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

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

Planets observable: Uranus and Neptune. Venus and Saturn are just observable in the very early evening.

**EXPLORING THE NIGHT SKY THIS MONTH**

The Southern Night Sky during December 2019 at 21:00 GMT
The chart above shows the night sky looking south at about 20:00 GMT on 15th December. West is to the right and east to the left. The point in the sky directly overhead is known as the Zenith 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 Sagittarius (the Archer) just moving over the western horizon, Aquarius (the Water Carrier), Pisces (the Fishes), Aries (the Ram), Taurus (the Bull), Gemini (the Twins), Cancer (the Crab) and Leo (the Lion).

Just disappearing over the south western horizon is the constellation of Sagittarius (the Archer). It is really a southern constellation but we can see the upper part creep along the horizon during the summer. The central bulge of our galaxy is located in Sagittarius so the richest star fields can be found in the constellation along with many of the beautiful and interesting deep sky objects that we seek out. Saturn is currently in Sagittarius but has moved over the western horizon.
The summer constellations are still prominent in the early evening sky in the west. Only just visible is Hercules (the Hunter). Following Hercules is the Summer Triangle with its three corners marked by the bright stars: Deneb in the constellation of Cygnus, Vega in Lyra, and Altair in Aquila. The Summer Triangle is very prominent and can be used as the starting point to find our way around the night sky. The Milky Way (our Galaxy) flows through the Summer Triangle passing through Cygnus, down to the horizon through Altair in the lower part of the Summer Triangle.

The Milky Way flows north from the Summer Triangle through the rather indistinct constellation of Lacerta (the Lizard), past the pentagon shape of Cepheus and on through the ‘W’ shape of Cassiopeia and down through Auriga and Orion to the south eastern horizon.

Prominent in the south 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. The Great Square can be used to judge the condition of the sky for observing. If stars can be seen within the square there seeing should be good. If no stars can be seen then seeing will not be good.

Coming into view in the south east 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 Messier 45 (M45) 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 south of Taurus and Gemini is the spectacular constellation of Orion (the Hunter). Orion is one of the best known constellations and hosts some of the most interesting objects for us amateur astronomers to seek out. We will be having a closer look at Orion in the January issue of this magazine.
The constellations of Auriga and Perseus

The chart above shows the constellations of Auriga (the Charioteer) and Perseus (the hero from Greek mythology). These two constellations sit above Taurus (on the ecliptic) and between Andromeda (to the west) and Gemini (to the east).

AURIGA is easy to find because its brightest star Capella is almost overhead at this time of the year. Capella is the sixth brightest star and appears bright and a slightly yellowish white. Although it appears as a single star it is actually a system of at least four stars. The two main stars Capella Aa and Capella Ab are Sun like stars but larger, both are about 2.5 solar masses. They orbit their common centre of gravity every 104 Earth days and are 111 million kilometers apart (approximately the Sun – Venus distance). Both stars are more advanced than our Sun and are starting to deplete their Hydrogen fuel supply.

The comparative diameters of the Capella system and our Sun
Component Capella Aa is slightly more massive at 2.5687\(\text{\textit{\textdegree}}\) (Ab is 2.4828\(\text{\textit{\textdegree}}\)) so has developed faster and is now fusing its Helium into Carbon and Oxygen and on its way to become a Red Giant. Component Ab is still approaching this stage but not far behind. There are two smaller Red Dwarf stars orbiting the pair. Component Capella H is 0.57\(\text{\textit{\textdegree}}\) and Capella L is 5.3\(\text{\textit{\textdegree}}\). The Red Dwarfs are too faint to be observed using an amateur’s telescope. The Red Dwarfs H and L are also an associated pair orbiting the main pair Aa and Ab every 300 Earth years at a distance of 10,000 AU (AU = Sun / Earth distance 150million kilometers).

![Constellations of Auriga and Gemini](image)

Auriga has three Messier objects all are rather nice Open Clusters. They appear to form a line across the lower half of Auriga and then appear to also include M35 in the adjacent constellation of Gemini in the line. This is of course merely a random effect and there is no actual line of clusters. The Open Clusters are just about visible using a good pair of binoculars but a telescope is required to see them well. At a magnification of 50x or higher the individual stars of the clusters can be seen.

M35 in Gemini is the most spectacular of the quartet but they are all well a look if a telescope is available. Close examination of M35 will reveal what appears to be curving line almost like a string of stars. It is very unlikely that it is actually a true line and is almost certainly a pure line of sight effect. Never the less it is a wonderful thing to see. M38 also has an apparent string of stars but this one is more difficult to see because of the myriad of Milky Way stars in the background. M38 is also rather sparse with its stars more spread out.

Open Clusters form in the gas and dust of a Nebula. Gravity draws the atoms of the Nebula together to form denser clumps of gas that become ever denser. Eventually the gas is squeezed into dense spheres where the pressure and high temperature at the core causes atoms to combine through Nuclear Fusion. As Hydrogen atoms are fused into Helium. Heat is produced and the sphere becomes a shining star. Any left-over gas and dust is blown away by intense radiation from the young stars and a cluster of new stars is revealed. This type of star cluster is called an ‘Open Cluster’.
PERSEUS is located between Auriga and Andromeda and the asterism (stick figure shape) looks a little like a horse riding spur. The constellation is located directly overhead this month so it is quite easy to find. Perseus has an interesting star called Algol see the chart below.
Algol is a three-star system, consisting of Beta Persei Aa1, Aa2, and Ab. The hot luminous primary is named β Persei Aa1 and the larger but cooler and fainter β Persei Aa2. The two stars regularly pass in front of each other, causing eclipses. The combined brightness of Algol (magnitude) regularly brightens and dims. The combined magnitude is usually near-constant at 2.1, but regularly dips to 3.4 every 2.86 days during the roughly 10-hour-long partial eclipses. The secondary eclipse when the brighter primary star occults the fainter secondary is very shallow and can only be detected photoelectrically. Algol gives its name to a type of variable stars called 'Algol Variables'.

The eclipsing binary pair is separated by only 0.062 astronomical units (AU is Sun Earth distance) from each other so they are very close to each other. The third star in the system (Algol Ab) is at an average distance of 2.69 au from the pair and the mutual orbital period of the trio is 681 Earth days.

The masses of the component stars of Beta Persei are: Aa1 = 3.17\( \odot \) (solar masses), Aa2 = 0.70\( \odot \) and Ab = 1.76\( \odot \).

Here is an interesting fact about Algol:

Algol is currently about 92.8 light years from the Sun but about 7.3 million years ago it passed within 9.8 light years of our Solar System. When it was at its closest its apparent magnitude would have been about −2.5 which is considerably brighter than the star Sirius (our brightest star) is today. Because the total mass of the Algol system is about 5.8 solar masses, at the closest approach this might have given enough gravity to perturb the Oort cloud. The effect may have been to increase the number of comets entering the inner Solar System. However, the actual increase in the number of comets moving in towards the Sun is thought to have been quite small.

There are two Messier objects in Perseus these are M34 and M76. They are both faint and need a telescope to see them.

Messier 34 (M34) is a rather sparse Open Cluster and quite difficult to make out. Messier 76 (M76) is a very beautiful Planetary Nebula but does need a medium to large telescope to see optically. Photographs show some colour and detailed structure. A Planetary Nebula is remnant of a star much like our Sun but more advanced in its 'life span'. It has used up its Hydrogen fuel and developed into a Red Giant. It eventually used up all its available fuel and gently collapsed under its own gravity to become a White Dwarf Star. The thin outer gaseous region of the Red Giant drifted away into space to create the beautiful Nebula we see today. The gas of the nebula is illuminated by the tint but very hot White Dwarf. It is not actively producing heat it is just the resident heat caused by the friction of the star’s collapse.
There is a very nice ‘Naked Eye’ and Binocular object in Perseus called The Double Cluster. It is two Open Clusters NGC 884 and NGC 869 (NGC – New General Catalogue) that appear to be close together.

NGC 884 and NGC869 are known together as the Double Cluster located 7600 light years away in the constellation of Perseus. NGC 884 is the easternmost of the Double Cluster with NGC 869 on the west side. NGC 869 and NGC884 are often designated h and χ Persei, respectively. The cluster is most likely around 12.5 million years old. The clusters are located physically close to one another, only a few hundred light years apart. The clusters were first recorded by Hipparchus but have likely been known since antiquity.

The Double Cluster is a favourite target for amateur astronomers. These bright clusters are often photographed or observed with small telescopes. They are easy to find and are visible with the unaided eye between the constellations of Perseus and Cassiopeia as a brighter patch in the winter Milky Way. The Double Cluster was also included in the Caldwell catalogue, a catalogue of astronomical objects for amateur observation.

The Double Cluster is best viewed using small telescopes so their entirety fits in the field of view. The clusters appear as a beautiful assemblage of bright stars located in a rich star field within the Milky Way. Both clusters are dominated by bright blue stars but also host a few orange stars that add to the visual interest. Both clusters together offer a spectacular low magnification view.
THE SOLAR SYSTEM THIS MONTH

MERCURY will not be observable this month as it will be too close to the Sun as it rises in the East. It was in ‘transit’ with the Sun (passing in front of the Sun) on 11th November.

VENUS is difficult to observe this month as it will be too close to the Sun and very low on the south western horizon at sunset. It is moving out from its conjunction with the Sun (passed above the Sun) on 14th August and is now moving away from the Sun. See the chart below.

MARS will be observable (with difficulty) this month low in the east before sunrise. Mars is still a long way from us on the other side of the Solar System so it looks rather small at just 4.1” (arc seconds) see the chart above.

JUPITER is now out of view and moving ever closer to the Sun. It has been very low in the sky this year and looked rather disappointing in the dirty and turbulent air close to the horizon. Jupiter will be in conjunction with the Sun on 27th December. See the chart below.

SATURN will be low in the south west as the sky darkens and is about to move below the western horizon. Saturn is very low and in the murky and turbulent air close to the southern horizon. It may still just be possible to see the ring system although it will appear unstable due to the air movement close to the horizon. It will require at least a small telescope 75mm to 100mm and a magnification of about 100x to see the rings at all. Saturn’s largest moon Titan may also be visible in a telescope but the fainter moons will be very difficult to see even using a larger telescope. See the chart above.
URANUS the Ice Giant Planet was at opposition to the Sun (due south at midnight – 24:00 GMT) on 28th October it was at its best position for observation this year. It will be visible during in the evening using a small telescope as a slightly fuzzy blue, star like, object. A larger telescope with a magnification of 100x or more will show it as a small blue/green disc. See the chart below.

NEPTUNE was at opposition on 10th September and at its best position for observation this year but it is now moving towards the western horizon. A medium sized telescope (100mm to 150mm) will be needed to show Neptune as a small blue/green disc using a magnification of 150x but it is small and difficult to find. See the chart above.

THE SUN
There may still be some occasional sunspots to see even though the active phase of the Solar Cycle is now over.
The Sun rises at 07:45 GMT at the beginning of the month and at 08:00 GMT by the end of the month. It will be setting at 15:53 GMT at the beginning and 16:00 GMT by the end of the month. 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/.

THE MOON PHASES IN DECEMBER

First Quarter will be on 4th December
Full Moon will be on 12th December
Last Quarter will be on 19th December
New Moon will be on the 26th December

The Winter Solstice will be on 22nd December