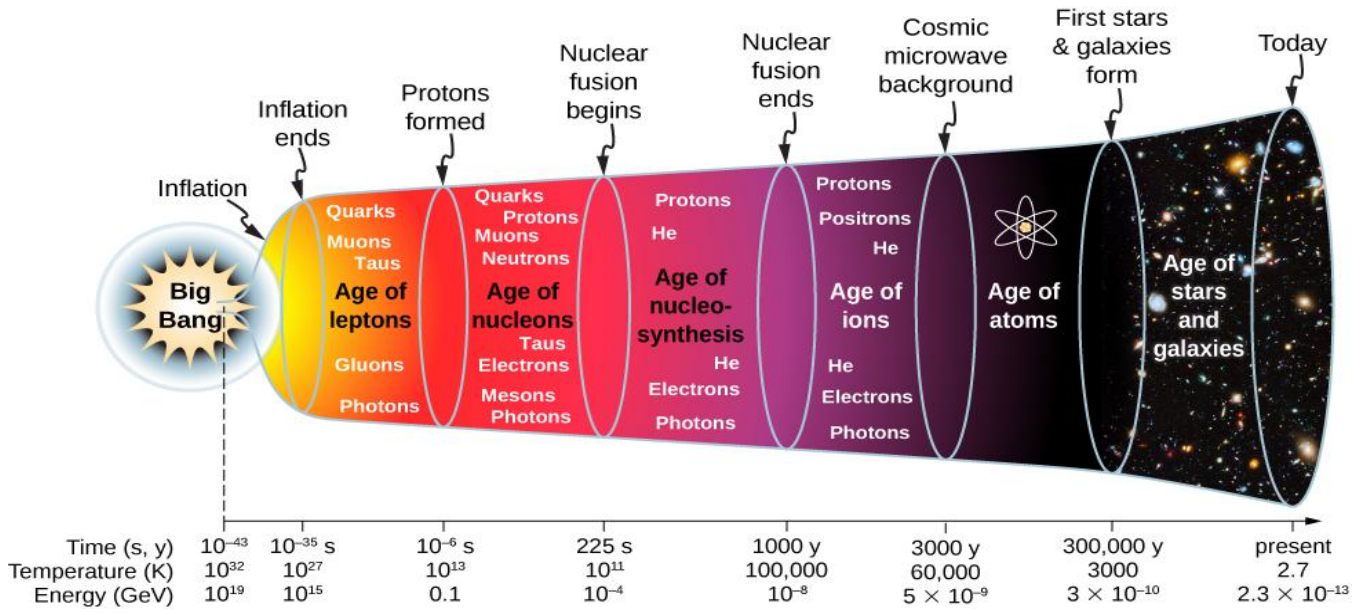
After it had expanded for 10^{-10} of a second the universe had cooled from 10^{32} degrees to 10^{27} degrees and sub atomic particles began to form. After 3 minutes the sub atomic particles began to create atoms. Over the next 300,000 years atoms formed as the free sub atomic particles were consumed by the forming atoms. The Universe became transparent and a flash of electromagnetic radiation (light) was released.

After this point the atoms began to be attracted to each other by their gravitational force. As the atoms moved closer to each other their combined gravitation pulled in more atoms to create denser regions within the expanding universe. On the largest scale the atoms were drawn into vast filaments like a spider web. This left equally vast empty spaces that we call Voids between the filaments where there are almost no atoms at all.

On a smaller scale within the filaments and particularly at the junctions of the filaments, large clouds of gas formed and started to create huge spinning clouds of gas that became galaxies.

At the smallest scale, within these developing galaxies, stars started to form. This star and galaxy formation began within the first 500million years. The very first stars were enormous Super Giant Blue Stars that exploded after just a few million years. These Supernova explosions produced the heavier elements.

HOW THE UNIVERSE DEVELOPED



A diagram showing the development of the Universe

We have already seen how the Universe began with the 'Big Bang' 13.8 billion years ago. Now we can consider how the unbelievably small, dense and hot fireball expanded and cooled into the complex Universe we can observe today.

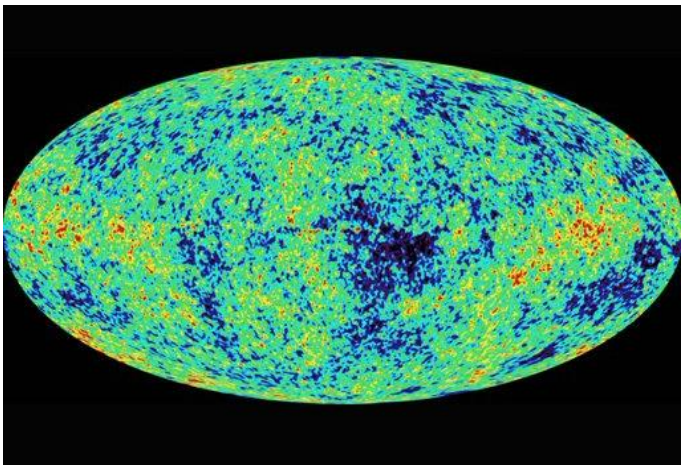
Things began to develop very fast immediately after the Big Bang. If we look at the horizontal scales at the bottom of the diagram above the time scale begins on the left using very small decimal fractions of a second.

In the next sub-second phase on the diagram the pure energy expanded and cooled enabling sub-atomic particles (proto-matter) to form. It seems very strange that matter can be created from energy but Albert Einstein's famous equation $E = mc^2$ shows us it is possible. If we mathematically transpose ($E = mc^2$) into ($m = E \div c^2$) then we have Mass (matter) created from Energy (E) divided by the speed of light squared (c x c). The sub-atomic particles are listed on the diagram (these are the building blocks of atoms).

In the next 1000 years the sub-atomic particles were forced together by the pressure and heat and started to create Protons (the positive (+) nucleus of an atom) and Electrons (the negative (-) particles orbiting a Proton). As a Proton and Electron fuse together they create an atom of Hydrogen gas. There were some fusion events that joined two Protons and two Electrons together to create an atom of Helium gas. Some sub atomic particles called Neutrons (similar to Protons but with no electrical charge neither + or -) but were able to be combined into the forming atoms to create stable isotopes of these atoms.

The Nuclear Fusion process also produced sub-atomic energy packets called photons that are the carrier of what will become light. However these photons could not leave the expanding fireball because it was too dense and opaque. After 300,000 years most of the subatomic particles had been converted into atoms and the universe became transparent. The photons could be released as electromagnetic waves (light).

This release of the electromagnetic waves was at the most energetic end of the scale. They were in the form of highly energetic and short waves of Gamma Rays and X-Rays but now appear as Microwaves. As the Universe and space expanded the X-Rays were stretched and now appear as longer Microwave electromagnetic waves.



The remnant of the Big Bang flash

The image above shows the Cosmic Microwave Background (CMB) which is the remnant of the original X-Ray flash from the Big Bang.

After about 300,000 years the Universe became transparent so the flash could travel through space. Gravity started to exert its effect on the matter that had been created. Atoms that were already moving due to the Big Bang were drawn together by their mutual gravity. As more atoms were drawn together their mutual gravity increased and pulled even more atoms together.

At the largest scales the atoms of Hydrogen and about 11% Helium were drawn into vast filaments stretching across the expanding Universe. At a smaller scale the atoms by virtue of their velocity (movement through space) began to form into great swirling clouds and eventually created spinning Spiral Galaxies.

As the Galaxies formed the gas was drawn into a thin disc around the central core of the galaxy. The movement in the disc caused denser clouds to form into smaller spinning discs that contracted to create stars. The heavy elements created by the first giant stars formed into planets that orbit some stars.

THE BIRTH OF STARS IN GALAXIES

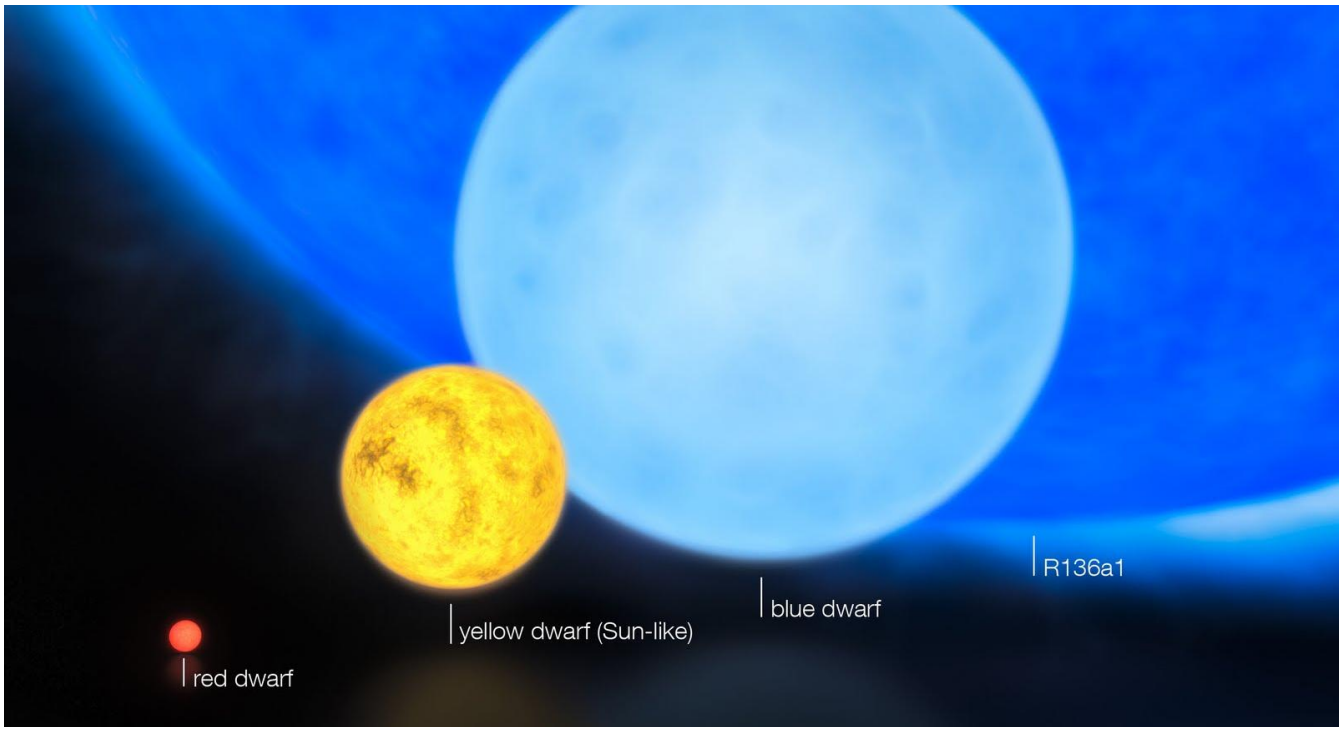


Diagram showing the range of sizes of stars

We have already seen how the Universe began with the 'Big Bang' 13.8 billion years ago. Now we can consider how the unbelievably small, dense and hot fireball expanded and cooled into the complex Universe we can observe today. Things began to develop very fast immediately after the Big Bang.

After 300,000 to 400,000 years the first stars began to form as at the larger scale atoms began to be drawn together into filaments. With all Hydrogen and Helium drawn into dense filaments vast voids with almost no atoms were left between the filaments.

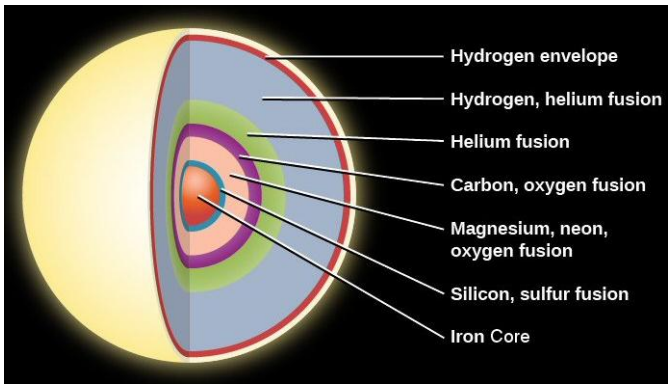
On a smaller scale within the filaments and particularly at the junctions of the filaments, large clouds formed and became galaxies. At the smallest scale, within these developing galaxies, stars formed. This star and galaxy formation began within the first 500million years

At this early stage all the matter (mainly Hydrogen atoms with 10% Helium) was still close together but expanding. As there was so much matter in a relatively small volume the very first stars were able to grow very large and very quickly. These stars were mainly Blue Super Giants that were over 300 times the mass of the Sun. Giant stars are exponentially more powerful than smaller stars and use up their fuel exponentially faster so they don't 'live' very long, the largest lasted just a few million years.

A giant star has so much extra gravity to compress the core so that the Helium can be fused into heavier atoms in sequence. The sequence of atom production from the original Hydrogen is: Helium, Carbon, Oxygen, Neon, Magnesium, Silicon and finally Iron.

The Iron at the centre of the core does not contribute any additional energy so the atom production fusion process cannot continue on to even heavier atoms. When the mass of the Iron core reaches 1.44 times the mass of our Sun it collapses to momentarily create a White Dwarf. With additional mass falling on to the core it continues to collapse and becomes a Neutron Star.

With additional matter falling in on the core it exceeds the limits for a Neutron Star (2.7 time the mass of our Sun) to form a Black Hole. In a Super Giant Star the process of the core collapse produces an enormous explosion that may form a Black Hole or may completely destroy the star. The elements that the Supernova has created will be distributed into the surrounding nebula to be incorporated into stars forming later in the nebula.



The core of a Giant Star

As a giant star explodes as a Supernova other elements heavier than Iron are also be created. They are blasted away and become mixed with the Hydrogen of the original nebula. The blast from the Supernova disturbs the gas in the nebula to start the formation of new stars. As the next generation of stars form they will contain the heavier elements created in earlier giant stars. This process continues with new stars containing increasingly higher proportions of heavier elements created.

Smaller stars, like our Sun cannot fuse atoms beyond Carbon so they end their life in a different and gentler way than their giant relations. They swell to become Red Giants but they do not explode as a Supernova. When the Hydrogen and Helium fuel is exhausted the star gently collapses to form a tiny but very dense White Dwarf Star that is about the same diameter as Earth.

THE BIRTH OF OUR STAR THE SUN

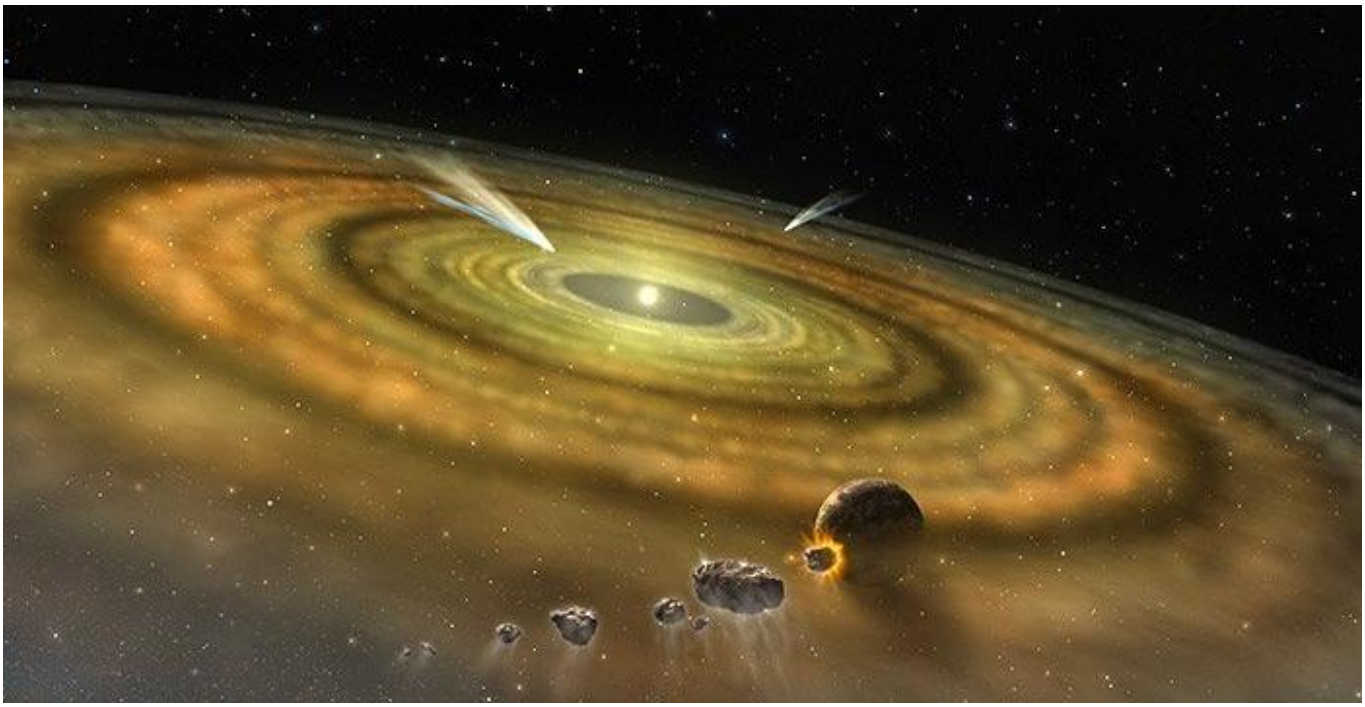


Diagram showing the formation of our Solar System

Our Sun formed in a Nebula (a cloud of gas and dust) in the spiral arm structure of a Giant Spiral Galaxy that we call the Milky Way about 4.5 billion years ago. The nebula where our star formed had been heavily contaminated with dust particles from many previous generations of giant stars. These giant stars had exploded as Supernovae over the previous billions of years.

The Nebula would have looked something like the Great Nebula Messier 42 (M42) in the constellation of Orion the Hunter. See page 8. As gravity pulled the gas and dust into denser clumps, the momentum (speed) of the gas and particles caused the developing dense clumps to form into rotating discs. Most of the gas and dust was pulled into the centre of the disc where the greatest mass was concentrated and the force of gravity was greatest.

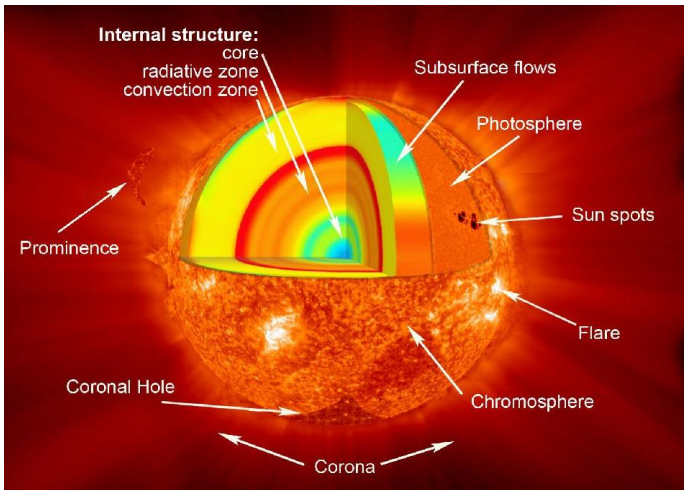
The centre of the disc formed into a dense sphere of gas (mainly Hydrogen) and a mix of other elements. The pressure in the core of the sphere of gas increased to millions of times the pressure of our atmosphere. The increasing pressure caused the temperature at the core to increase to millions of degrees.

With the high temperature and with the atoms forced together by the enormous pressure the Hydrogen atoms were fused together to form a new atom of Helium gas in the process called Nuclear Fusion.

A Hydrogen atom has one Proton as its nucleus with one electron orbiting the Proton so it is the simplest atom and most abundant in the Universe. A Hydrogen atom can also have a particle called a Neutron attached to its Proton which adds mass and makes it an isotope of Hydrogen that we call Deuterium.

The Helium atom produced by the fusion of two Hydrogen atoms will have two Protons and two electrons and may have one or two Neutrons depending on the two Hydrogen atoms that were fused. The created Helium atom will weigh a little less than the two Hydrogen atoms that had created it.

As mass and energy are interchangeable but cannot be lost, the lost mass will have been converted to energy. The energy is released as a flash of X-rays that add heat to the core of the developing star. Atoms are very close together in the core and they absorb the X-Rays and then re-emit the energy until the X-Rays eventually reach the Convection Zone outside of the Core. Here the X-rays heat the Hydrogen gas which rises to the surface by convection where it radiates the energy into space as visible light and the star begins to shine.

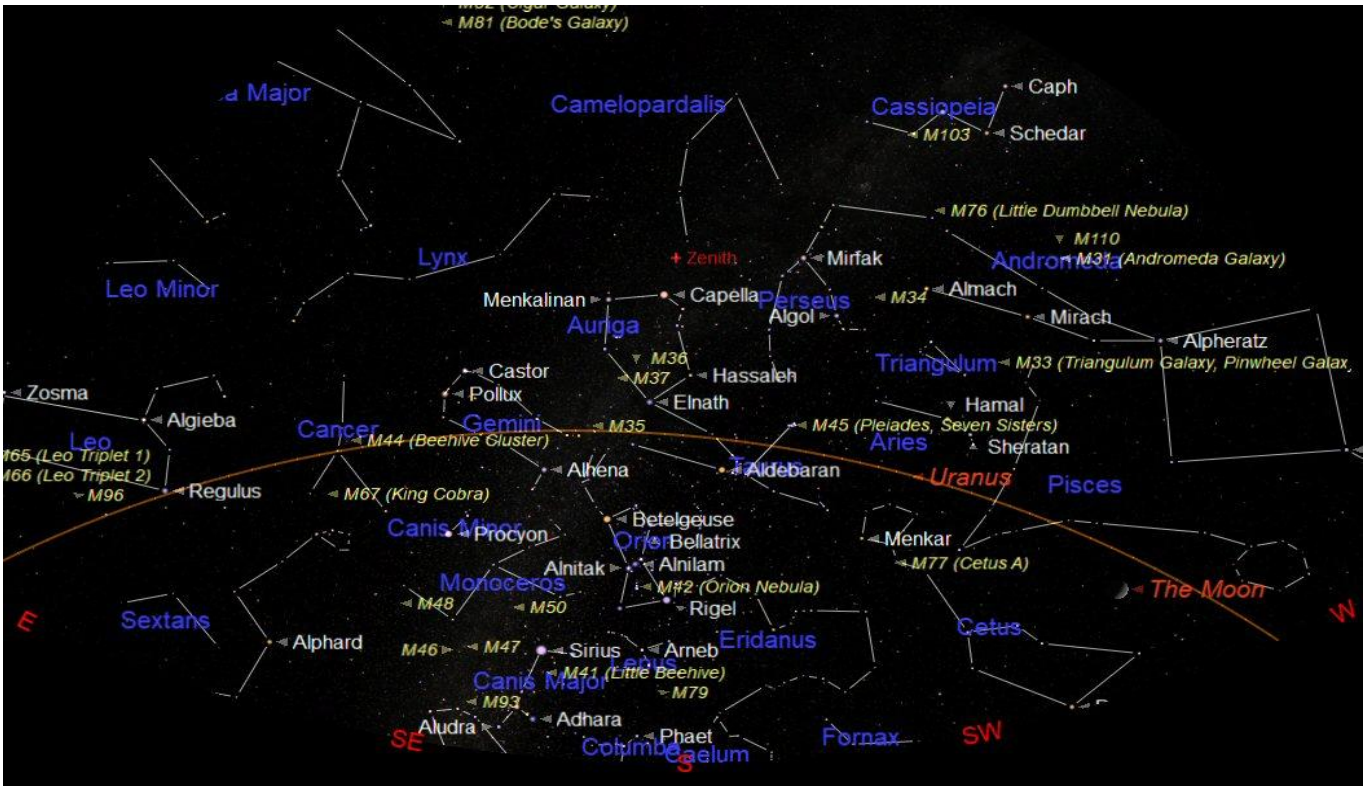


The structure of our Sun

Helium from the Nuclear Fusion process is heavier than the Hydrogen atoms so they sink to the centre of the core where they accumulate. Our Sun had enough Hydrogen fuel to last about nine billion years. It is now about 4.3 billion years old so it is about half way through its 'life'.

In another 4 billion years the hydrogen will start to run out. Helium that accumulated in the core will begin to fuse to produce Oxygen and Carbon atoms that will add heat to the star and cause it to inflate to become a Red Giant. Finally it will gently collapse to form into a tiny but very dense White Dwarf Star.

A TOUR OF THE NIGHT SKY - JANUARY 2022



The chart above shows the night sky looking south at about 21:00 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 and is shown (in red) at the upper centre of the chart. The curved brown line across the sky at the bottom is the Ecliptic or Zodiac. This is the imaginary line along which the Sun, Moon and planets appear to move across the sky. The brightest stars often appear to form a group or recognisable pattern; we call these 'Constellations'.

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

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

The southern sky is now dominated by 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). Orion is easily found by looking for his very obvious three stars of his belt. Orion has his Hunting Dogs Sirius (the big dog) and Procyon (the little dog) to the east (left) and following him. Orion is the featured constellation for this month, on the next page.

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 Ecliptic was low in the sky during the summer months so the Moon and planets appeared close to the southern horizon. Saturn, Jupiter, Neptune and Venus are now moving towards the western horizon and out of view. Uranus is still well placed for those who are fortunate enough to have access to a telescope. Mars is still located on the other side of the Sun so it appears small, close to the Sun and difficult to see.

CONSTELLATION OF THE MONTH – ORION

The Constellation of Orion photographed by Nicky Fleet

Orion (the Hunter) is one of the best known constellations and one of the easiest to recognise and begins to dominate 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 and remember 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. See the chart on the next page.

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. They were normal stars that had reached the end of their lives and used all their Hydrogen fuel. They have collapsed to become very compact and dense White Dwarfs stars.

M42 THE GREAT NEBULA IN ORION

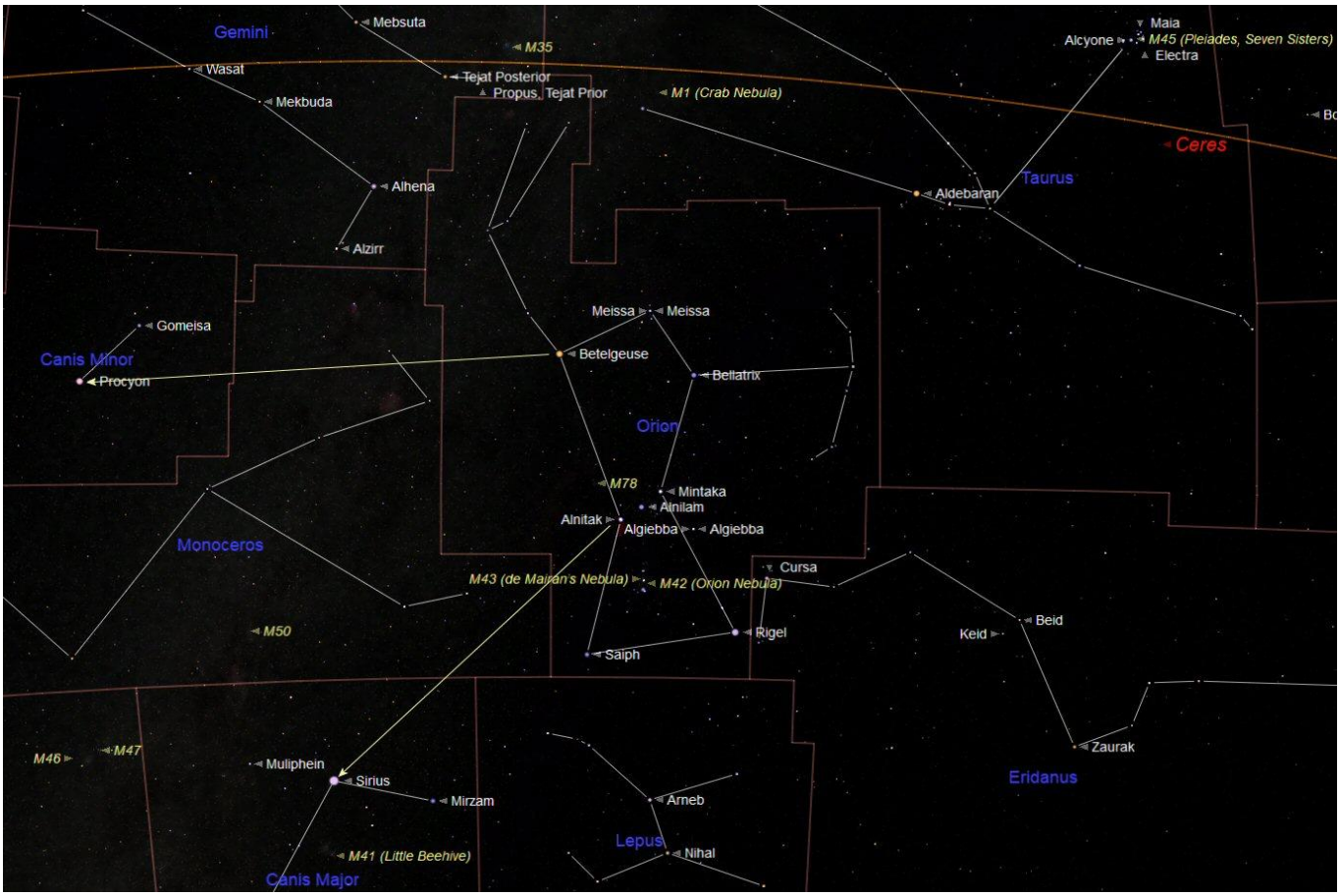
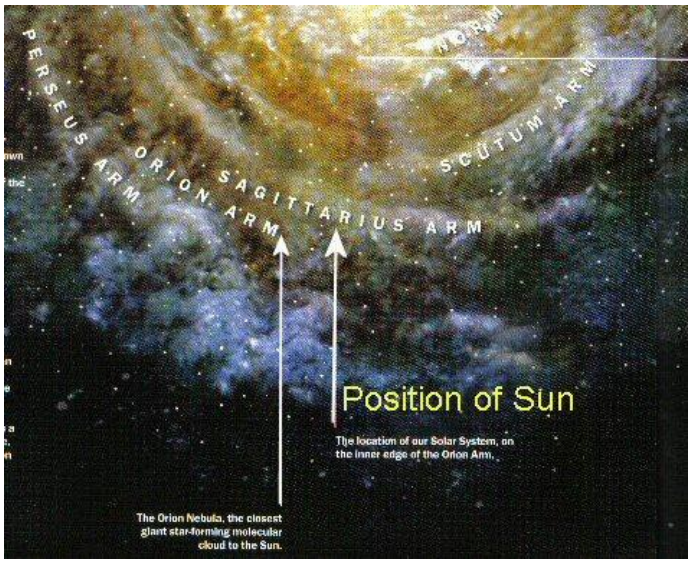


Chart showing M42 the Great Nebula in Orion

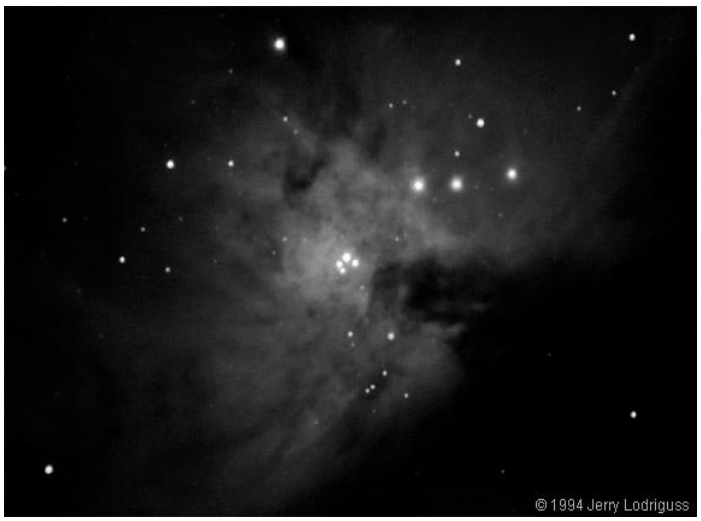
When we look towards Orion we are looking into one of the nearest spiral arms of our galaxy the Milky Way. Our Sun appears to be located in the area between two spiral arms. Towards the centre of the galaxy from our point of view is the Sagittarius Arm and looking away from the centre is the Orion Arm.



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 part of 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 'fan shaped' 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 part of the 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.

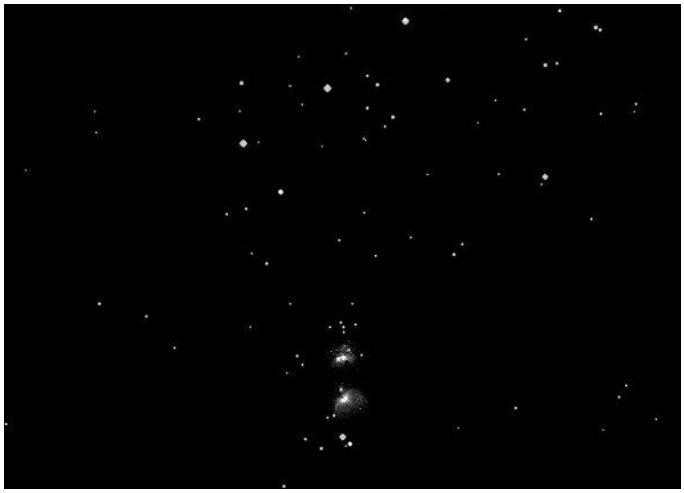
Stars forming in M42

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

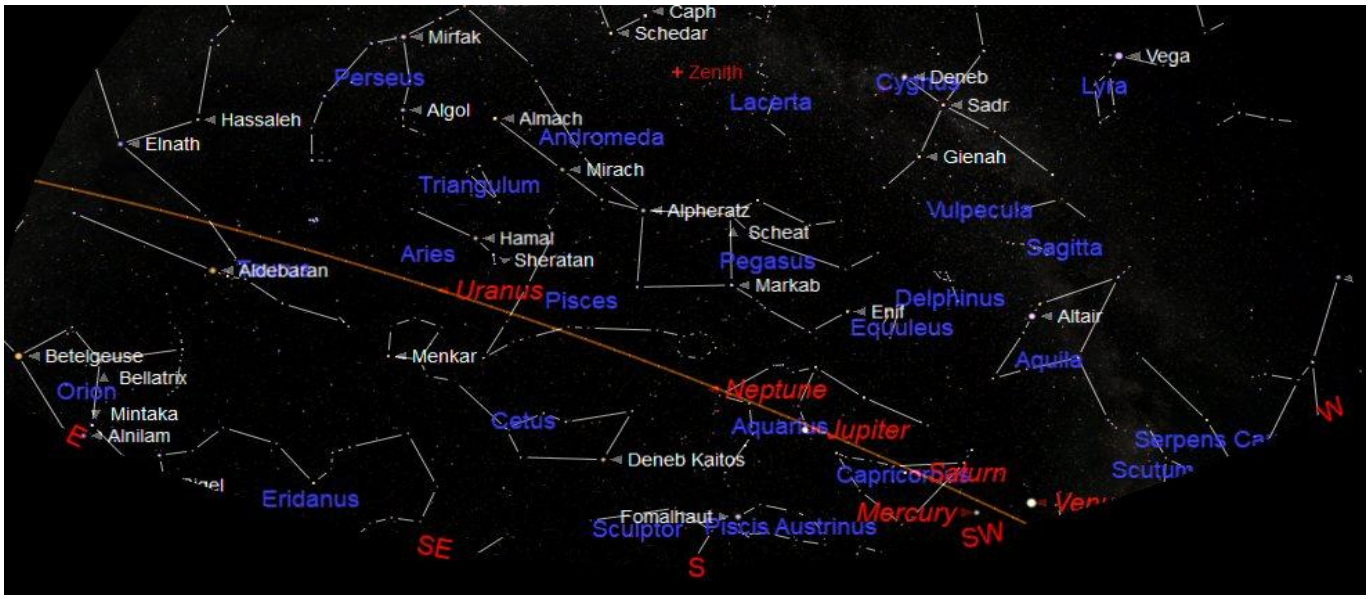
A small telescope will show a larger view and some detail in M42. Structure in the nebula can be seen with parts of the nebula illuminated and other parts appearing dark.

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 excited Hydrogen gas in the nebula.

A photographic image of M42

THE SOLAR SYSTEM - JANUARY 2022

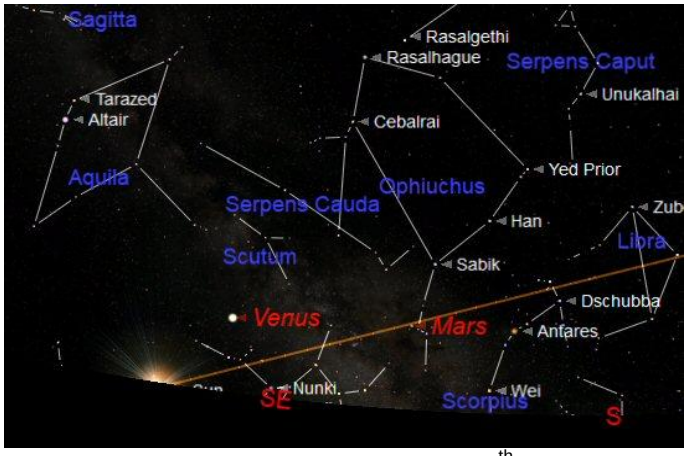


The planets at 17:00 GMT on 1st January 2022

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

MERCURY will be very close Saturn the just after sunset early in the month in the west but will be difficult to see this month. It will be in conjunction on 23rd January

VENUS will be moving into inferior conjunction on 9th January, when it will pass between Earth and the Sun (but above the Sun). It will be at its largest diameter but as its narrowest crescent. It will reappear in the early morning sky near the Sun at sunrise next month.



Mercury and Venus at sunrise on 15th January

MARS is on the other side of the Sun (so appears very small) and is still very 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 be visible in the south west as the sky darkens before sunset. It will be at its rather poor best in the south at about 17:00 but it will be moving towards the western horizon to set at about 20:30. It will start to be visible in the morning sky in the next few months.

SATURN is now bidding us goodbye until next year. It will be difficult to see in the turbulent air close to the south western horizon after sunset. Saturn will set over the western horizon at 18:30.

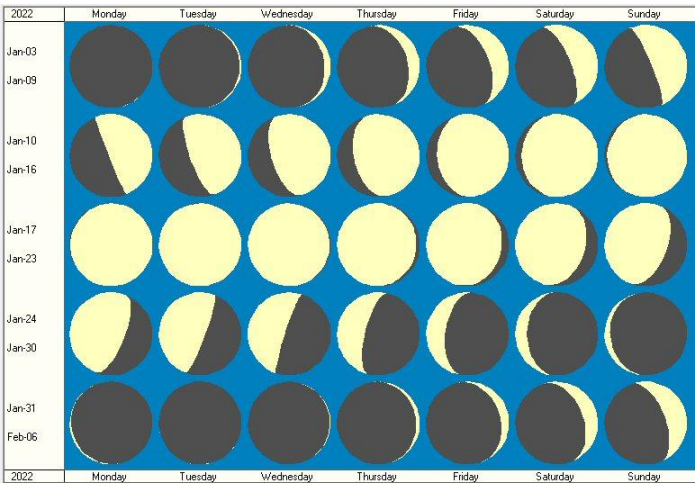
URANUS will be observable this month and will be best at 21:00 when it will be due south and at its highest point above the horizon but is small and faint at +5.7.

NEPTUNE will be just visible to the east of Jupiter and will be at its best at 16.30 as the sun sets. It is small a difficult to see at only 2.9 arc-seconds in diameter and at magnitude +7.7.

THE SUN

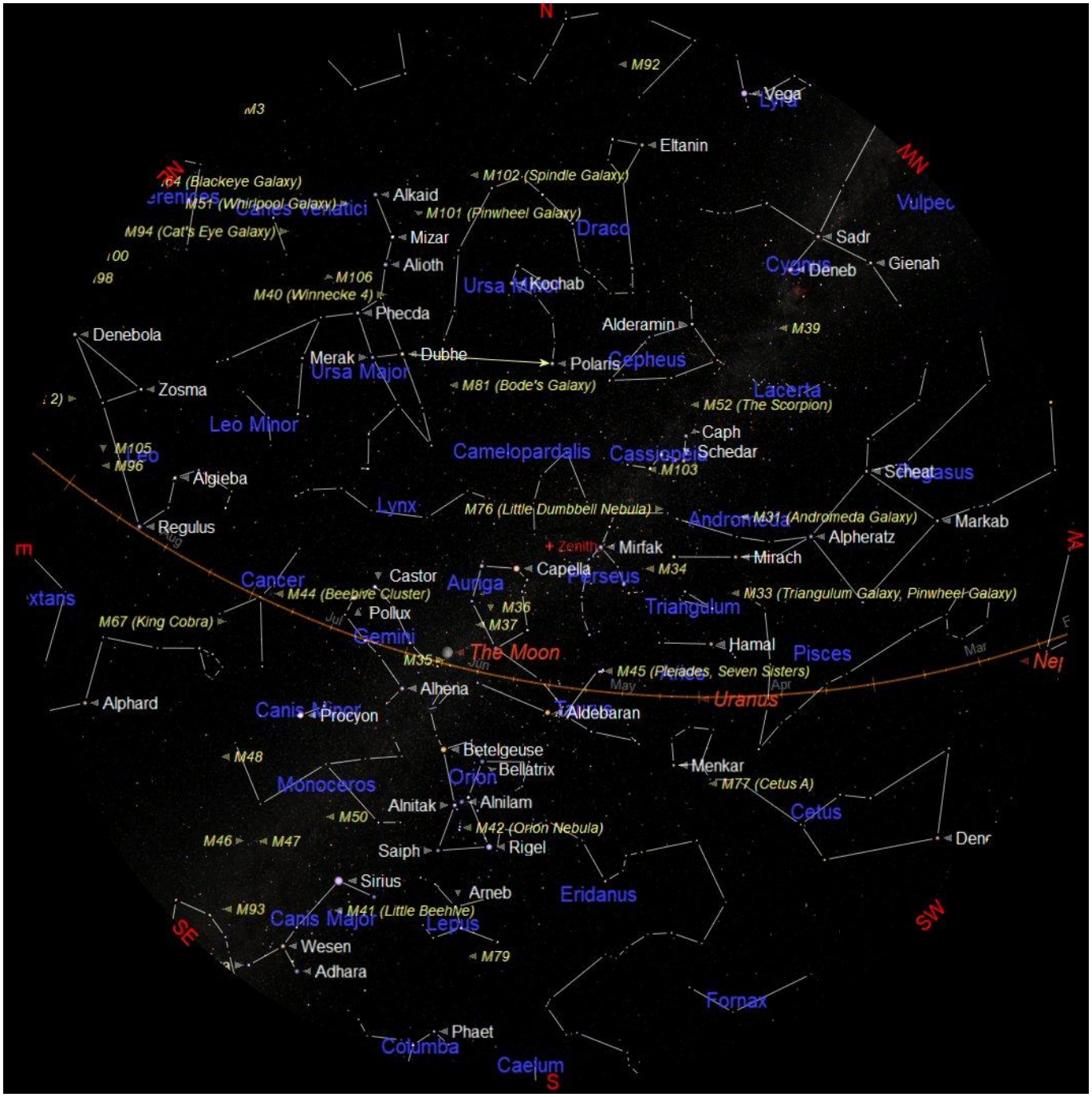
The Sun rises at about 08:00 at the beginning of the month and 07:35 by the end. It sets at 16:30 at the beginning of the month and 16:00 at the end of the month. It was at its lowest point in the sky on 21st December and at the Winter Solstice. That was the longest night at 16 hours and shortest day at just 8 hours long. There have been a few small Sunspots recently.

THE MOON PHASES DURING JANUARY



New Moon will be on 2nd January
First Quarter will be on 9th January
Full Moon will be on 17th January
Last Quarter will be on 25th January

THE NIGHT SKY – JANUARY 2021



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

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

Planets observable in the evening sky: Neptune (in the early evening) and Uranus later.