NEWBURY ASTRONOMICAL SOCIETY
MONTHLY MAGAZINE – AUGUST 2020

COMET 2020 F2 (NEOWISE)

Comet 2020 F3 imaged by Steve Knight

Comet 2020 F3 (NEOWISE) has graced the night sky since early July and is now moving away and will not return for over 6000 years. It is fair to say that this comet has exceeded expectations after so many recent disappointments. It has reach naked eye visibility even in light polluted areas such as Thatcham.

The comet imaged by Emma Chivers Thatcham

The image above was taken by Emma using just her mobile phone camera through the window in her roof.

The comet has been close to the northern horizon and has therefore needed a clear view to north. The bright star Capella in the constellation of Auriga has been a useful guide to help with locating NEOWISE (see Emma's picture, on the right edge half way up).

In a darker sky the comet has been easy to spot and well within 'Naked Eye' capability. It reached Perihelion (closest approach to the Sun) on 3rd July. It stayed at naked eye brightness until its closest approach to Earth on 23rd July. It had reached a magnitude of around +3 and was even visible in light polluted areas but perhaps requiring binoculars in the more light polluted areas.

Comet 2020 F3 should stay within naked eye visibility into August in the darker areas as it speeds through Ursa Major (the Plough) and into Coma Berenices but fading as it goes.

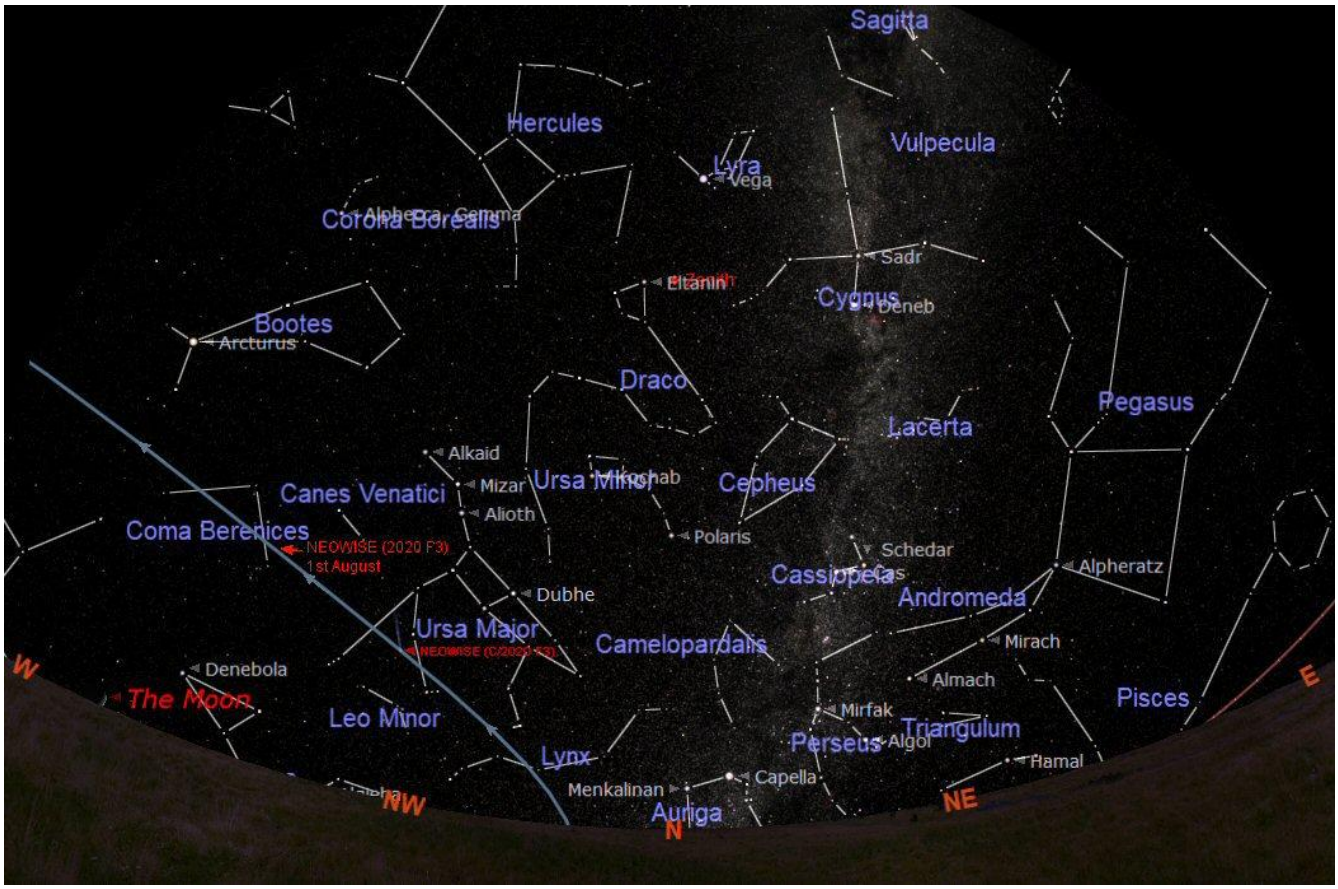
NEWBURY ASTRONOMICAL SOCIETY MEETING

7th August	Astro Photos (Zoom meeting)
Website:	**www.newburyastro.org.uk**

NEXT NEWBURY BEGINNERS MEETING

19th August	Comets and Meteors (Zoom meeting)
Website:	**www.naasbeginners.co.uk**

COMET 2020 F2 (NEOWISE)



The orbital path of Comet 2020 F2 (NEOWISE) looking to the north

The chart above shows the path of Comet 2020 F2 (NEOWISE) as it speeds across our sky. The path is marked where it was in line with the Polaris Pointers in Ursa Major. These are the two stars in the saucepan shape of Ursa Major (the Great Bear) furthest from the 'handle' of the saucepan. We usually use these to point up to the Pole Star but we were able to use the Pointers to help find the comet around 23rd July.

The image below was taken using a DSLR camera mounted on a tripod and set to manual operation. So the focus was set manually and the exposure set to 25 seconds and making sure the flash was turned off. It took some trial and error to get the image right but a reasonable result was achieved in the end.

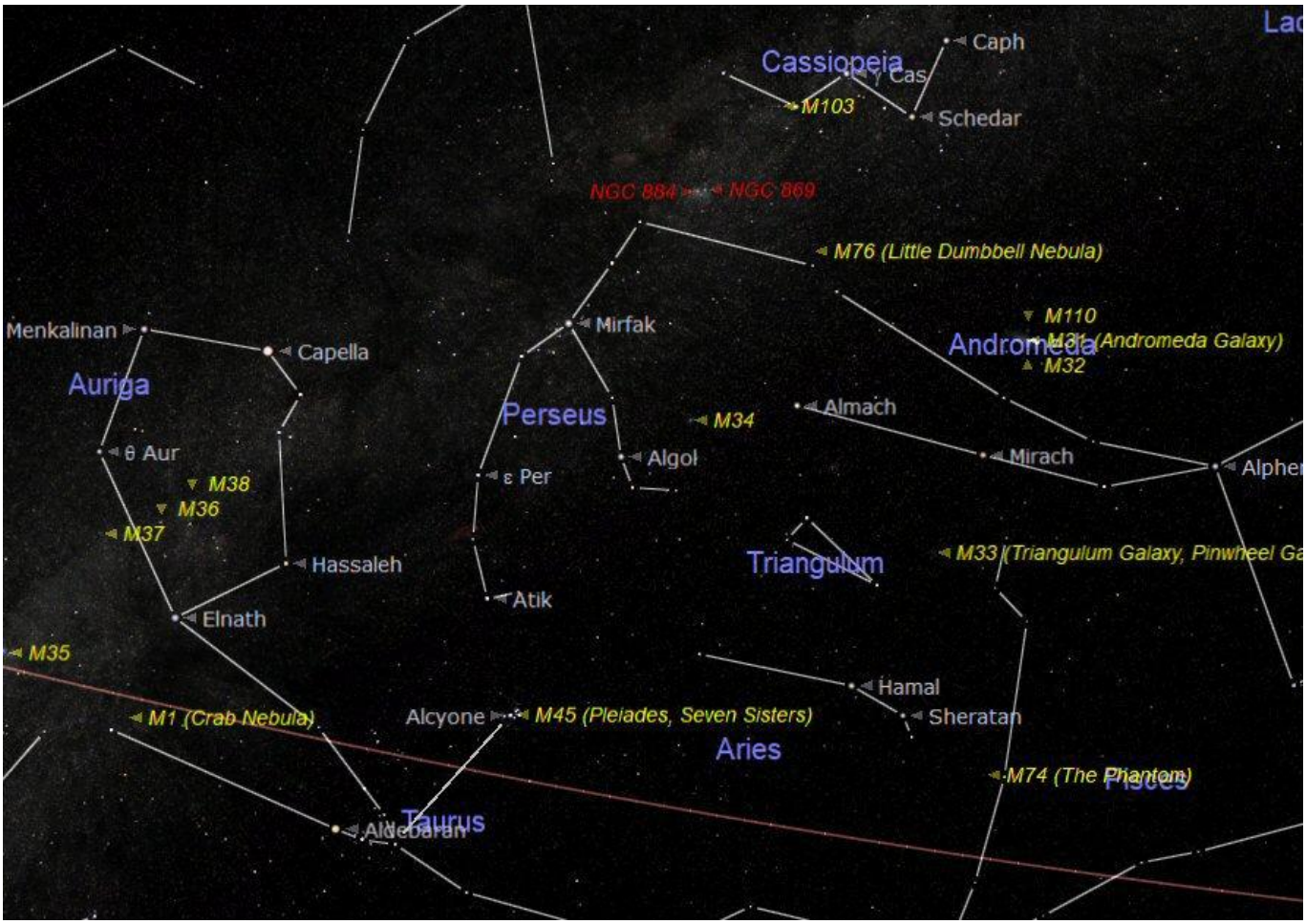
Comet 2020 F3 imaged by Steve Harris 17th July

The bright coma is well defined in the image as was described by other observers. The location was in a 'pull in' by the roadside on Burys Bank at Greenham Common looking over Thatcham to the north.

Comet 2020 F3 imaged by Steve Knight

The image used 36x 10sec exposures from a Sony A7S with a 135mm f2 lens on Astrotrac and was set at ISO 6400. The 36 images were stacked in DSS and processed in Pixinsight and Faststone Image Viewer.

The constellation of Perseus



Perseus is our constellation of special interest this month because it is host to the Radiant of the Perseid Meteor shower. The other articles in the magazine this month give the details of the meteor shown but the constellation of Perseus has interesting things to see as well.

The asterism (stick figure shape) looks rather like a horse riding stirrup. The two brightest stars Algol and Mirfak along with the fainter star Atik mark out the 'V' main shape with another line of stars pointing from Mirfak towards the very obvious 'W' shape of Cassiopeia.

Other constellations around Perseus are: Cassiopeia to the north, Andromeda to the west (right) Auriga to the east (left) and Taurus to the south (below). Continuing the line of stars from Mirfak to Atik the beautiful Open Cluster of stars Messier 45 (M45) the Pleiades also called the Seven Sisters can be found in the constellation of Taurus (the Bull).

During the summer months Perseus is located in the north close the horizon so that is where it can be found this month. During the winter it is located almost overhead and during November and December is actually host to the Zenith (the point in the sky directly over head).

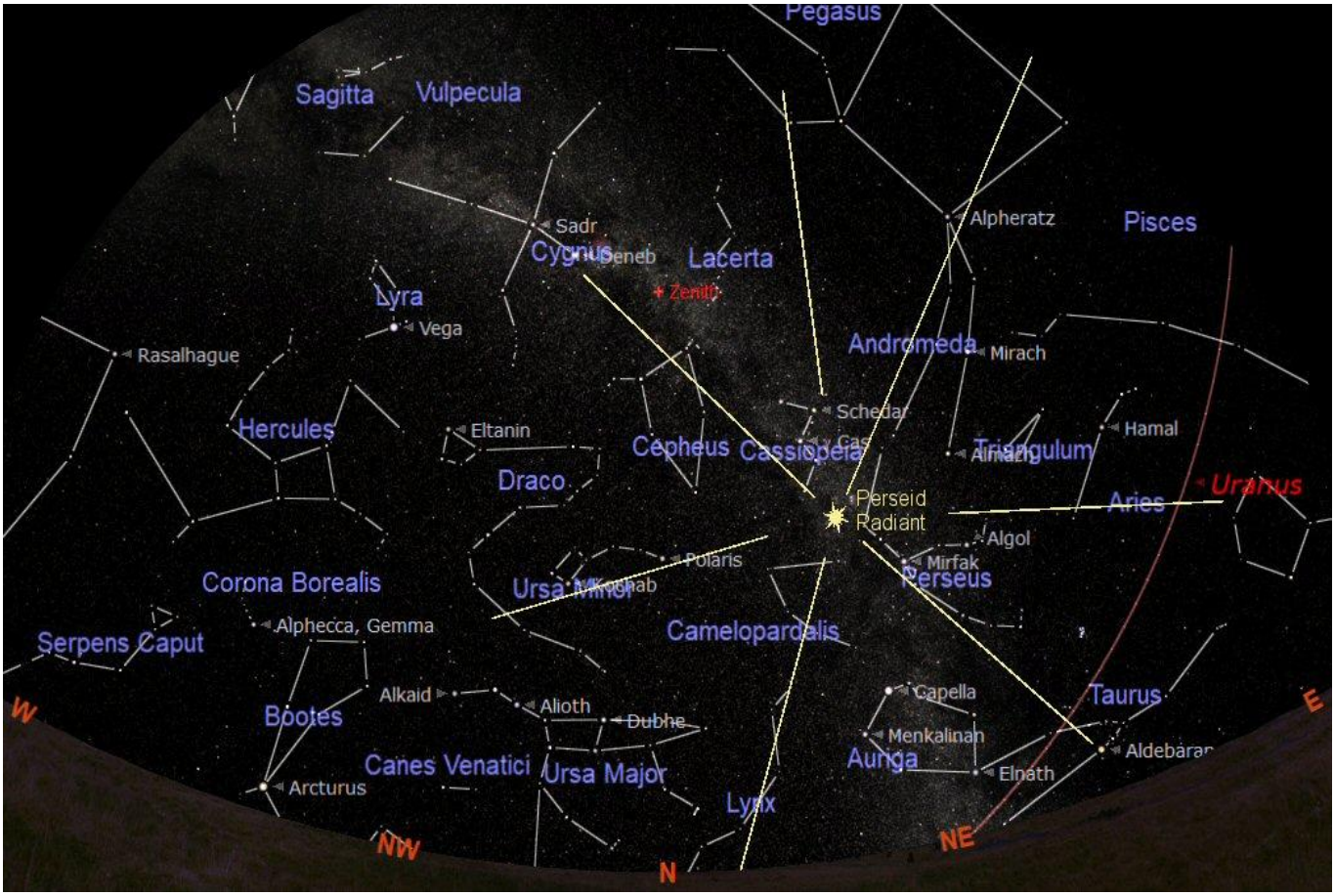
Perseus is also host to two Messier 'deep sky' objects Messier 34 (M34) and Messier 76 (M76). M76 is a rather nice Planetary Nebula which is sometimes called the Little Dumbbell. This is a star similar to our Sun that has collapsed to become a White Dwarf and has developed a 'bubble' of gas around it. It does need a medium sized telescope to see.

Messier 34 is a fairly bright Open Cluster comprised of about 80 stars. It can be seen as a small 'fuzzy' patch of light using binoculars but does need a telescope to see as a cluster of stars. However there is another Open Cluster or rather two clusters called the Double Cluster that is listed in the New General Catalogue as NGC 869 and NGC 884 and shown in the image below.

NGC 869 and NGC 884 the Double Cluster

The Double Cluster can be seen on a clear dark night with the 'Naked Eye' as a 'fuzzy patch of light in the line of stars leading from the star Mirfak up towards the constellation of Cassiopeia. It is best seen using binoculars or a small telescope fitted with a low power eyepiece (25mm or 32mm). It is not clear whether this is a true associated double cluster or just a 'line of sight' coincidence.

THE PERSEID METEOR SHOWER



The Perseid Meteor Radiant at 01:00 14th August looking north

Meteor showers are notoriously unpredictable. The exact time of any spectacular increase in numbers or if the meteors will be bright is difficult to predict as is the clear weather needed to see them. However every year on the evenings of the 11th and 12th August there is always a spectacular display from the Perseid Meteor Shower.

Unfortunately this year there will be a bright Last Quarter Moon rising in the east on the 12th August so some of the fainter meteors may be drowned out. The meteors of a shower appear to radiate from a point in the sky that is called the 'Radiant'. The meteors of this particular shower appear to originate from a 'Radiant' point in the constellation of Perseus. See the chart above also the previous page and last page of this magazine.

If the trail of any meteor that is seen can be tracked back and found to have originated from this radiant point it will be a Perseid. A few meteors might appear to originate from other directions so these are the meteors that might be seen randomly and not part of any named shower. These are known as Sporadic Meteors.

From a clear dark site, the constellation of Perseus can be clearly seen as a line of stars stretching from the very distinctive 'W' shape of Cassiopeia towards the northern eastern horizon. The brighter stars appear to mark out the rough shape of a horse riding spur. See page 3.

If the sky is clear the Milky Way (our galaxy) can be seen rising up from the northern horizon passing through Perseus, Cassiopeia and right across the sky though Cygnus and the Summer Triangle. The bright star Capella in the constellation Auriga will be twinkling noticeably close to the northern horizon.

No special equipment is required to see meteors but it does pay to make yourself comfortable for a meteor watch. It is essential to dress to keep warm. A warm coat should be worn along with a good thick pair of trousers or perhaps an extra pair of trousers or long legged underwear can be worn for additional comfort. It can get very cold during the night even during the summer. A garden lounger will make the observer much more comfortable and avoid getting a stiff neck from looking up for too long. It will also allow an extra blanket to be used if it is chilly.

Observing can start as soon as it is dark but there is likely to be more meteors after midnight. Position the lounger so that the northern horizon can be seen. Look at about 45º above the horizon and anywhere between west, through north and to the east. Meteors will appear as a fast streak of light flashing across the sky. One or two meteors every five to ten minutes may be seen.

Some might be faint and difficult to see from a well-lit area in the towns. Any bright meteors will be seen even from fairly light polluted skies. These may appear anywhere in the sky from close to the radiant in the north to directly overhead. With a clear sky it may be possible to follow the tracks back through the constellations they passed through to the radiant point in Perseus. See the images on the next page.

The following pages give guidance for observing meteors and some background information about where meteors come from, what they are, how and where is best to observe them.

WHAT IS A METEOR?

Driving into a snowstorm

A meteor shower radiant

On any clear night if you sit back and look up into the night sky for a while you will more than likely see a streak of light speed across the sky - this will be a METEOR or shooting star. It is not a star at all it is just a small speck of dust known as a METEOROID entering the Earth's atmosphere at very high speed. Just as the space shuttle or other space craft become very hot as they re-enter the atmosphere at about 30 thousand km/h. However these dust particles get even hotter at their re-entry speed of up to 270 thousand km/h. At this speed the dust is vaporised by the heat and the surrounding air is also heated until it glows in a similar way to a fluorescent light.

There are two types of Meteor, the first is thought to originate from the large lumps of rock and iron left over when the planets formed, known as ASTEROIDS. Most asteroids orbit the Sun in a belt between Mars and Jupiter. The huge gravitational forces exerted by Jupiter may have pulled the rocks apart before they could accumulate into a planet.

Very rarely two asteroids may collide but when they do, chips of rock and Iron are thrown off and occasionally may head towards Earth. These can be a few millimetres across or up to tens or even hundreds of metres across. They are quite rare and are seen as individual 'fireballs'. Large ones can sometimes impact the ground as METEORITES and may even cause craters.

The second type of meteor originates from a comet and is much more common. Comets are large lumps of ice, typically between five and thirty kilometres across that reside beyond the orbits of the outer planets. There are millions of these objects just sitting there quietly orbiting around the Sun at enormous distances.

Occasionally one of these objects may be nudged out of its orbit by a close encounter with another object and may begin to move in towards the Sun. A comet can be thought of as being like a giant dirty snowball. As it approaches the Sun, the water and frozen gases begin to boil off and are blown away by the radiation from the Sun. This gas and dust will form the familiar twin tails associate with comets. See the following pages.

Dust particles released by the melt are heavier and therefore continue more or less on the same orbit. These particles spread out along the orbital path and may eventually form a complete ring around the orbit.

Comet Hale Bopp 1998

Once or twice a year Earth may pass through this stream of particles that then collide with the atmosphere as Meteors. Meteoroid dust particles are usually small and very light and generally have the consistency of cigarette ash but are travelling very fast (~50 km/sec.).

The clarity of the sky will make a significant difference to the number of meteors that can be seen. Any mist or hazy cloud will severely reduce the chance of seeing the fainter meteors especially if observing from a light polluted area. If it is cloudy there is of course less chance of seeing any meteors at all. It is never possible to predict exactly when the maximum peak might appear and sometimes it may not appear at all. This it because the dust from the comet that produces the meteors moves through space in wisps and filaments. All depends on whether Earth passes through a filament and how thick that filament is.

Travelling at between 11 and 76 km per second meteors have a lot of kinetic energy (energy due to velocity) and burn up in the atmosphere at a height of about 100 km. Only the largest rocky or metal meteors from asteroids reach the ground. So all the meteors originating from comets burn up in the upper atmosphere and present no danger to us.

The only thing that is predictable about meteor showers is they will always be unpredictable. Just hope for clear skies and a good shower.

WHAT IS A COMET?

Throughout history comets have been regarded as bad omens and harbingers of doom. They have been depicted on paintings and other works of art and shown as being in the sky when important events have occurred. Probably the best know is on the Bayeux Tapestry which shows the events around the invasion of England by William the Conqueror in 1066.

Halley's Comet shown on the Bayeux Tapestry

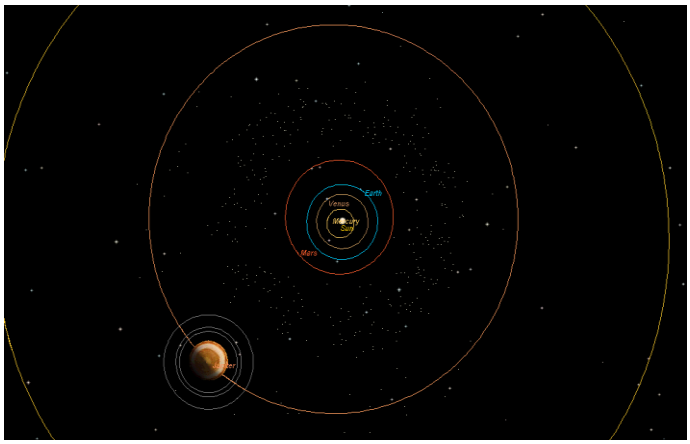
The men on the left of the image above are pointing at the comet so it was obviously regarded as something important in relation to the invasion.

With the tremendous advances in modern science and technology we now know what comets are, where they come from and how they appear in our sky. In this article we will be looking at where the comets originate how they formed in the first place and how they become visitors to our sky.

WHERE DO COMETS COME FROM?

Comets come from the outer reaches of our Solar System and there are millions of potential comets out there. They reside in two areas outside the orbit of the most distant planet Neptune.

The four inner planets of our Solar System are: Mercury, Venus, Earth and Mars and are all 'Rocky' planets with an Iron core. They orbit relatively close to the Sun and are known as the 'Terrestrial' (Earth like) Planets.

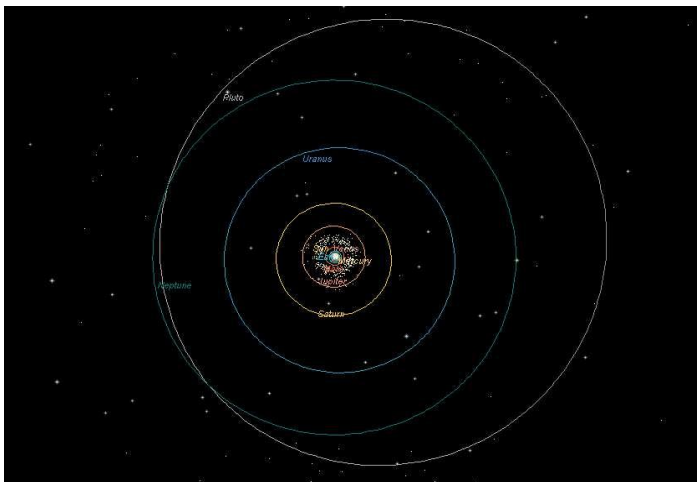


The Inner Solar System and Jupiter

The terrestrial planets, shown at the centre of the diagram above, have orbits that are comparatively close together and almost equally spaced from each other.

Between the orbits of the inner 'Terrestrial' planets and the outer four planets there is an orbital space but there is no planet. However this space is occupied by many thousands of lumps of rock, Iron and Nickel that we call the Asteroid Belt.

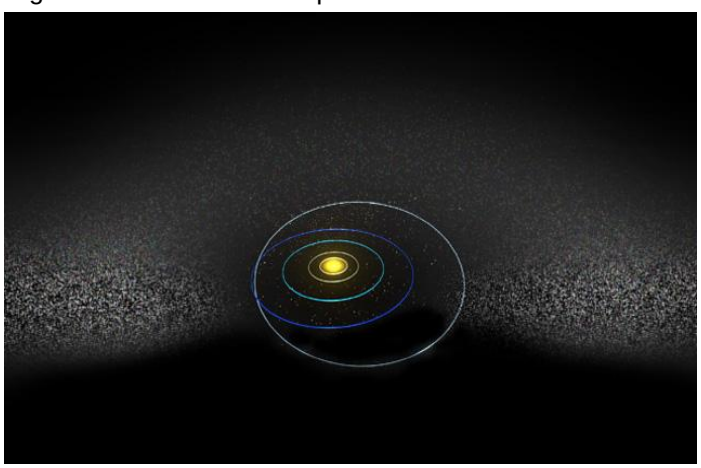
The orbits of the four outer planets are much further apart. The first two of outer planets: Jupiter and Saturn are classified as Gas Giants. This is because they are very large and are comprised almost entirely of gas (mainly Hydrogen). The two outer planets: Uranus and Neptune are called Ice Giants because most of the gases that they are comprised of are frozen.



Our Solar System out to the orbit of Neptune

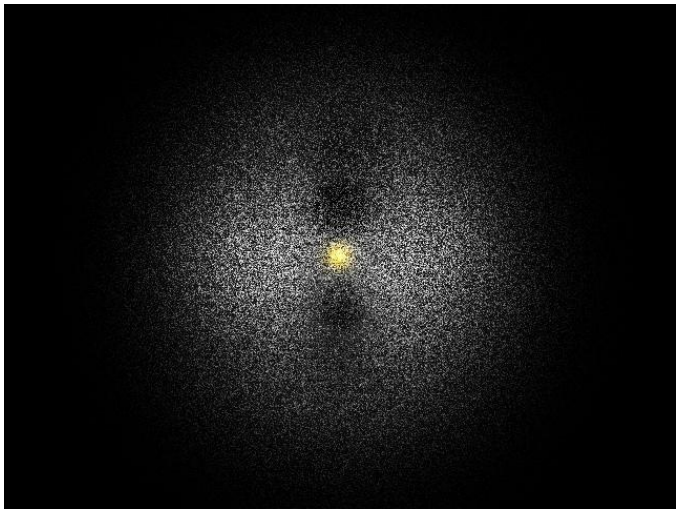
In the diagram above the 'Dwarf Planet' Pluto is shown as the white outer orbit. Pluto was originally classified as one of the (then nine) main planets but was reclassified by the International Astronomical Union (IAU) in 2006 and became a 'Dwarf Planet'. The main reason for this was the discovery of a large number of similar objects even further out from the Sun. These objects are now also classified as Dwarf Planets.

Most Dwarf Planets are smaller than Pluto (a few are larger) but all thought to be comprised mainly of water ice and frozen CO_2. It is now accepted that these Dwarf Planets are almost certainly the largest and closest of what may be millions of similar objects orbiting the Sun far beyond Neptune. These objects form a belt around the Sun in the same plane as the main planets. This region is known as the Kuiper Belt.



An artist's impression of the Kuiper Belt

To complete the Solar System family we must journey beyond the Kuiper belt, out to the limits of the gravitational influence of our Sun. Beyond the Kuiper Belt there is thought to be a vast halo of icy bodies perhaps stretching half way to our nearest neighbouring stars (out to about two light years). This halo of icy bodies is known as the Oort Cloud.

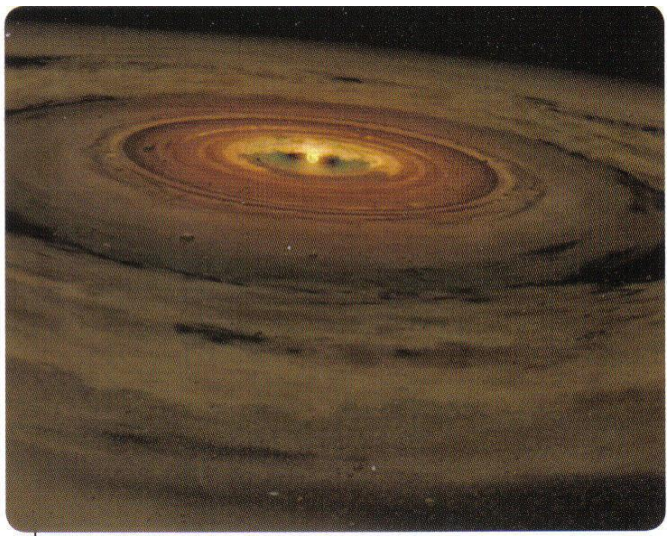


An artist's impression of the Oort Cloud

We have no way to confirm that the Oort cloud exists but the theory is generally accepted. The Oort Cloud and the Kuiper Belt are thought to be where our comets originate.

HOW DID THE COMETS GET OUT THERE?

When our Solar System formed from a vast 'Nebula' (cloud) of Hydrogen gas and dust, about 4.3 billion years ago, gravity created a rotating disc of the gas and dust. At the centre of the disc a denser bulge formed and pulled in more and more material. Eventually the bulge became so massive and dense that the extreme pressure and heat at the centre caused the Hydrogen atoms to fuse into Helium atoms. This Nuclear Fusion process produced enormous amounts of energy that caused the central bulge to light up and become a star – Our Sun.



An artist's impression of the very early Solar System

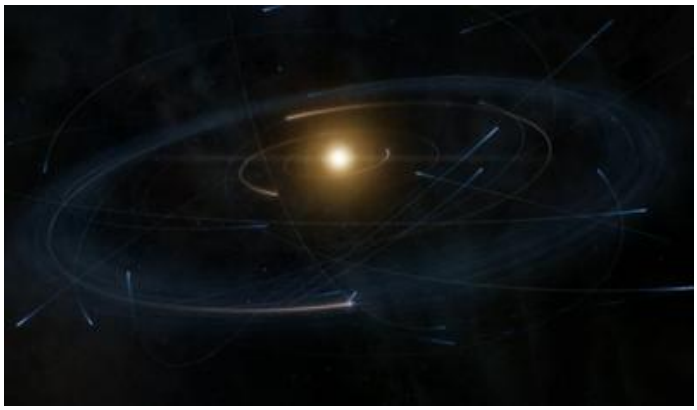
While the central bulge was forming, turbulence in the disc caused other smaller denser regions to form within the disc. These grew to form planets that can be seen represented in the picture above as lumps orbiting the Sun and creating gaps in the disc.

As the Sun burst into life it produced enormous amounts of radiation in the form of Ultraviolet light. This was so intense it blasted any gas and volatile materials away from the centre of the disc. The inner proto-planets were stripped of much there early atmospheres and any water was boiled away and pushed to the outer regions of the disc. In the cold of the outer disc the gases froze to form the lumps of ice of the Kuiper Belt and Oort Cloud.

During the period from 4.1 to 3.8 billion years ago millions of these lumps of ice returned to bombard the centre of the Solar System in what is called the 'Late Heavy Bombardment' (LHB). It is thought that the Oort Cloud may have been disturbed at this time, perhaps by the gravity of a star that may have formed in the same nebula as the Sun then passed close to our Sun.

An alternative theory is that many more planets formed around proto-stars including our Sun which may have originally had 80 or more. Initially many of these newly formed planets would have been in unstable orbits and may have had close encounters with other planets. There were likely to have been collisions like the one involving our Earth and a Mars sized planet called Thea. This collision is thought to have created of our Moon.

As a result of these close encounters and collisions some planets may have been thrown out into the Kiuper Belt and the Oort cloud. Here they may have disrupted the orbits of the 'lumps of ice' out there. Many of these lumps of ice would have been moved into trajectories that took them in towards the Sun and the planets.



There were many comets during the LHB period

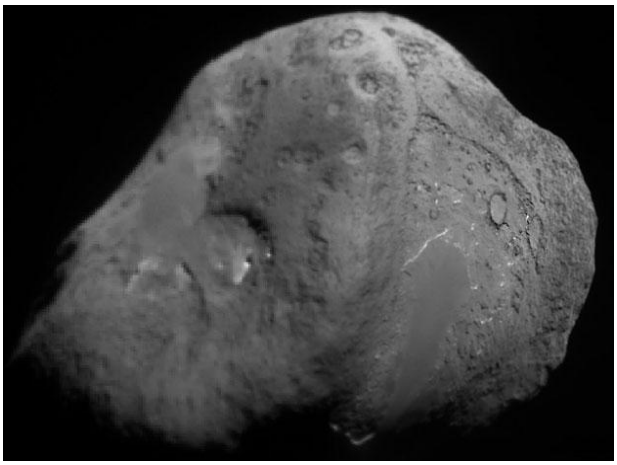
The planets and moons we see in the Solar System today show signs of the Late Heavy Bombardment on their heavily cratered surfaces. It is thought that most of the water found on our planet may have originated from the huge number of water laden comets that hit Earth during the Late Heavy Bombardment period.

WHY DO COMETS COME IN TO VISIT US?

The Late Heavy Bombardment finished about 3.8 million years ago but we still have occasional visits by comets but these are a tiny fraction of the activity during the LHB. It is likely that there are still close encounters and even collisions of the Dwarf Planets in the Oort Cloud and the Kuiper Belt. Any close encounters are likely to disturb the fragile orbits of these icy bodies. The effect of the gravity of the Sun is extremely weak at these vast distances. Just a tiny change to the path of one of the objects could send it on a course towards the Sun and its planets. These journeys into the Sun may take many thousands or even millions of years.

WHAT MAKES A COMET?

A comet is a lump of ice mainly comprised of water ice with Carbon Dioxide (CO_2) as the second largest constituent. It will also have traces of many other frozen gases and dust particles from the nebula (cloud of gas and dust) in which the Sun formed. When the comet is in the outer reaches of the Solar System it does not have a tail and resembles our much closer neighbours the Asteroids. The solid lump of material that has the close encounter with the Sun is called the Nucleus and is typically around 3 to 30 km in diameter.



Comet Temple-1 imaged by Deep Impact

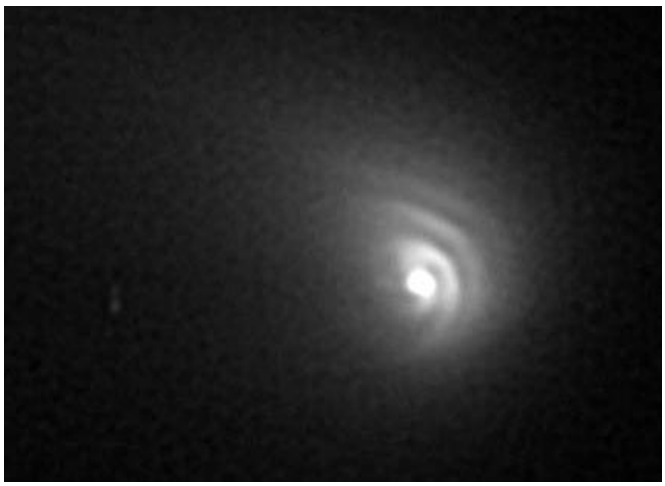
The image above was taken by a probe called Deep Impact that was sent to have a close encounter with Comet Temple-1. On 4th July 2005 Deep Impact sent a Copper projectile crashing into the nucleus of Comet Temple-1 then analysed the ejected material from the impact.

The results showed that the constituents of the comet nucleus were much as expected (mainly water) but the outer region was much softer and lighter than expected.

As the comet nucleus approaches the Sun the frozen gases begin to sublime (melt directly into gas and not form a liquid) and form a cloud around the nucleus called the 'Coma'. Between the orbits of Jupiter and Mars is the point when the Carbon Dioxide (CO_2) on the surface begins to sublime. As the comet moves across the orbit of Mars there is enough heat from the Sun to sublime the water ice into the coma.

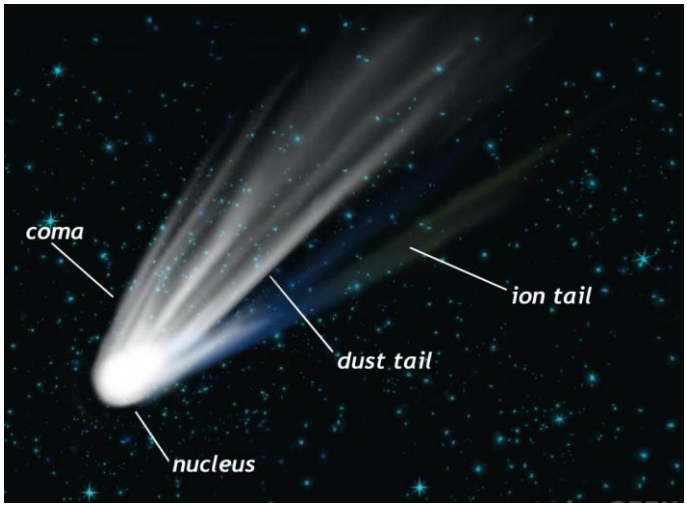
Halley's Comet Nucleus imaged by Giotto in 1986

The coma of a comet is extremely tenuous but may be very large, often over 100,000 kilometres in diameter.



The coma of Hale-Bopp with jets spiralling out

As the comet approaches the orbit of Mars the radiation from the Sun will begin to sweep the material of the coma into a long tail that trails away from the Sun. When the comet has looped around the Sun and is moving back to the outer Solar System the tail will still point away from the Sun (in front of the nucleus/coma).

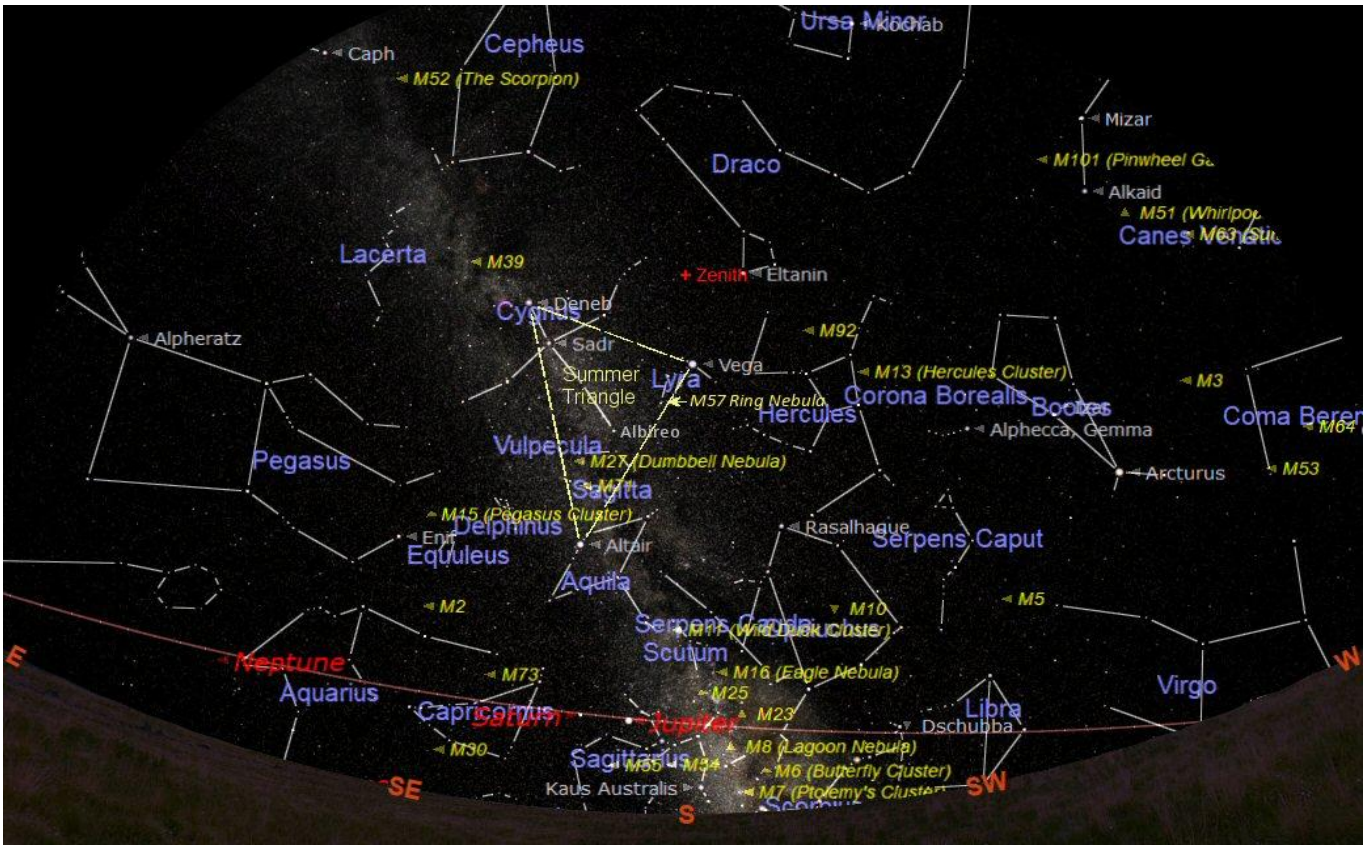


The named parts of a comet

Often a comet will produce two or more tails. Comet DeCheseauxklinkenberg seen in 1744 was very bright and had six tails. However two tails are most common. Comet Hale-Bopp (1998) which was the brightest comet that has been visible from Britain in recent years had two very distinct tails. The white tail that can be seen in the image above is the Dust Tail. It is formed by particles of ice and dust that in most cases have the consistency of cigarette ash. These particles are pushed away from the coma by the Solar Wind (radiation from the Sun) and normally form an arc behind the coma. The dust tail is illuminated by the reflecting light from the Sun.

The blue tail shown in the image above is the Gas Tail. This is created, as the name implies, by gas being ejected from the nucleus into the coma. The Solar Wind pushes the lighter gas particles from the coma in a straight line away from the Sun. The gas is ionised by the ultraviolet radiation from the Sun and glows in much the same way that a Neon light glows. The tails of a comet may be tens of millions of kilometres long.

THE NIGHT SKY – AUGUST 2020



The chart shows the sky as it will appear at 22:00 on 15th August. Across the lower part of the chart is the brown curved line depicting the Ecliptic. This is the imaginary line along which the Sun, Moon and planets appear to move across the night sky. It is actually the equator of the Solar System and the plane of the orbits of the planets including Earth. The Ecliptic is low at this time of the year due to Earth's 23.4º tilted axis of rotation. So we see the Moon and planets low in the night sky and the Sun high in the midsummer sky during the day.

All the stars in the night sky appear to rotate around a point in the sky that we call the 'North Celestial Pole'. This point is located very close to the star Polaris in the constellation of Ursa Minor (the Little Bear) which is partly visible at the top of the chart. See the chart on page 11.

Polaris can always be found by first finding Ursa Major and following the two 'pointer' stars opposite the handle of the 'saucepan shape', up out of the pan. This line points to Polaris about five times the distance between the two pointer stars in Ursa Major. See page 11.

Our planet Earth rotates around the North Celestial Pole (Polaris) once every day (24 hours). As Earth rotates, the sky appears to rotate above us. As the sky appears to rotate, Ursa Major and the other constellations will appear to move around the North Celestial Pole in an east to west direction. The whole sky will appear to move anticlockwise around Polaris. The movement is slow and not perceivable in real time. The whole sky also appears to move east to west by approximately 1º per day due to Earth's orbit around the Sun every 365.25 days.

The summer sky is dominated by the 'Summer Triangle' first identified by Sir Patrick Moore. The corners of the triangle are marked by the stars Deneb in Cygnus, Vega in Lyra and Altair in Aquila.

Albirio in Cygnus can be seen as a beautiful double star when viewed through a telescope. One star is bright and gold in colour the other is fainter and distinctly blue. This is not a true pair they just happen to be in the same line of sight. Although the blue star is much bigger and brighter than the golden coloured star it is a lot further away from us.

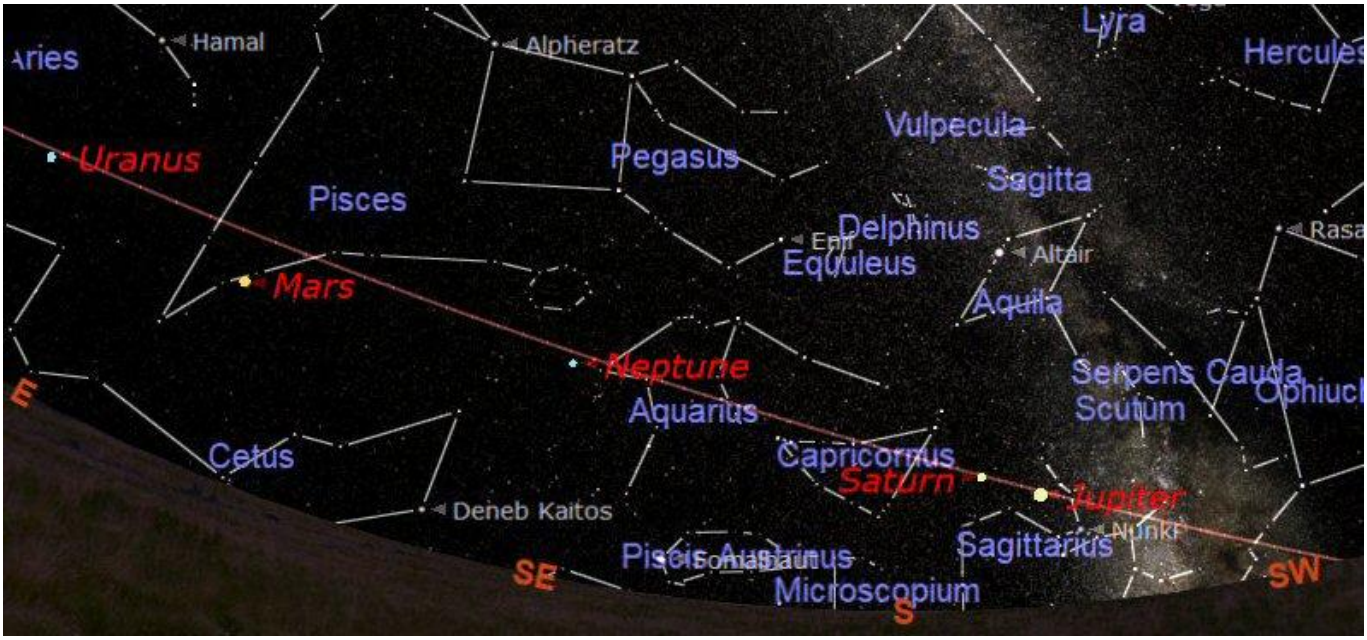
The constellation of Lyra (the Harp) is located to the west (right) of Cygnus but is much smaller. The most obvious feature of Lyra is the very bright star Vega that is located the top right corner of the Summer Triangle. Vega is the fifth brightest star in our sky with a magnitude of +0.4. It is located at a distance of 25.3 light years from us and is thought to be 3.2 times the diameter of our Sun and 58 times brighter. The main asterism (shape) of Lyra is composed of a line of three stars with Vega in the centre and a group of four fainter stars that form a parallelogram shape that is known as the 'Lozenge'.

Between the two lower stars: Sulafat and Sheliak is the Messier object M57 also known as the Ring Nebula. This is a 'Planetary Nebula' which has nothing to do with a planet. It is in fact a dying star that was similar to our Sun but older. The star had used most of its Hydrogen fuel and expanded to form into a Red Giant.

After passing though that red giant phase it gently collapsed to become a White Dwarf. The very thin outer mantle of the red giant drifted away into space as the star collapsed. The white dwarf is now surrounded by a bubble of gas and dust. It looks like a small 'smoke ring' when seen through a telescope but can't be seen using binoculars.

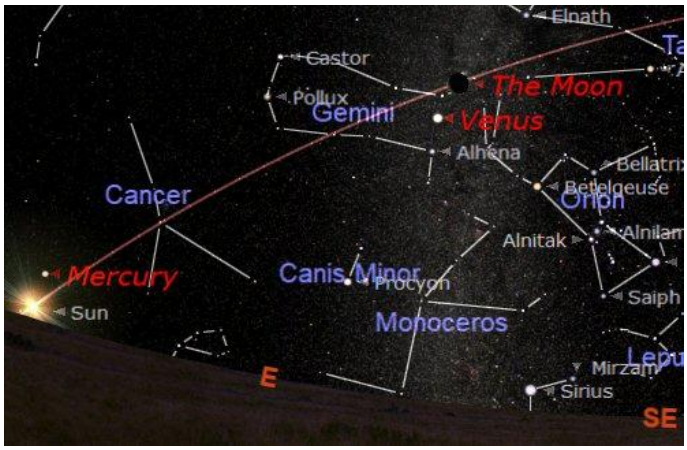
What we are seeing in M57 is what the last gasps of our Sun will be at the end of its existence as a normal star in about five billion years time.

THE SOLAR SYSTEM AUGUST 2020



The night sky at midnight showing the positions of all five of the outer planets

MERCURY will not be visible this month as it is in the bright sky before sunrise on the north eastern horizon. See the chart below.



Mercury and Venus at sunrise on 15th August

VENUS will be observable in the east before sunrise. It rises over the eastern horizon at 02:00 so will be observable from 03:00 until sunrise. Venus will appear 'half Moon' shaped as it will be at greatest western elongation (at its furthest from the Sun) on 14th August. On the 15th August the 'old' crescent Moon will be close to Venus and will make a good photo. The phase of the Moon on 15th August is shown on the Lunar Chart opposite.

MARS rises in the east at about 22:30 but looks small as it is still a long way from Earth. See the chart at the top.

JUPITER rises over the eastern horizon at about 19:00 and will be observable in the south east early evening. A pair of binoculars may reveal the four brightest of Jupiter's moons, Io, Europa, Ganymede and Callisto. A small telescope will allow the moons to be seen very clearly. Jupiter will be close to the horizon but still good for observing. For more details about Jupiter see the June magazine.

SATURN will be visible in the late evening sky rising over the eastern horizon at 19:00. Both of the gas giants will be in the thick, murky and turbulent air close to the horizon. Saturn will be observable but not at its best.

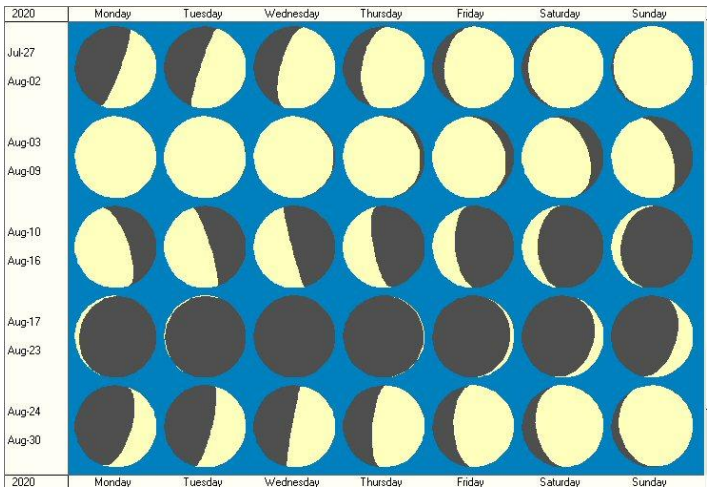
URANUS will not be easy to see this month as it will be close to the southern eastern horizon. It will rise at about 23:00 and be visible for the rest of the night. It will require a clear view to the horizon and modest telescope to see.

NEPTUNE will not be easily visible this month as it will be rising at about 21:00 and will be close to the south eastern horizon in the early hours of the morning.

THE SUN

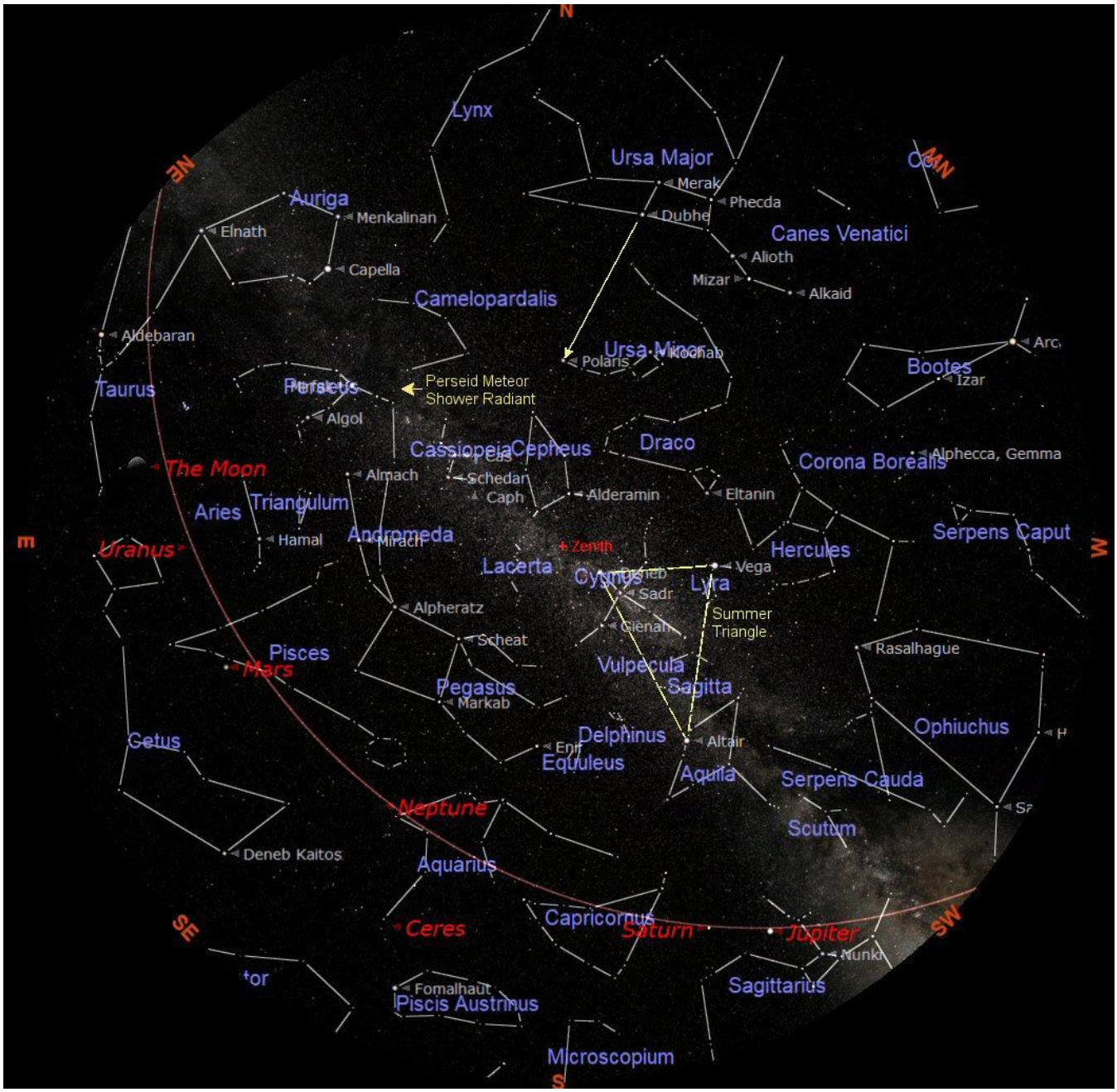
The Sun rises at about 05:30. A small sunspot was seen towards the end of July. Any activity on the Sun can be found live using the day to day images of the Sun in detail by visiting the very good SOHO website at: http://sohowww.nascom.nasa.gov/.

THE MOON PHASES DURING AUGUST



Full Moon will be on 3rd August
Last Quarter will be on 11th August
New Moon will be on 19th August
First Quarter will be on 25th August

THE NIGHT SKY – 12th AUGUST 01:00 Perseid Meteor Shower



The chart above shows the whole night sky as it appears on 12th August at 01:00 (1 o'clock) in the British Summer Time (BST). 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 02 o'clock BST at the beginning of the month and at midnight BST 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 west. 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: Jupiter, Saturn, Neptune, Mars and Uranus.

The Perseid Meteor Radiant is shown marked in yellow in the constellation of Perseus, see page 4.