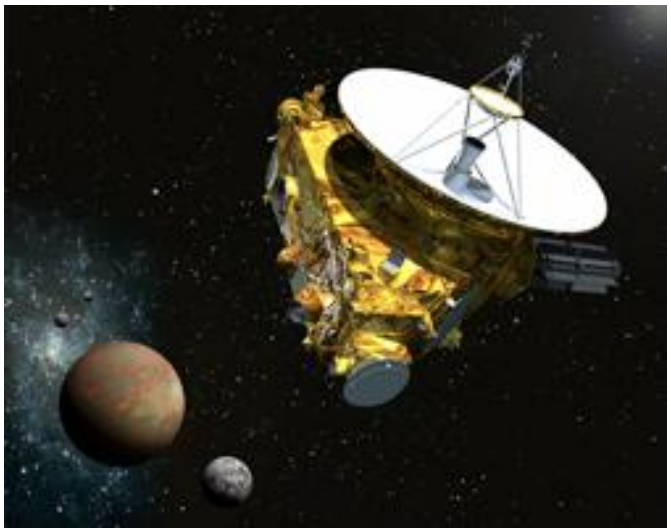
NEWBURY ASTRONOMICAL SOCIETY
MONTHLY MAGAZINE - MAY 2015

NEW HORIZONS GETTING CLOSE TO PLUTO

The first colour image of Pluto and Charon taken by New Horizon

NASA's New Horizons Probe is now about 100 million kilometres (65 million miles) which is approximately the distance from the Sun to Venus on its main mission path to Pluto. The probe was launched on 6th January 2006 on an Atlas V 551 rocket from Cape Canaveral, Florida and will have its closest approach with Pluto on 14th July 2015 when it will pass within 10,000 kilometres.



An artist's impression of New Horizons at Pluto

The image above showing Pluto and its largest moon, Charon was taken by the RALPH colour imager aboard NASA's New Horizons spacecraft on 9th April and downloaded to Earth the following day. It was the first colour image ever made of the Pluto system by a spacecraft on its approach to the Dwarf Planet.

At this distance, neither Pluto nor Charon was well resolved by the onboard colour imager but their distinctly different appearances can be seen. As New Horizons approaches its flyby of Pluto on 14th July, it will deliver colour images that eventually show surface features as small as a few kilometres across.

Pluto is thought to be a giant snowball comprised mainly of water ice and frozen gases about 2300 kilometres in diameter. Pluto's largest satellite Charon is 1200 kilometres in diameter and also thought to be mainly water ice.

NEXT NEWBURY ASTRONOMICAL SOCIETY MEETING

1st May — The Sun our nearest star. - Member's Evening

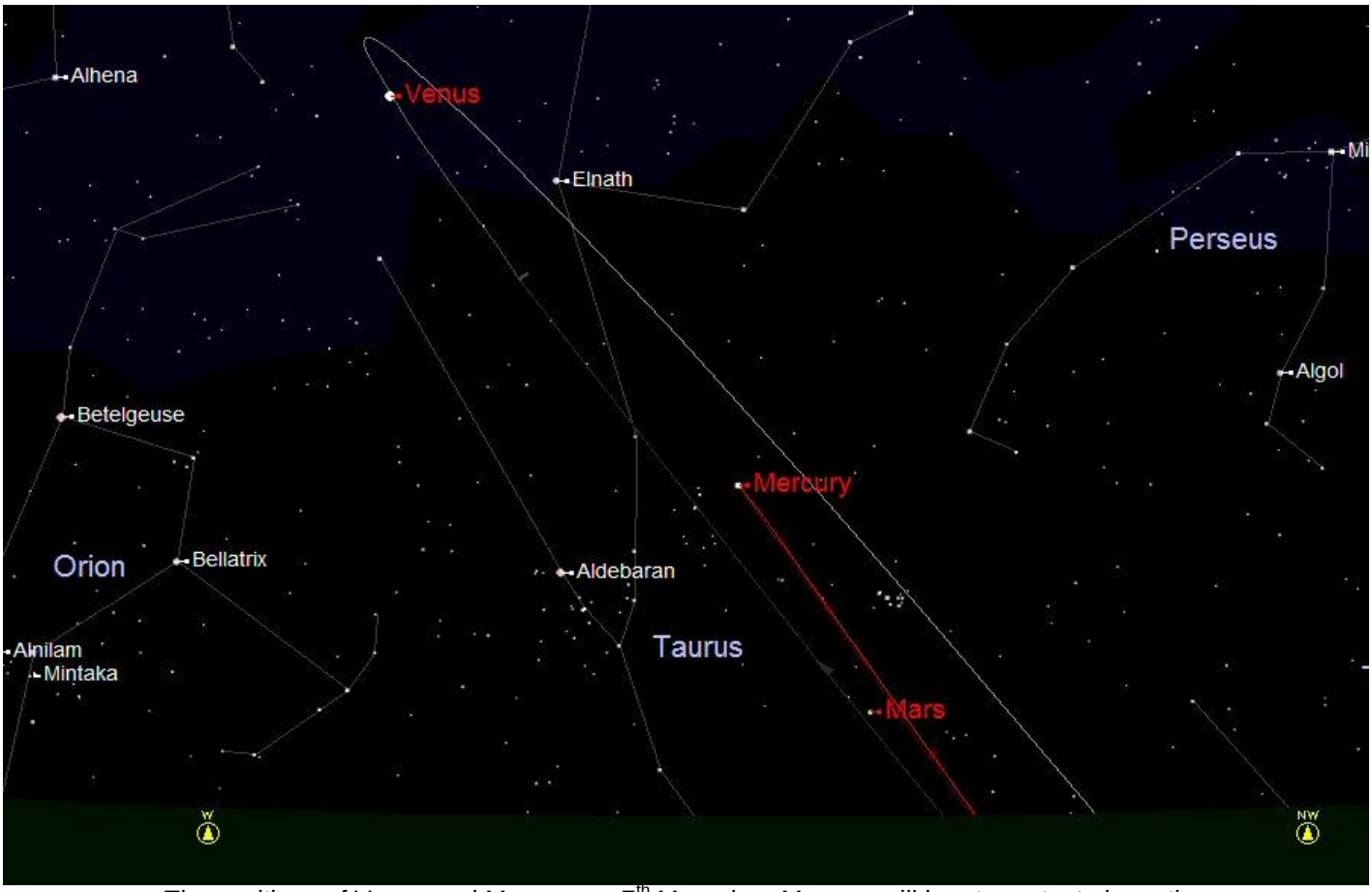
Website: **www.newburyas.org.uk**

NEXT NEWBURY BEGINNERS MEETING

20th May — Exotic Stars and The Summer Night Sky

Website: **www.naasbeginners.co.uk**

VENUS BLAZING IN THE WEST WITH MERCURY FOR COMPANY



The positions of Venus and Mercury on 7th May when Mercury will be at greatest elongation

Venus is the brightest object in the night sky at the moment except for the Moon. As the Sun sets in the west and the sky begins to darken the first 'star' to appear is in fact the planet Venus. It is so bright that it cannot be missed as soon as the light begins to fade in the west.

Venus is currently moving towards us having emerged from behind the Sun in October 2014. The diagram above shows the orbit of Venus with the darker half plotting the passage of Venus as it moved out from behind the Sun. Over the next few months Venus will begin to move back towards the Sun. The lighter part of the orbit shows how Venus will eventually move back to pass between the Sun and Earth. It will then emerge as the 'Morning Star', shining in the east, later in the year.

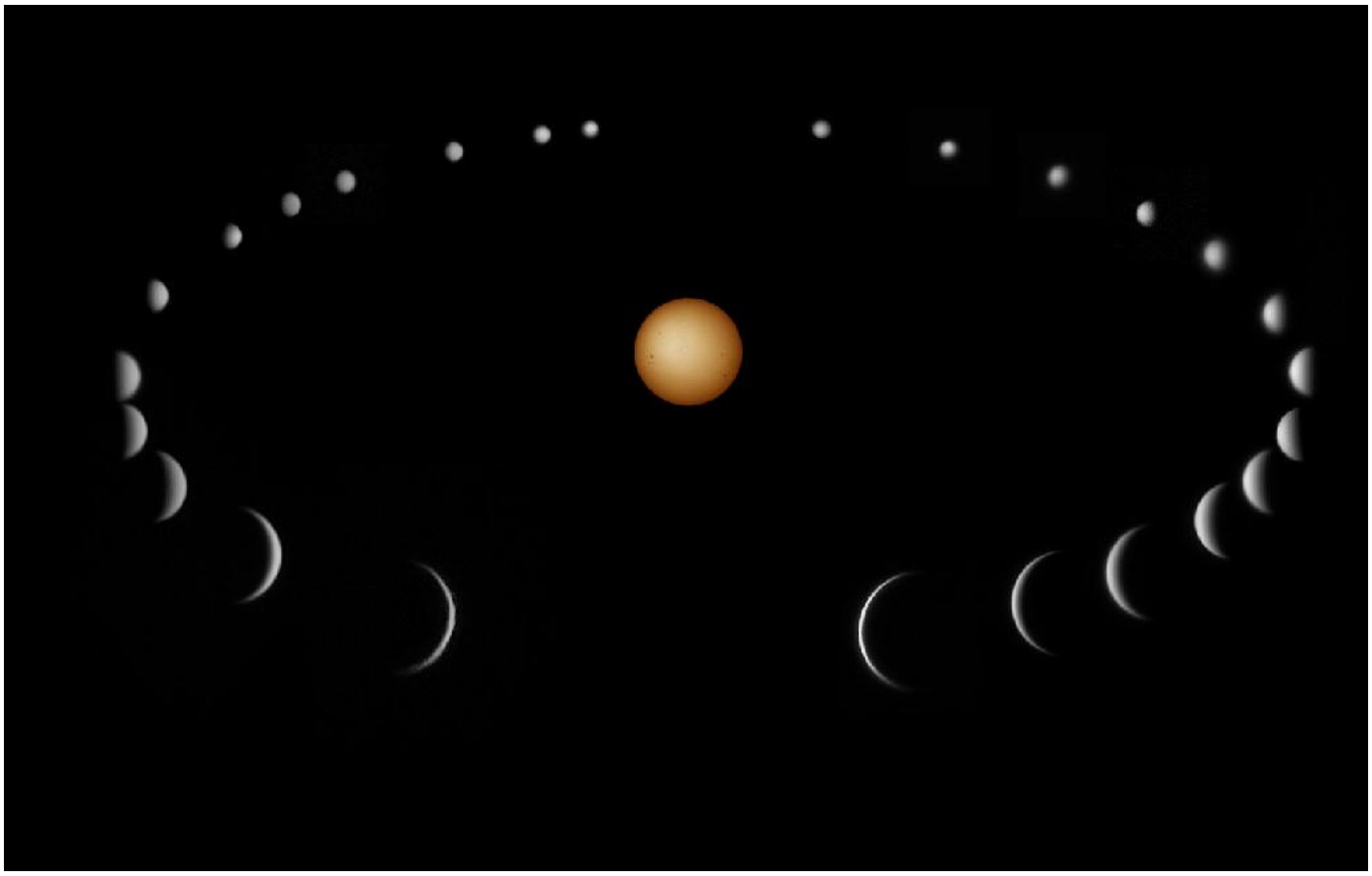
When Venus emerged from superior conjunction with the Sun it was on the far side of the Sun and 40 million kilometres further away from us. It therefore appeared comparatively small in diameter. However the whole of the surface facing towards us was illuminated by the Sun so it appeared bright. When Venus reaches the top of the loop of its orbit, on 6th June, it will appear larger because it will then be at the same distance away as the Sun. However only the half of the planet facing the Sun will be illuminated so we will see it half illuminated.

As Venus moves further towards us and closer to inferior conjunction with the Sun it will be 40 million kilometres closer than the Sun and will appear much larger to us. Strangely Venus will not be noticeably brighter this is because the other side of the planet (facing the Sun) will be illuminated and all we will see is a thin crescent (see the images on the next page).

A small telescope will show Venus as a 'half Moon shape' and it will be possible to watch it develop into a thinning crescent. The view through a telescope may be improved by fitting a mask over the open end to reduce the glare of the bright planet. Venus is regarded by astronomers as the twin of Earth but the two planets are defiantly not identical twins. Earth is 12,756km in diameter and Venus is slightly smaller at 12,104km. Both planets have a similar composition but the composition of their atmospheres is completely different.

Earth as we know has a surface that is just warm enough for life and allows water to exist as solid ice, liquid and as vapour. It also has an atmosphere comprised of Nitrogen and Oxygen with traces of other gasses like Carbon Dioxide. Venus has very little Nitrogen no oxygen but a huge proportion of Carbon Dioxide. Earth and Venus have a similar amount of Carbon Dioxide however on Earth it has nearly all been trapped in the rocks of the crust but on Venus it is nearly all in the atmosphere. Venus has a run-away Green House effect and as a consequence has a surface temperature of 450°C. Venus also has an atmosphere so thick that the surface pressure is 90 times that on Earth.

From Earth and indeed from orbit above the surface of Venus the planet is seen to be shrouded in white cloud. It is impossible to see the surface from above and the clouds are virtually featureless. Faint makings can be detected in the clouds when viewed in ultraviolet light but these are very subtle. Radar can be used to penetrate the clouds and scan the surface. The planet does have mountains, canyons and plains like the surface of Earth. Some of the mountains appear to be volcano shaped but there is no evidence yet that they are active or have been active for millions of years.



The phases of Venus imaged by Dave Smith

The sequence of images of Venus above were taken by Dave Smith from his home in Maldon in Essex using a Vixen FL102S refracting telescope fitted with a x2 barlow and a DMK21 camera. The purpose of his project was to show the varying phase of Venus and its apparent change in size as it orbits the Sun. The image of the Sun was taken on 4th March 2011. As this inferior conjunction has been unfavourable with Venus well south of the ecliptic all images were taken in daylight. The individual Venus images are accurately positioned based on their position in the sky relative to the Sun.

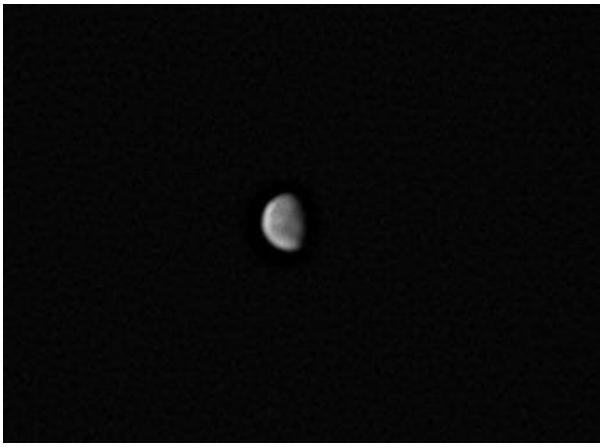
The last image to complete the set was taken on 13th January 2012. The individual frames were stacked in Registax 5/6 and processed in Photoshop.

For an observer new to astronomy it is interesting to follow Venus as it emerges from behind the Sun in the evening sky low in the west. This phase is shown at the top left of the orbit in the image above. As Venus moves out from the Sun it also moves towards us and appears to grow larger. When the planet reaches greatest eastern elongation (about where the eighth image to the left is) it will have reached its furthest separation from the Sun as viewed from Earth. This is where Venus will be on 6th June this year.

Venus will then continue on its orbit moving closer towards Earth but appearing to draw back in towards the Sun. As it moves between us and the Sun we will see less of the illuminated side and the crescent shape will become progressively narrower. The gap in the images of Venus at the bottom of the sequence is where the planet was too close to the Sun to be imaged.

Radar scans have also shown that the ratio of the number of days to a year on Venus is very odd. A year on Venus is equivalent to 226 Earth days and day on Venus is equivalent to 243 Earth days – a day is longer than the year on Venus.

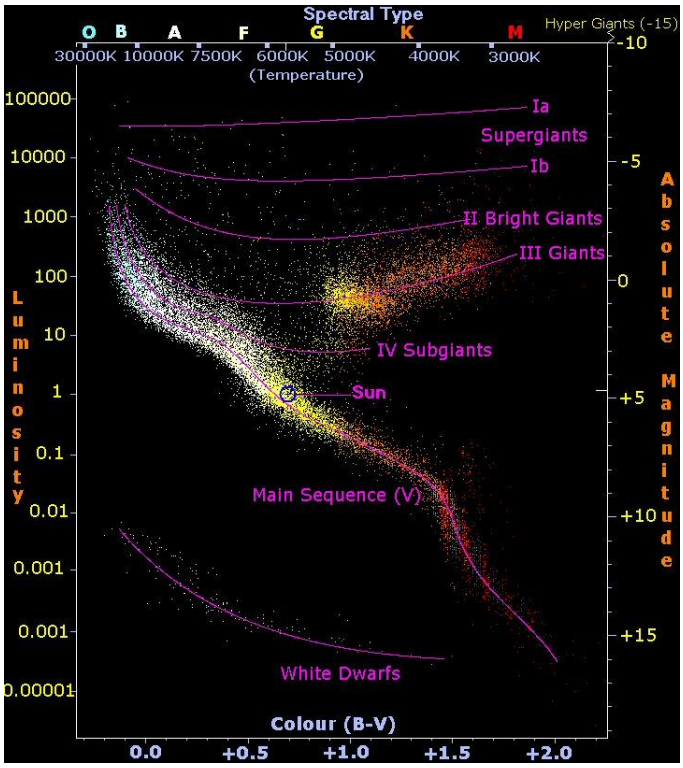
MERCURY is south of Venus in the first half of May. It will reach greatest eastern elongation on the evening of 7th May. The chart on page 2 shows the passage of Mercury on its orbit around the Sun at the beginning of May. The red line from the horizon is actually one loop with Mercury at the top of the loop. The side of the loop that is hidden is where Mercury emerged from behind the Sun on 10th April and appeared to climb up from the western horizon as it moved around its orbit and towards us. After 7th May Mercury will track back towards the Sun along the thick red part of the loop that obscures the other side of the loop.



Mercury as it will look on 7th May

SPECIAL AND EXOTIC STARS

The stars that we refer to as normal stars are those that appear to be similar to our own star that we know as the Sun. These stars are created in nebulae (vast clouds of gas and dust) and produce energy in their core through the process of Nuclear Fusion. These stars may be smaller than the Sun, the smallest as small as 0.01 of the mass of our Sun. We call these stars Red Dwarfs because they are relatively cool and appear red in colour. At the other end of the scale of size there are Super Giant stars that may be up to 100 times the mass of our Sun and in the very earliest times after the birth of the Universe may have been up to 300 times the mass of our Sun. Normal stars are shown on a diagram used by astronomers called the Hertzsprung-Russell Diagram.



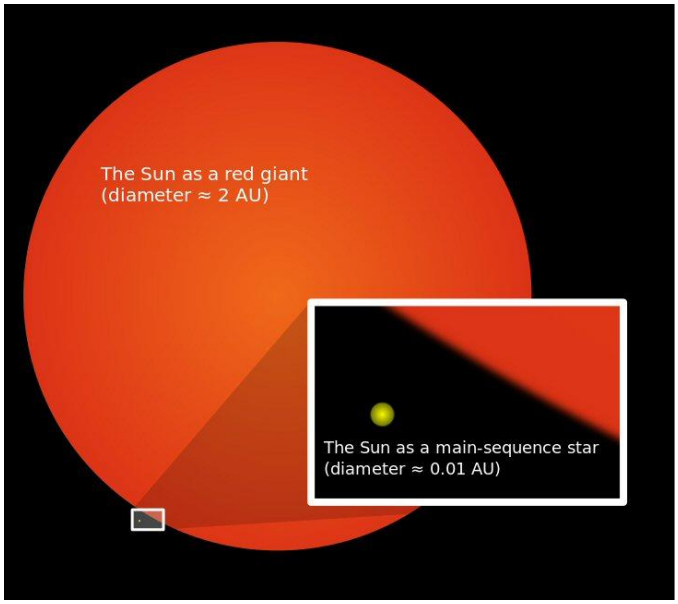
The Hertzsprung-Russell (HR) Diagram

On the Hertzsprung-Russell Diagram shown above the stars shown clustered along the diagonal line across the centre of the diagram are those stars that are in the normal stable phase of their existence known as their Main Sequence. The smallest (Red Dwarfs) are at the lower right end of the Main Sequence, our Sun (a middle sized yellow dwarf star) is shown in the centre and the more massive white or blue Giant stars are shown on the upper left of the Main Sequence.

Stars convert their Hydrogen into Helium through the process known as nuclear fusion that in turn produces huge amounts of energy in the form of X-Rays which heat the star and cause it to shine. Stars around the size of our Sun along with those a little smaller and those up to about 2.5 times the size are also able to process the Helium into Carbon. This additional Nuclear Fusion produces extra energy that causes the star to inflate to become a Red Giant.

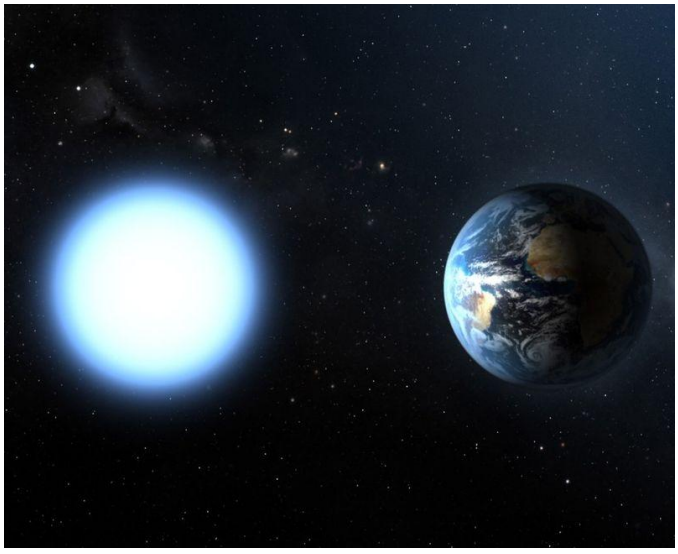
A Red Giant formed from a star the size of our Sun may grow to a diameter equivalent to the orbit of the planet Mars.

The outer layers of the Red Giant are very tenuous and will become detached from the star and be driven off by the radiation from the star. This halo forming around the giant bloated star will eventually become what we know as a Planetary Nebula, like the Ring Nebula in Lyra.



The Sun as a Red Giant

Eventually all the fuel that had powered the star will be exhausted and the star will begin to gently collapse to become a White Dwarf which will be about the size of our Earth. It will be very hot and super dense.



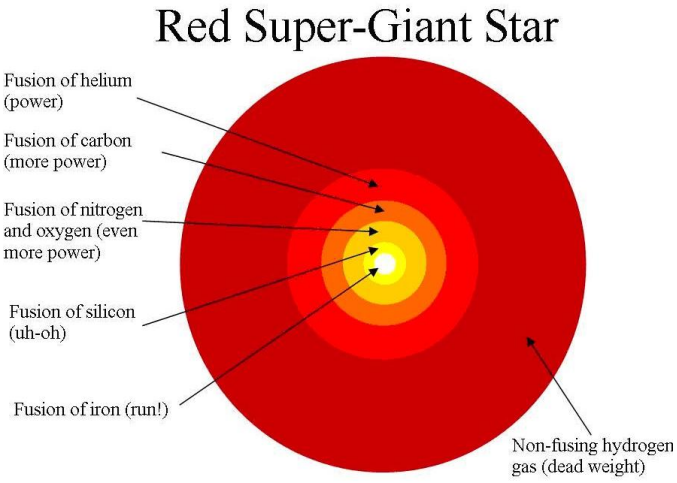
A White Dwarf compared to the size of Earth

Larger stars are able to continue the Nuclear Fusion process to produce the sequence of heavier elements until Iron is created. The additional energy created in the multiple Nuclear Fusion levels causes the star to grow into a Red Giant or even a Red Super Giant for the largest stars. As the Iron core grows the star becomes unstable and eventually undergoes a catastrophic collapse causing it to explode as a Supernova. A star up to about 20 times the mass of our Sun will leave a stellar remnant at the centre of the supernova known as a Neutron Star. So Red Giants, White Dwarfs and Neutron Stars are the exotic products of normal stars.

NORMAL STARS THAT ARE RATHER EXOTIC

On the previous page we saw that normal stars naturally develop into objects that are very different to how they appeared during the long active fusion phase know as the main sequence. There are however some rare stars that are very strange and very different to the normal stars. First we must just consider the final phases of stars that are larger than our Sun.

Normal stars that are more than 3 up to 30 times the mass of our Sun spend most of their existence as element conversion factories. The fusion process begins by combining (or fusing together) hydrogen atoms to create Helium atoms. The core of giant stars are subjected to huge pressure from the mass of the star pushing inwards by the force of gravity so the atoms at the centre are forced together and become very hot. Under these conditions the Helium atoms a fused into Carbon atoms which in turn are fused into Nitrogen, Oxygen, Silicon and finally Nickel and Iron. All these fusion phases, except the production of Iron, produce energy as a byproduct of the fusion process.



Each fusion phase produces a heavier atom which sinks to the centre of the star. The fusion process that creates Iron does not produce energy and the star becomes unstable and will eventually collapse inwards to produce a run-away fusion explosion that destroys the star. The outer layers are blown away at enormous speed to form a Super Nova Remnant like the Crab Nebula, Messier 1 (M1) in the constellation of Taurus.

Messier 1 (M1) the Crab Nebula in Taurus

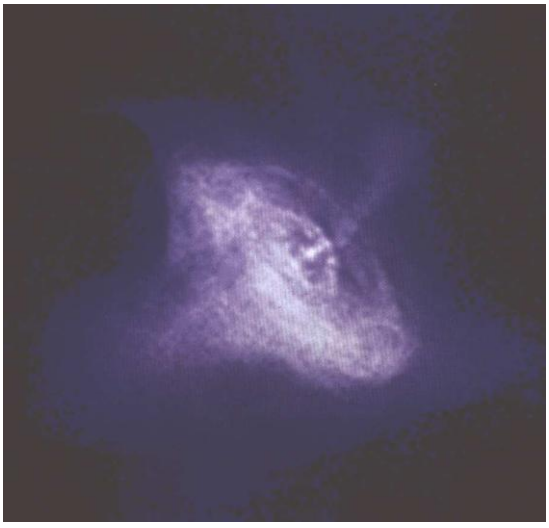
A star that is up to about 2½ times the mass of our Sun will be able to fuse Helium into Carbon but will not be massive enough to produce the pressure and temperature in its core required to fuse the Carbon atoms. So when its fuel supply of Hydrogen and Helium are exhausted it will gently collapse to form a White Dwarf. A White Dwarf has an upper limit of mass that is 1.4 times the mass of the Sun. If the remaining mass of a collapsing star is greater than the 1.4 Solar Mass limits it will continue to collapse after it has reached the stage of forming a White Dwarf and create a Neutron Star.

A White Dwarf with a mass of less than 1.4 solar masses is prevented from further collapse under the force of its own gravity by a process known as 'electron degeneracy pressure'. The collapse compresses the atomic structure by reducing the space between the atoms causing the White Dwarf to be extremely dense with a cubic centimetre weighing thousands of tonnes. The approximate diameter of a White Dwarf is about 12,000km which is about the size of Earth.

If the collapsing star has a mass greater than 1.4 solar masses the star will exceed the 'electron degeneracy pressure' capability to support the star. It will continue to collapse past the White Dwarf phase and create a Neutron Star. A Neutron Star has a diameter of about 12km.

Neutron stars are the densest star-like objects known and are composed almost entirely of neutrons. These are are subatomic particles without a neutral electrical charge and with slightly larger mass than protons. Neutron stars are very hot and are supported against further collapse by 'Quantum Degeneracy Pressure' due to the phenomenon described by the Pauli Exclusion Principle which states that no two neutrons (or any other fermionic particles) can occupy the same place and quantum state simultaneously.

Some neutron stars rotate very rapidly (up to 716 revolutions a second) and emit beams of electromagnetic radiation from their poles as pulsars. In fact, the discovery of pulsars in 1967 first suggested that neutron stars did exist. There are thought to be on the order of 10^8 neutron stars in the galaxy but they can only be easily detected in certain instances, such as if they are a pulsar or part of a binary system.



The Neutron Star at the centre of the Crab Nebula

VERY STRANGE EXOTIC STARS

MAGNETARS

A magnetar is a type of neutron star with an extremely powerful magnetic field. The magnetic field decay powers the emission of high-energy electromagnetic radiation, particularly X-rays and gamma rays. The theory regarding these objects was first recorded when a burst of gamma rays thought to have been from a magnetar was detected on 5th March 1979. During the following decade the magnetar hypothesis had become widely accepted as a likely explanation for soft gamma repeaters (SGRs) and anomalous X-ray pulsars.

When a dying star collapses causing supernova explosion a neutron star is created and the magnetic field increases dramatically. Halving the star's diameter increases the magnetic field fourfold. It has been calculated that when the spin, temperature and magnetic field of a newly formed neutron star falls into the right ranges a dynamo mechanism could convert heat and rotational energy into magnetic energy and increase the magnetic field, enormously. It is estimated that about one in ten supernova explosions results in a magnetar rather than a more standard neutron star or pulsar.

THORNE-ZYTKOW STARS

First theorised in 1975 by physicist Kip Thorne and astronomer Anna Zytkow, Thorne-Zytkow Objects (TZO) have proven notoriously difficult to find in real life because of their similarity to red super giants, like the well-known Betelgeuse in Orion. It's only through detailed spectroscopy that the particular chemical signatures of a TZO can be identified.

One had never been spotted for sure in the wild jungle of strange stellar objects but astronomers now think they have finally found one of these theoretical cosmic curiosities: a TZO hiding in our neighbouring Small Magellanic Cloud. It has the outward appearance of normal red supergiant but the TZOs is actually two stars in one: a binary pair where a super-dense neutron star has been absorbed into its less dense supergiant partner and from within it operates its exotic elemental factory.

WOLF–RAYET STARS

Wolf–Rayet stars (often referred to as WR stars) are a heterogeneous set of stars with unusual spectra showing prominent broad emission lines of highly-ionised helium and nitrogen or carbon. The spectra indicate very high surface temperatures of 30,000 K to around 200,000 K, surface enhancement of heavy elements and strong stellar winds. Classic Wolf–Rayet stars are evolved massive O-type stars of over 20 solar masses when they were on the main sequence and were fusing helium or heavier elements in the core. They are all highly luminous due to their high temperatures and thousands of times the more powerful than our Sun. Wolf–Rayet stars are not exceptionally bright visually as most of their radiation output is in the ultraviolet and even soft X-rays.

A subset of WR stars are the central stars of planetary nebulae (CSPNe), post Asymptotic Giant Branch stars that were similar to the Sun while on the main sequence but have now ceased fusion and shed their atmospheres to show a bare carbon and oxygen core.

THEORETICAL EXOTIC STARS

There are some exotic stars that are derived from hypothetical compact stars composed of something other than electrons, protons and neutrons. The collapse of these stars is balanced against gravitational collapse by degeneracy pressure or other quantum properties. These include quark and strange stars (composed of quark or strange matter) and the more speculative preon stars (composed of preons).

These truly exotic stars are largely theoretical but observations by the Chandra X-Ray Observatory in 2002 may have detected two candidate quark stars.

QUARK STARS

It is possible that the neutrons will decompose into their component up and down quarks when sufficient gravitational pressure is applied. In this case, the star will shrink further and become denser but it may survive in this new state indefinitely if no extra mass is added. It will have become a very large nucleon. A star in this hypothetical state is called a quark star. If quark stars contain strange matter then they are called strange stars. The pulsar 3C 58 has been suggested as such a possible quark star.

ELECTROWEAK STARS

This is a theoretical type of exotic star, whereby the gravitational collapse of the star is prevented by radiation pressure resulting from electroweak burning, that is, the energy released by conversion of quarks to leptons through the electroweak force. This process occurs in a volume at the star's core approximately the size of an apple but containing about two Earth masses.

The stage of life of a star that produces an electroweak star is theorized to occur after a supernova collapse. Electroweak stars are denser than quark stars and may form when quark degeneracy pressure is no longer able to withstand gravitational attraction but may still be withstood by electroweak burning radiation pressure.

BOSON STARS

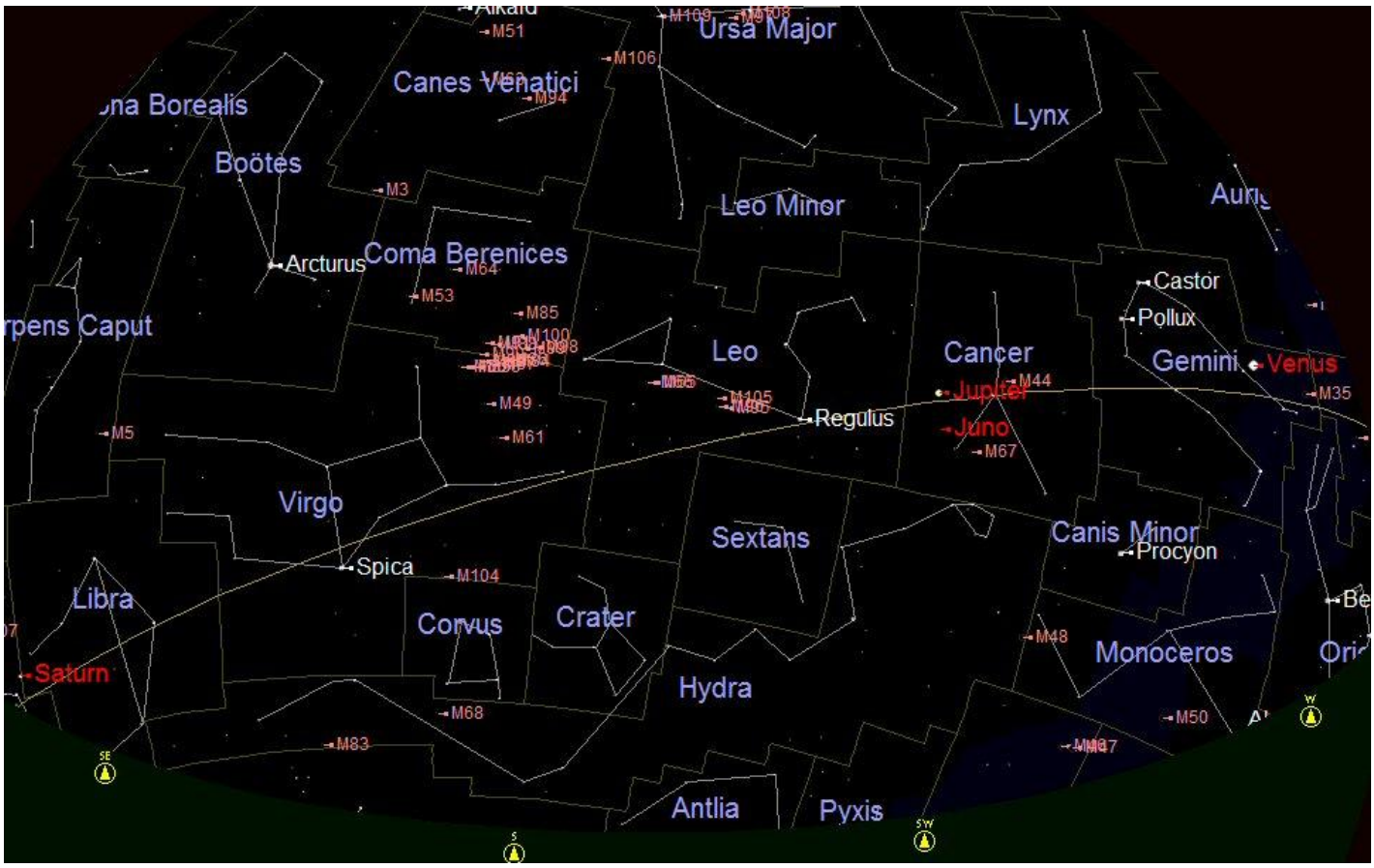
This is a hypothetical astronomical object that is formed out of particles called bosons (conventional stars are formed out of fermions). For this type of star to exist, there must be a stable type of boson that possesses a small mass. There is no significant evidence that such a star exists. However, it may become possible to detect them by the gravitational radiation emitted by a pair of co-orbiting boson stars.

Boson stars may have been formed through gravitational collapse during the primordial stages of the big bang. A supermassive boson star could exist in active galactic cores. Boson stars have also been proposed as a candidate for dark matter objects.

PLANCK STARS

This is a hypothetical astronomical object where the energy density is around the Planck density. (5.15500×10^{96} kg/m^3). These may exist inside a black hole if correct it would resolve the black hole firewall and black hole information paradox.

EXPLORING THE NIGHT SKY - MAY 2015



The chart above shows the night sky looking south at about 22:00 on 15th May. The sky has been darkened in the chart to allow the interesting objects to be displayed but it will not be dark for a while after 22:00. West is to the right and east to the left. The curved line across the sky is the ecliptic. This is the imaginary line along which the Sun, Moon and planets appear to move across the sky. The constellations through which the ecliptic passes are known as the constellations of the 'Zodiac'.

The constellations through which the ecliptic passes are (west to east): Gemini (the Twins), Cancer (the Crab), Leo (the Lion), Virgo (the Virgin) and Libra (the Scales).

On the ecliptic to the east (left) of the chart is the constellation of Gemini (the Twins) with its lovely open cluster M35 located just off the end of the upper line of stars. Gemini also hosts Venus this month. Gemini is followed along the ecliptic by the constellation of Cancer. Cancer is quite indistinct but is worth tracking down with binoculars to find the lovely open cluster M44 which is also known as Praesepe or the Beehive Cluster. Jupiter is located in Cancer this year making it very easy to find.

The most striking constellation now is the distinctive shape of Leo (the Lion) looking rather like the crouching Sphinx in Egypt. The brightest star in Leo is Regulus located almost on the ecliptic. Because it is located very close to the ecliptic it is often occulted by the Moon. This occurs when the Moon passes in front of Regulus. It is an interesting thing to observe and follow.

The most obvious feature of Leo is the distinctive back to front question mark '?' pattern of stars above Leo. This is known as the 'Sickle' due to its resemblance to the curved blade of a sickle tool used to cut hay and grass.

The constellation of Leo is quite large in the sky which may make it just a little difficult to find for the first time especially in a light polluted sky. However once it is found it is much easier to locate. The rest of Leo to the east (left) of the 'Sickle' resembles the body and hind quarters of a resting lion.

Leo hosts four of the brightest galaxies in our sky only the Great Spiral Galaxy (M42) is brighter. The galaxies M65, M66, M95 and M96 can be seen using a moderately sized telescope, located below Leo.

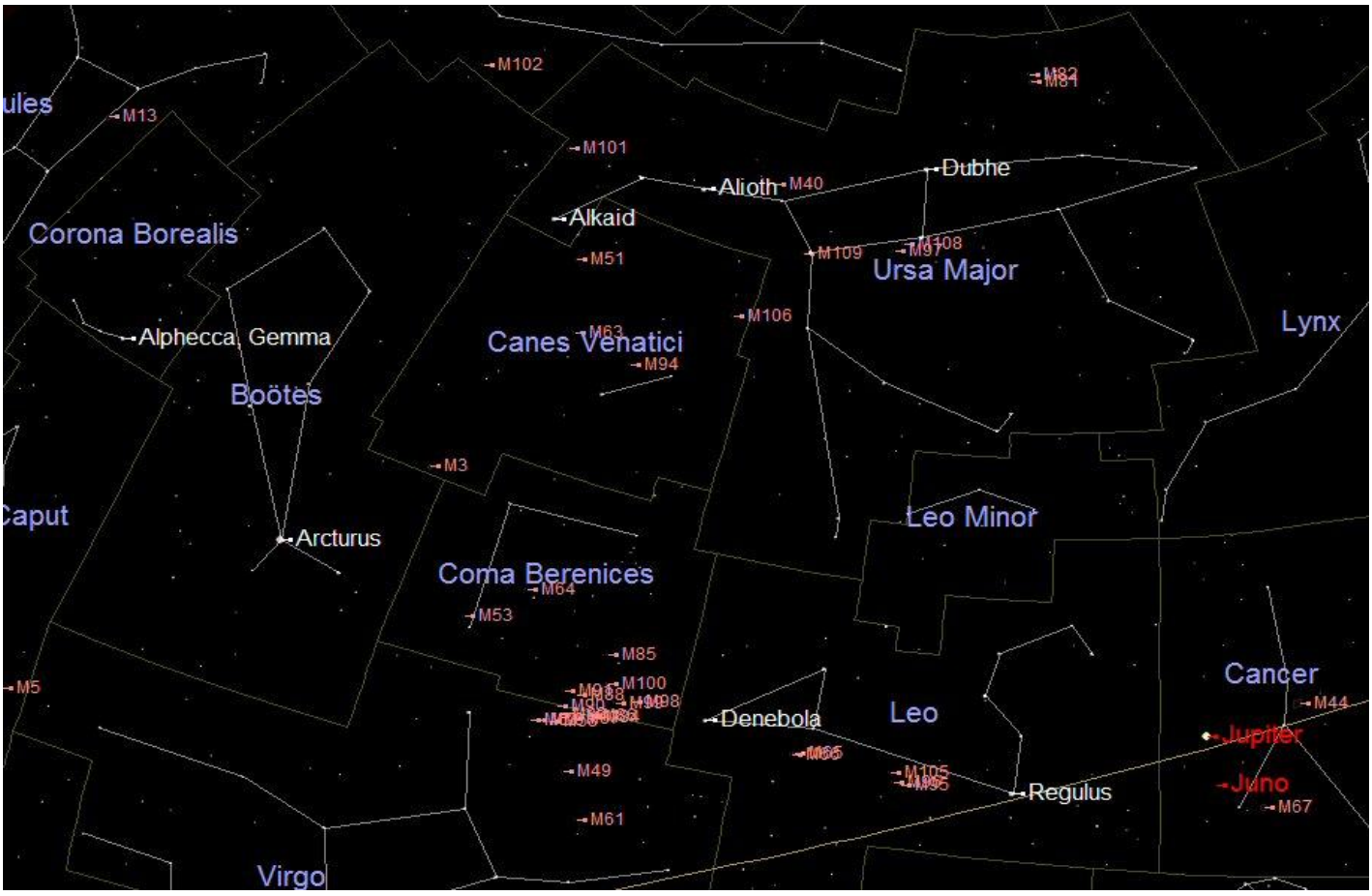
To the east of Leo are the constellations of Coma Berenices and Virgo. Coma Berenices has no bright stars and no distinctive shape but on a clear night the three brighter stars can be made out. Virgo has one bright star called Spica that twinkles close to the horizon.

The whole area of sky around Leo, Coma Berenices and Virgo hosts many galaxies. These are the galaxies of our 'local group' of nearby galaxies close to our own galaxy that we call the Milky Way. Virgo hosts the lovely bright star Spica that twinkles above the southern horizon.

The constellation of Libra is now starting to appear over the south eastern horizon. Libra is of special interest this year because the beautiful ringed planet Saturn is resting within its bounds.

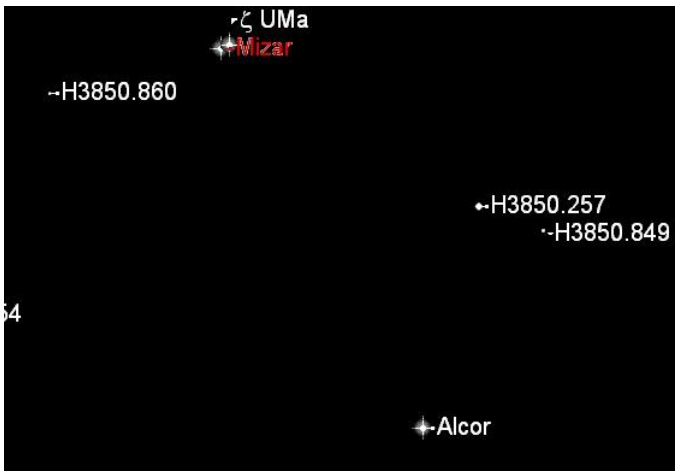
To the north of Leo is perhaps the best known and easiest constellation to recognise Ursa Major (the Great Bear sometimes called the Plough). The main asterism (pattern of stars) actually forms the shape of a saucepan and really looks nothing like a bear. Directly off the end of the 'handle of the saucepan is the rather unremarkable constellation of Canes Venatici (the Hunting Dogs).

THE CONSTELLATION OF URSA MAJOR



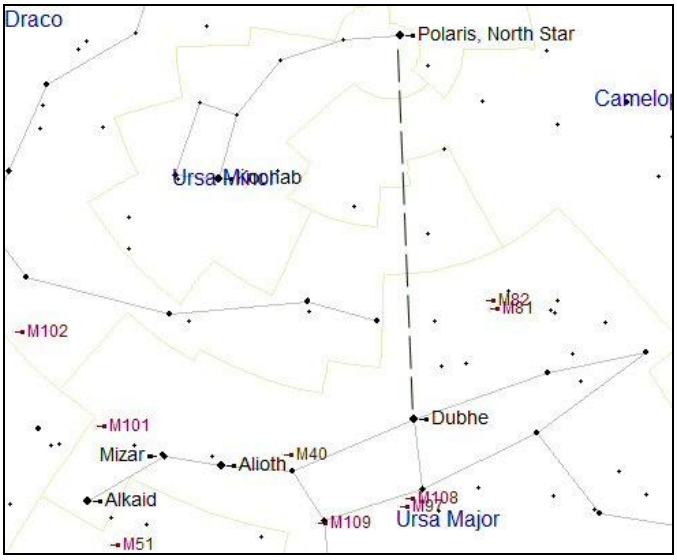
Ursa Major, the Great Bear (sometimes called the Plough or the Big Dipper) is one of the best known and most easily recognised constellations. Ursa Major does not remotely resemble a bear and even the ancient drawings depicting it as a bear had to result to giving the bear a long tail but bears do not have tails. However the pattern formed by the brightest stars does look remarkably like a saucepan.

The centre star of the three stars forming the 'handle' of the 'saucepan' is a famous naked eye double star Mizar and its companion Alcor. Viewed through a telescope, Mizar itself can be seen to be a double star. When the light from the two Mizar stars is split using a spectroscope each star is found to be double thus making this a five star system. These Mizar pairs are too close to be separated using any amateur telescopes.



The Double star Mizar (top) and Alcor (bottom).

The two stars forming the pan farthest from the handle are the are called 'the pointers' to the pole star Polaris also known as the 'North Star' in Ursa Minor (the Little Bear). Ursa Major is a circumpolar constellation this means it can be seen above the horizon all year although in the winter it is less obvious when it is close to the northern horizon.

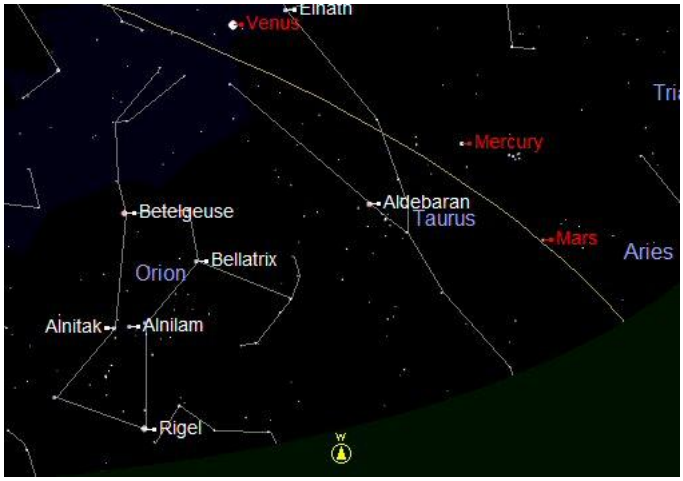


The pointers show the way to the Pole Star (Polaris)

There are six Messier objects in Ursa Major although one M40 is disputed and is in fact just a pair of bright stars. M97 is the famous Owl Planetary Nebula. M81, M82, M101 and M108 are all galaxies. The brightest galaxy M81 is a beautiful spiral and is bright enough to be seen using binoculars. Just off the end of the 'handle' in Canes Venatici is M51 the Whirlpool Galaxy.

THE SOLAR SYSTEM THIS MONTH

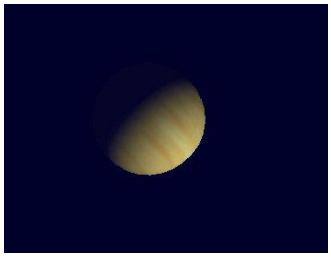
MERCURY will be observable at the beginning of the month after sunset, low in the west. Mercury will be at greatest eastern elongation (its maximum apparent distance from the Sun) on 7th May. It will be 19 degrees east of the Sun and 16 degrees above the western horizon. See pages 2 and 3.



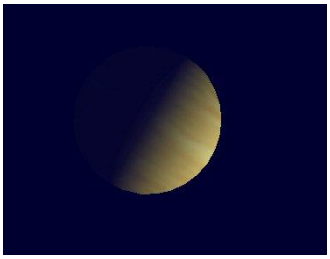
Mercury, Venus and Mars in the west at sunset

The sky in the chart above has been darkened to show the positions of the planets more clearly.

VENUS is rising higher above the south western horizon in the evening sky over the next few months. It is so bright at magnitude -4.2 that it cannot be missed. As Venus moves further out from the Sun it is moving closer to us and will appear larger. However as it gradually gets larger it will become crescent shaped. Venus will not reach its greatest eastern elongation (and its thinnest crescent) until 6th June when it will be at its greatest apparent distance from the Sun.



Venus at 23:00 1st May



Venus at 23:00 30th May

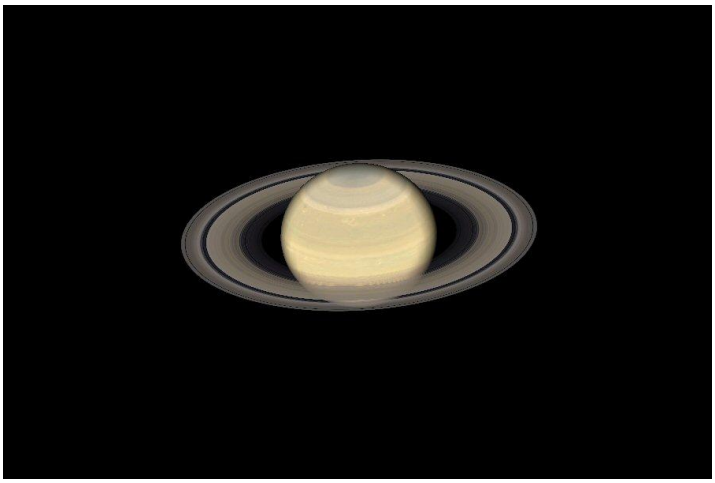
The images above show how Venus will be appearing larger but narrower through the month of May.

MARS will not be visible this month as it will be lost in the twilight glare as the Sun sets. See the Mercury chart above.

JUPITER is located in Cancer and will be in the south west as the sky darkens. It will be visible until it sets in the west at 02:15. See the chart on page 7. The cloud belts and zones can be seen using a small telescope. See the advice for observing Jupiter using a telescope in the March issue of this magazine.

Jupiter is still in a really good position for observing. We are still looking straight down on the equator and therefore see the moons passing in front and behind the planet. This means we see the moons cast an eclipse shadow on to the planet.

SATURN rises at about 21:00 mid-month and will be well positioned for observing quite low in the south from about midnight until the sky begins to brighten. Saturn can be seen in the south and will be observable until about 04:30 when the sky begins to brighten before dawn. For those who stay up to make observations of the beautiful ringed planet in the hours around midnight there is the reward of seeing the rings system wide open. It is also possible to see Saturn's largest moon Titan using a small telescope and up to six moons using a larger telescope.



Saturn as it appears during May 2015

URANUS rises in the east just before the Sun so will not be observable this month.

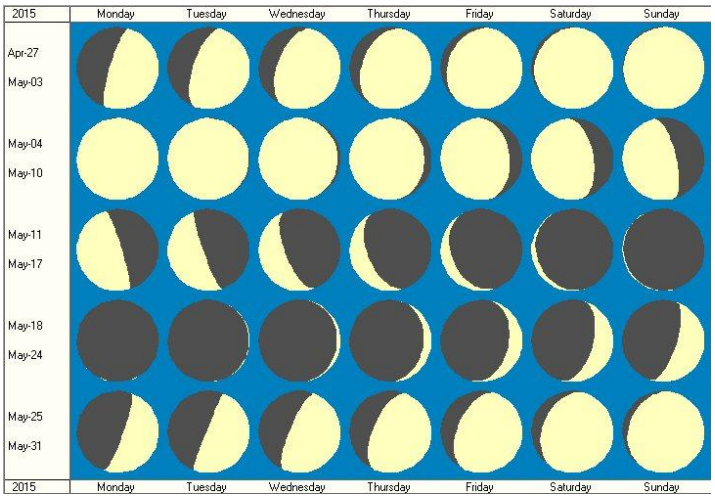
NEPTUNE rises in the east at about 04:00 just as the sky is beginning to brighten so will not be observable this month.

THE SUN

The Sun rises at 05:25 at the beginning of the month and at 04:55 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 MAY 2015



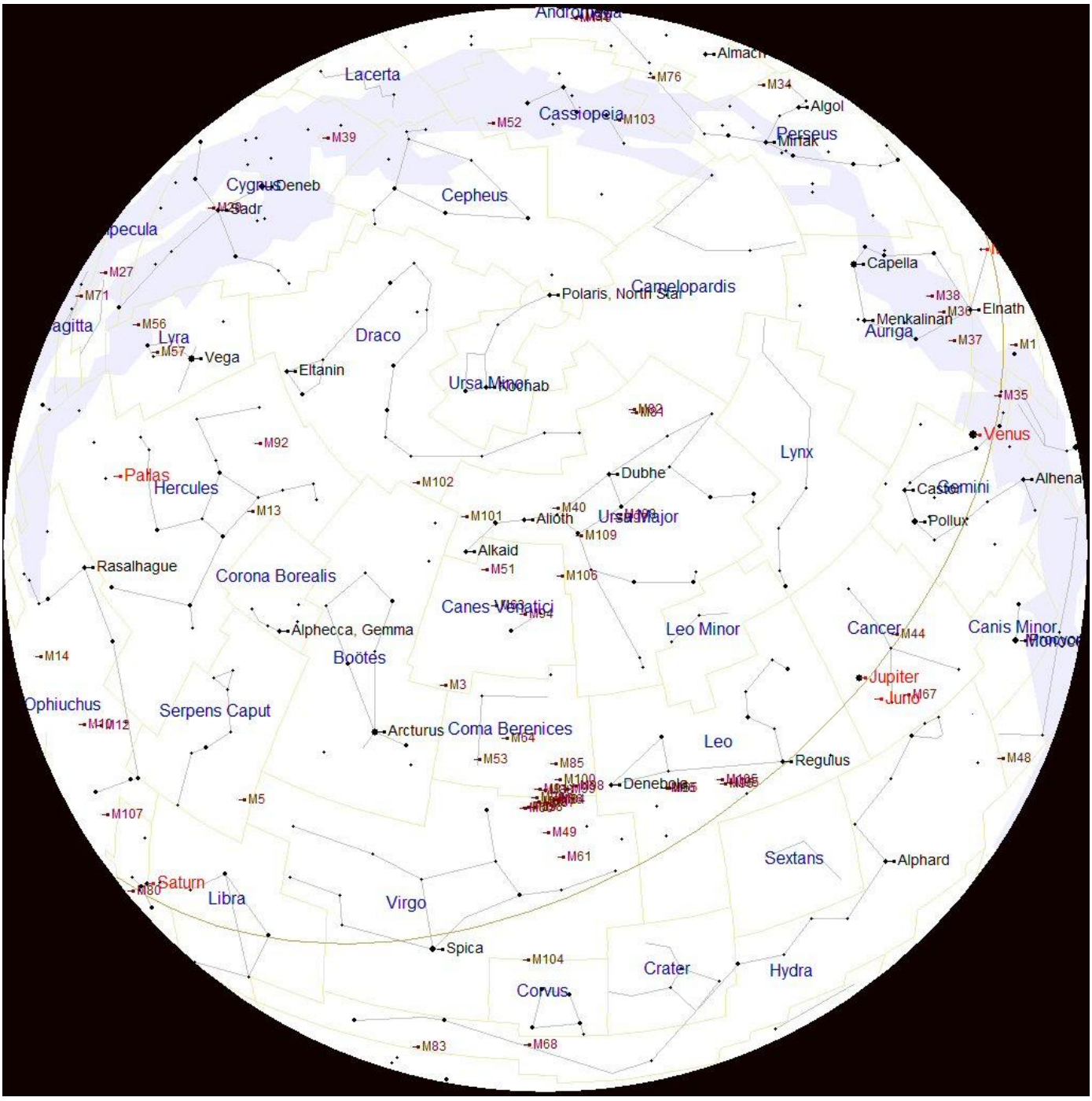
Full Moon will be on 4th May

Last Quarter will be on 11th May

New Moon will be on the 18th May

First Quarter will be on 25th May

THE NIGHT SKY THIS MONTH



The chart above shows the night sky as it appears on 15th May at 10 o'clock in the evening 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 11 o'clock BST at the beginning of the month and at 9 o'clock 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 directly overhead. 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 night sky: Jupiter, Mars and Venus. Saturn can be seen in the early morning.