NEWBURY ASTRONOMICAL SOCIETY
MONTHLY MAGAZINE - MAY 2017

NEW SOLAR SYSTEM FOUND AROUND A TINY STAR

An artist impression of Trappist-1 and its planetary system

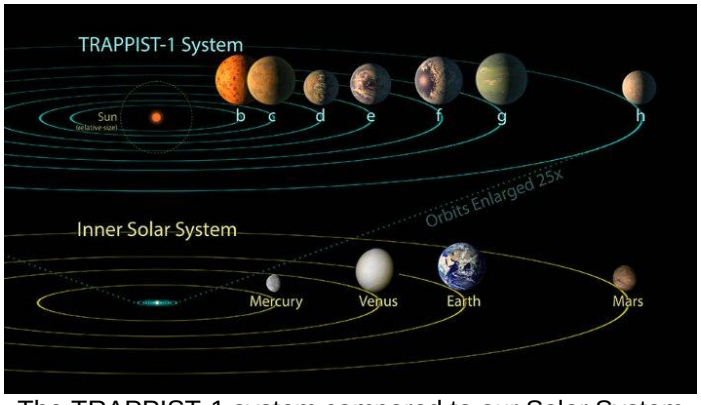
Seven Earth-sized planets have been discovered orbiting a single ultra-cool dwarf star 40 light years away. Depending on their atmospheric conditions, all seven could potentially be habitable, making the system a prime target for scientists hunting for another Earth.

The planets were discovered in the TRAPPIST-1 system by a team led by Michaël Gillon, of the University of Liège in Belgium. TRAPPIST-1 is an acronym for the TRAnsiting Planets and PlanetesImals Small Telescope. It is actually two 0.6-metre telescopes located in Chile and Morocco that together monitor 60 ultra cool dwarf stars and brown dwarfs, looking for evidence of exoplanets. Three of TRAPPIST-1's planets labelled b, c and d were discovered using the TRAPPIST-South telescope in Chile last year. With the other four new planets the system it is the first system known to host so many Earth-sized worlds, not to mention they may all be potentially habitable worlds.

All seven planets transit their star; (they cross in front of the star's disc) blocking some of the starlight. The amount of light each planet blocks tells us their diameter and how regularly they transit tells us their orbital period. From this we can calculate their distance from the star. Their masses are then determined by judging how big a wobble the planets' gravity induces in the star's rotational motion.

The star is located in the constellation of Aquarius and is tiny, barely larger than a super Jupiter with a mass just eight percent of the Sun. Its surface temperature is a relatively cool 2,270°C, which is less than half the surface temperature of our Sun.

The star is very small therefore the planets orbit very close to the star. In fact all the TRAPPIST-1 planets (now referred to as b to h) would fit inside the orbit of Mercury around our Sun. The diagram below shows how small the Trappist-1 planetary system would be if was placed at the centre of our Solar System.



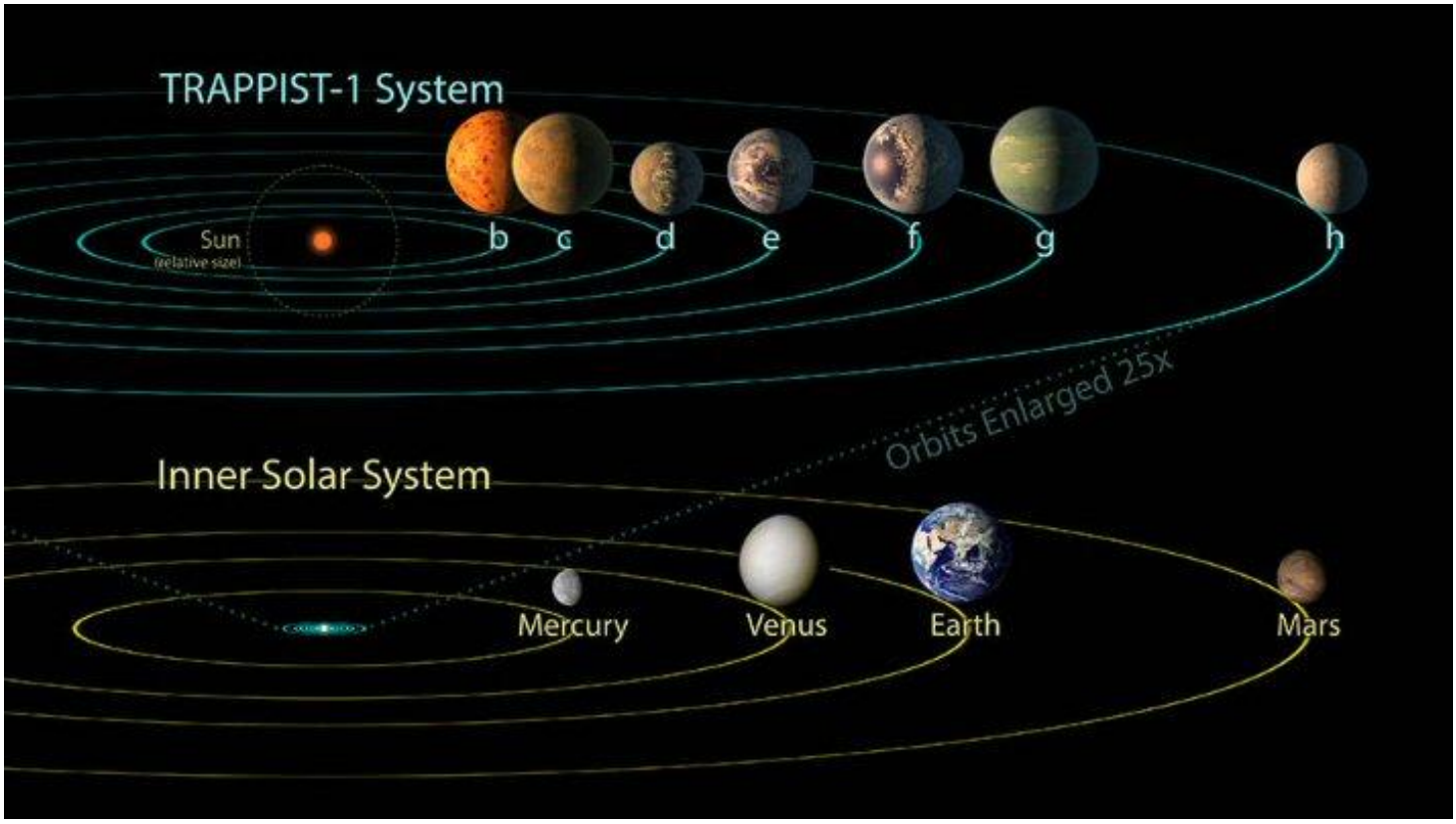
The TRAPPIST-1 system compared to our Solar System

NEWBURY ASTRONOMICAL SOCIETY MEETINGS

5th May — The rise of a Giant (the ELT)
Website: www.newburyastro.org.uk

NEXT NEWBURY BEGINNERS MEETING

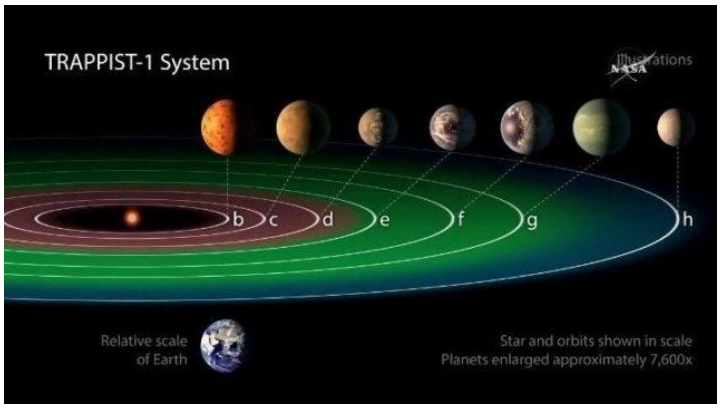
17th May — Noctilucent Clouds
Website: www.naasbeginners.co.uk



The physical attributes of the TRAPPIST-1 planets

The diagram above shows the size and the physical attributes, including an artist's impression of what the TRAPPIST-1 planets may look like. The latest indications are that all the planets are rocky and similar in size to Earth. However because the planets are so close to the star their orbit times are very short. The inner planet 'b' takes just 1.5 days to complete one orbit and the outer planet 'h' takes about 20 days (this is an estimate because the outer planet's orbit has not been confirmed yet).

The most interesting thing about the discovery of this planetary system is that all the planets appear be in the Habitable Zone around the star. This is the zone where a planet would receive just the right amount of heat and light to make it possible for liquid water to exist on the planet. This zone is also known as the 'Goldilocks Zone' where the temperature is 'just right'. To be in the Habitable Zone is thought to be the main requirement for a planet to have the possibility of being able to support life. It does not mean there is life on any of the planets it just means that the temperature could suitable for life (as we know it) to exist.



A diagram of the TRAPPIST-1 Habitable Zone

The Red Dwarf Star TRAPPIST-1 is just 8% the mass of the Sun so it is very small in stellar terms. It is located nearby in the constellation Aquarius (The Water Carrier) but appears very dim. Astronomers expected that such dwarf stars might host many Earth-sized planets in tight orbits, making them promising targets in the hunt for extraterrestrial life but TRAPPIST-1 is the first such system to be found.

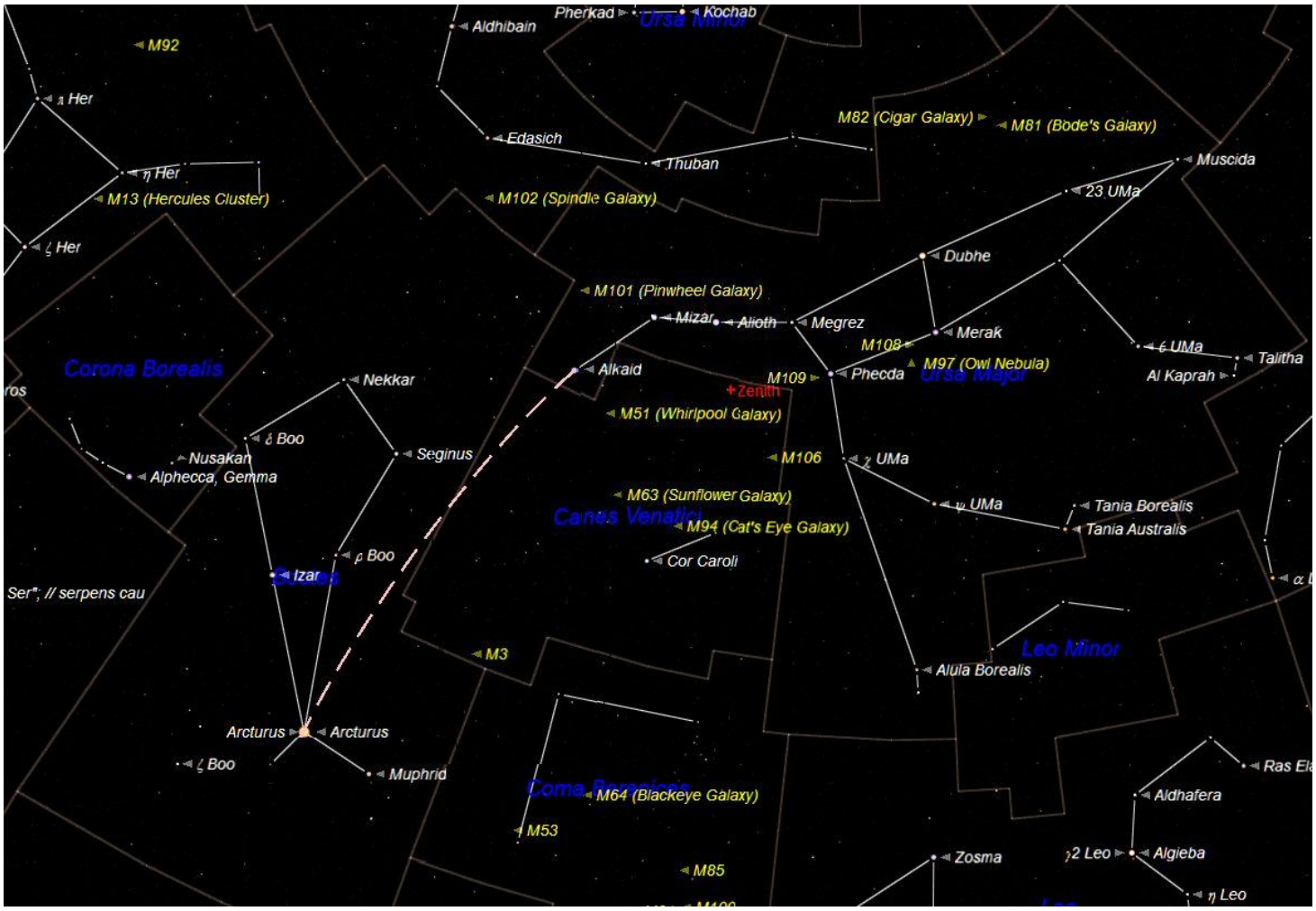
As these Red Dwarf stars are so small they are very faint and only the closest can be detected and studied. It has long been thought that even these very small stars should have planets and providing any planets are orbiting close to the star they could be in the warm 'Habitable Zone'.

The physical nature of any planets can also affect the possibility of supporting life. A planet could be dry and have no significant water or may not have any significant atmosphere. On the other hand a planet may have a very thick atmosphere and have a runaway greenhouse effect on the heating making it too hot to support life, like Venus.

A planet in a very close orbit to a star may also have a captured rotation (like our Moon) where the same half of the planet permanently faces the star. This means that the half of the planet facing the star will be hot and the side facing away would be cold. However if that planet has an atmosphere then the heat could be transported around the planet by the atmosphere and provide temperate zones. So there are many things that can affect the planets and their possibilities of supporting life.

Needless to say this tiny star and its family of planets will be the subject of intense investigations by astronomers and scientists all over the world. More powerful telescopes will be teasing out every bit of information from this system over the next few years to see what the planets are really like.

CONSTELLATIONS OF THE MONTH – BOÖTES and CANES VENATICI



The location of Arcturus in the constellation of Boötis

The constellation of Boötis (the Herdsman) does not contain any bright deep sky objects but it is a very useful constellation to help find our way around the night sky. This is because its (only) bright star Arcturus is a beautiful bright Red Giant. The asterism (pattern or shape), formed by the other less bright stars, appears to look like a traditional 'diamond' shaped kite. Arcturus is conveniently located at the lower point of the 'kite' where the tail would be attached.

Although Arcturus is bright and distinctly orange in colour it can be conclusively identified by following a simple idiom phrase 'Arc Down [from Ursa Major] to Arcturus'. This simply means: follow an arc down from the handle of the saucepan shape of Ursa Major (the Plough) to Arctaurus, as shown on the chart above.

Arcturus also designated as Alpha (α) Boötis, is the brightest star in the constellation of Boötes and the fourth-brightest in the night sky also the brightest in the northern celestial hemisphere. Together with Spica and Denebola (or Regulus, depending on the source) Arcturus is part of the Spring Triangle.

Arcturus is relatively close at 36.7 light-years from the Sun and is a Red Giant of spectral type K0III. This is an ageing star around 7.1 billion years old that has used up most of its hydrogen fuel supply. It is 1.08 ± 0.06 times the mass of our Sun but has expanded to about 25 its diameter and is around 170 times more luminous. It therefore gives us an insight of what our Sun will be like when it becomes a Red Giant in about 4 billion years time.

Arcturus is a beautiful sight when seen using binoculars or a telescope. If the image is put slightly out of focus the orange colour becomes much more apparent.

A photographic image of Arcturus

At some point in the next few million years Arcturus will have consumed all its supply of Hydrogen and Helium fuel. At this point the star will no longer be able to support its own mass. The outward force of the radiation energy that had sustained the star will disappear and the inward force of its own gravity will cause the star to collapse. It will collapse until it is about the size of our Earth to become a White Dwarf Star. It will be very dense and hot at about 50,000°K. For more information about white Dwarfs and other dense stars see the April 2017 magazine on our website.

THE CONSTELLATION OF CANES VENATICI (the Hunting Dogs)

Canes Venatici is a rather indistinct constellation with no bright stars and no obvious pattern of stars. However this constellation is very easy to find because it is located next to Ursa Major (the Great Bear) in fact it is directly below the 'handle' of the saucepan shape of Ursa Major. See the chart on the previous page.

Although Canes Venatici is not very interesting to look at using our naked eye or binoculars it does have some very interesting deep sky objects to search out. There are four very nice galaxies and a beautiful Globular Cluster.

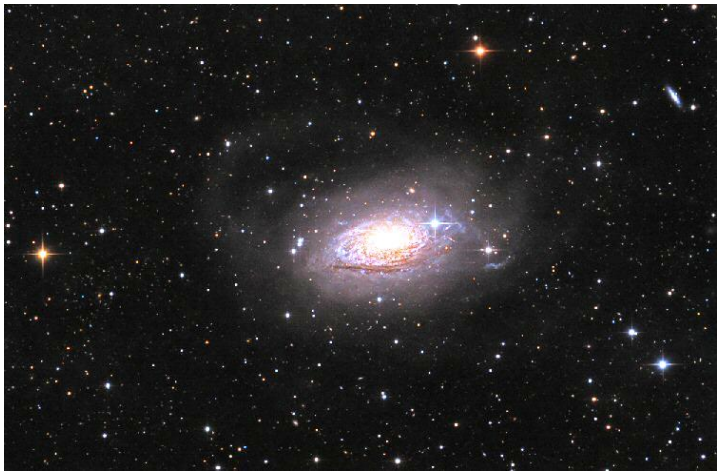
The most interesting of the galaxies is Messier 51 (M51) the Whirlpool Galaxy. This is in fact two galaxies that have been involved in a collision.

Messier 51 (M51) the Whirlpool Galaxy

The image above shows M51 in great detail and clearly shows how the smaller galaxy on the right has swept past the larger one and pulled off a trailing arm of stars and gas.

This galaxy was the first to be determined as an object outside of our galaxy. The discovery that this galaxy was not in our galaxy, resulted in the realisation that the universe was much bigger than was hither to believed and our galaxy was not the whole universe. It does require a larger telescope and a dark sky to see M51. The pattern of the spiral arms can be seen in a 200mm telescope but the sky does need to be dark and unpolluted by street lights.

Messier 63 (M63) is a spectacular spiral galaxy also known as the Sunflower Galaxy. It was one of the first galaxies found to have spiral arms. The spiral arms of M63 are particularly tightly wound. The contrast of the image below has been increased to show an arc of stars on the left.



Messier 63 (M63) the Sunflower Galaxy

Messier 94 (also known as the Cat's Eye Galaxy) is unusual because it has both an inner ring and an outer ring of spiral arms. These rings appear to form at resonance locations within the disk of the galaxy. The inner ring is the site of strong star formation activity and is sometimes referred to as a starburst ring. This star formation is fueled by gas that is dynamically driven into the ring by the inner oval-shaped bar-like structure.

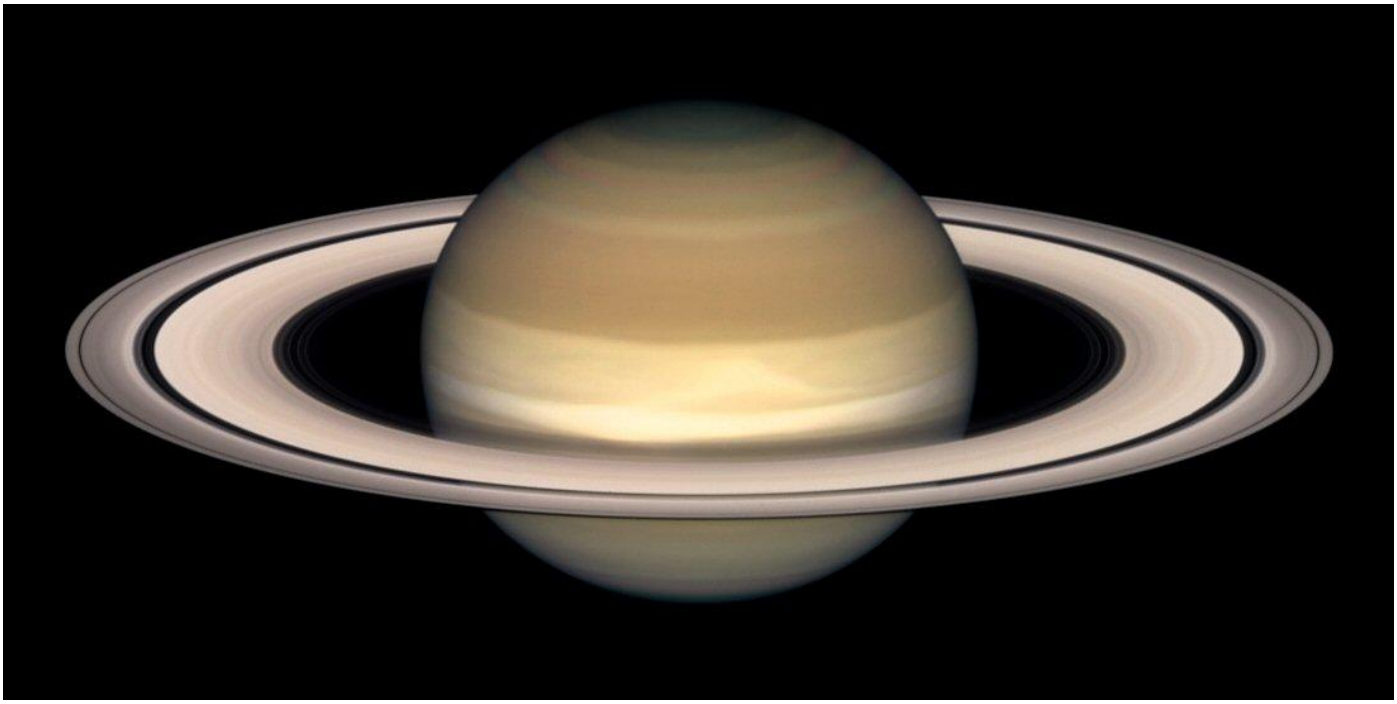
Messier 94 (M94) a beautiful spiral galaxy

Messier 106 is an intermediate size spiral galaxy in the constellation Canes Venatici and located at a distance of about 22 to 25 million light-years away from Earth. It is also. It is suspected that part of the galaxy is falling into a super-massive black hole in the centre and is also classified as a Seyfert II type galaxy due to the X-rays and unusual emission lines detected.

Messier 106 (M106) a medium sized Spiral Galaxy

Messier 3 (M3) is a lovely Globular containing around 500,000 stars and is estimated to be 8 billion years old. It is located at a distance of about 33,900 light-years away from Earth and can be seen using a moderate sized telescope.

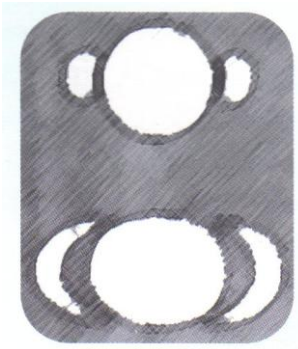
SATURN THE RINGED PLANET



Saturn the beautiful ringed planet

Saturn, with its magnificent ring system, is surely the easiest planet to recognise. Any poster or cartoon depicting a space scene will almost certainly have a planet with a ring system looking somewhat like Saturn. The large outer planets also have ring systems but these are all feeble compared to Saturn's.

Since the very early days of telescope astronomy, Saturn appeared to have something odd about it. Galileo thought it sometimes looked as it had 'ears' or handles like a jug. His first telescopes in the early 1600's were too small and too primitive to see any real detail.

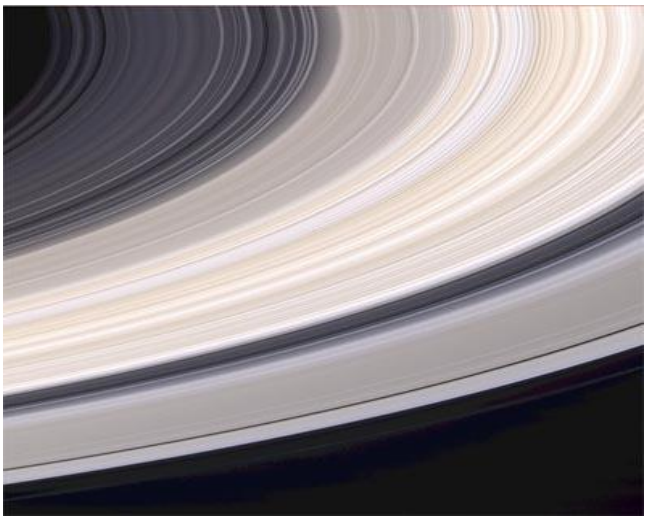


Galileo's sketch of Saturn with 'ears' 1610

In 1655 Christian Huygens recognised that Saturn had a ring. It wasn't until 1675 that Giovanni Cassini recorded seeing the gap in the rings that is now named after him. As the size and quality of telescope optics improved more detail could be made out. We generally think of Saturn as having 'a ring' but in fact it has a complex ring system comprised of hundreds of rings. Until the planet was visited by exploratory probes the finer details of the ring system could not be fully appreciated.

One theory about how the rings formed is that a comet or a small moon strayed too close to Saturn and the enormous gravitational forces pulled the body apart. The lumps of water ice and dust were pulled into orbit around the equatorial plane of the giant planet.

Until recently it was a mystery how the rings had lasted so long. Studies had estimated that the rings had been in existence for at least a million years and perhaps much longer.

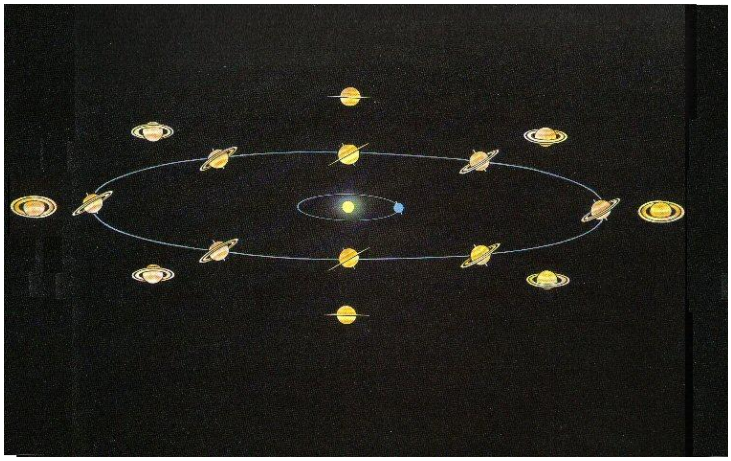


The rings imaged by the Cassini Probe in 2005.

When the Pioneer II probe passed close to Saturn in 1979 it imaged two moons orbiting on the outside of the ring system. These moons named Pandora and Prometheus were found to be moving the particles in the rings and preventing them from straying out of their positions and falling into the planet. These moons became known as 'Shepherd Moons' because they appeared to be herding the ring like a shepherd looking after his flock of sheep and keeping the rings in shape.

The Cassini probe has been orbiting Saturn and visiting its moons since 2004 and is due to complete its mission of discovery around Saturn in September this year. Before it is sent crashing into the atmosphere of Saturn it will carry out the closest survey of Saturn and its rings ever. It will even pass between the inner edge of the rings and the top of Saturn's atmosphere.

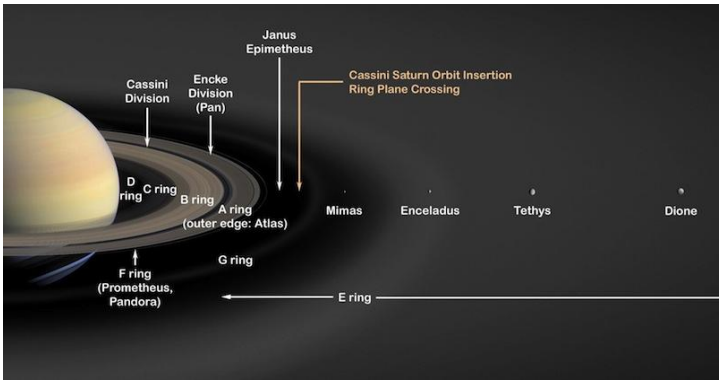
Saturn is approximately ten times further out from the Sun than Earth therefore we always see Saturn fully illuminated and never see phases. However we do see the rings from a different aspect over the course of Saturn's 29.46 (Earth) years orbit around the Sun. As Saturn is so far away from us and we are a lot closer to the Sun, we view Saturn almost as if we are at the same position as the Sun. Saturn has a 27.6° tilt but is always tilted in the same direction as it orbits the Sun. Therefore as we look out from our position, close to the Sun, Saturn's ring appears to tilt up and down as Saturn orbits the Sun every. In 2003 we were looking at Saturn when it was tilted with its south pole towards us. (Shown at the extreme left position in the diagram below). We were therefore able to see the ring system tilted away from us. In this position we could see the underside of the rings that appeared wide open.



After 7½ years Saturn would have completed approximately a quarter of its ~30 year long orbit around the Sun and was at the lower position shown in the diagram above. Therefore in 2009 we were looking at Saturn side on. As the rings are very thin they disappeared almost completely for a few months. Over the next 7½ years the rings gradually appeared to open out again until this year (2017) we will see the top surface tilted towards us as show in the position at the right of the diagram. The closing sequence then will continue until 2025 when we will again view the rings side on as shown at the top position in the diagram. Eventually in 2032 Saturn will return the same position that it we saw it in 2003 where the rings will be tilted away from Earth and wide open again.

Saturn is the second largest planet in our Solar System after Jupiter. The planet itself is 120,000 km in diameter at the equator but is flattened to 108,000 km at the poles due to its rapid rotation. Although Saturn is 10 times the diameter of Earth it rotates on its axis (1 day) in only 10 hours 14 minutes. The rings are 275,000 km (170,000 miles) across but are mostly less than 30 metres thick. To put this in perspective, the ring diameter is about ¾ of the distance from Earth to the Moon. The rings are made up of millions of small pieces of mainly water ice and varying in size from a few millimetres to a few metres across.

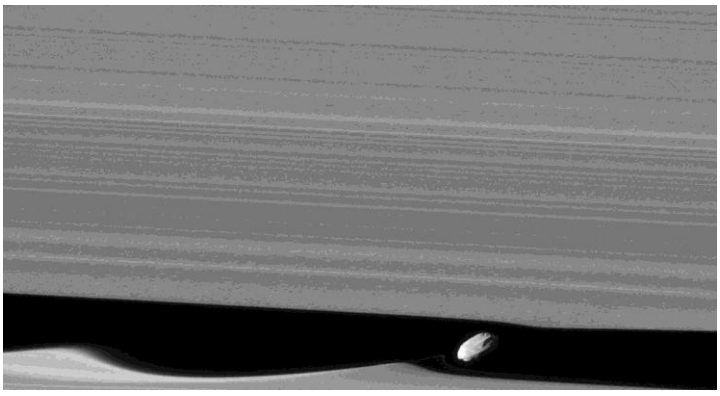
Like Jupiter, Saturn is a gas giant planet. This means it has no solid surface that a probe craft could land on. The majority of the planet (96.3%) is made up of Hydrogen gas with 3.7% Helium and traces of Ammonia and Methane. The cloud markings are more subtle than those on Jupiter and need a larger telescope to discern clearly.



The rings and shepherd moons

The diagram above shows identifications of the rings and some of the moons that shepherd the rings to maintain their structure. The rings are named alphabetically in the order they were discovered. The main rings are, working outward from the planet, C, B and A, with the Cassini Division, the largest gap, separating Rings B and A. Several fainter rings were discovered more recently. The D Ring is exceedingly faint and closest to the planet. The narrow F Ring is just outside the A Ring. Beyond that are two far fainter rings named G and E. The rings show a tremendous amount of structure on all scales, some related to perturbations by Saturn's moons but much unexplained.

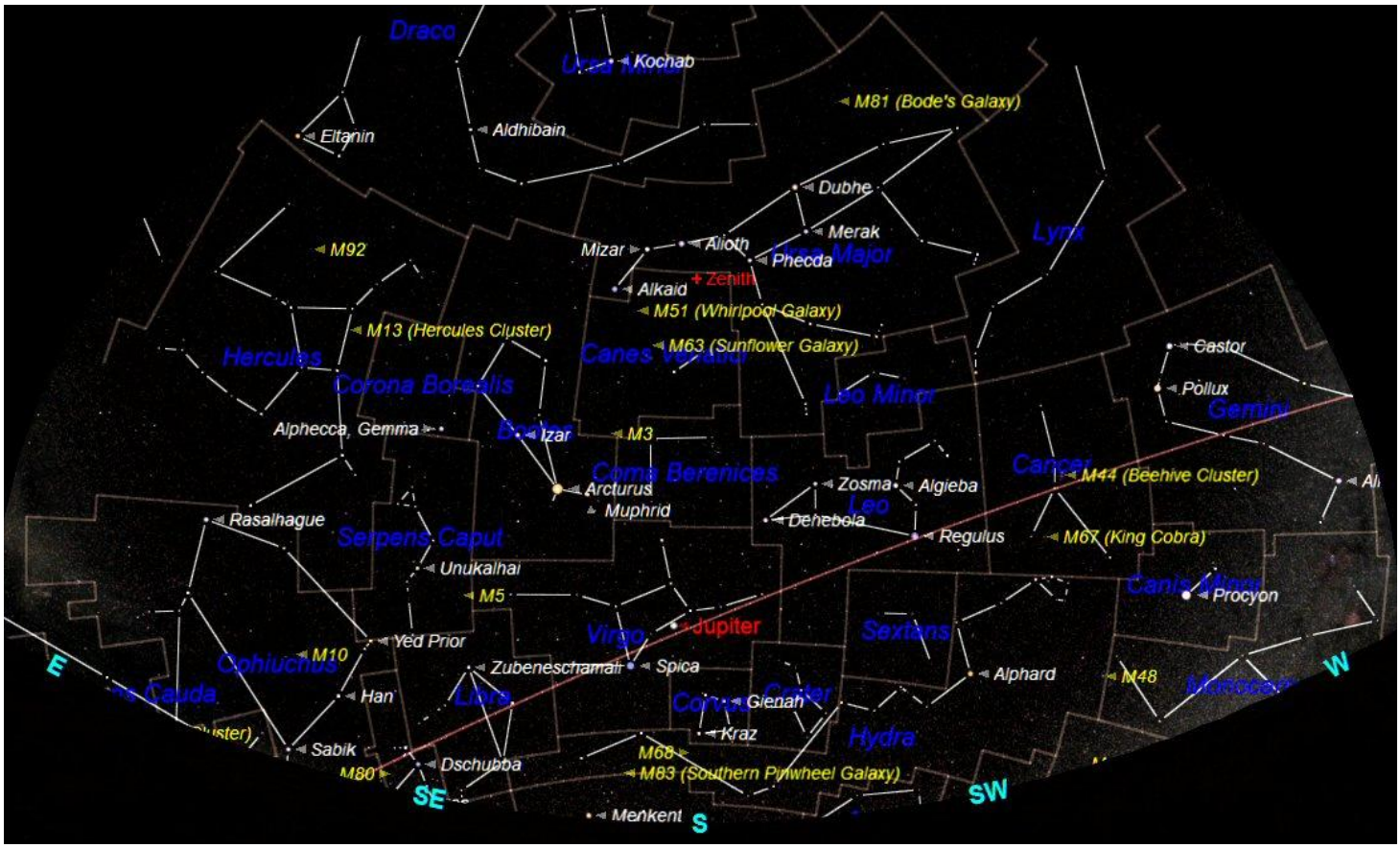
Four robotic spacecraft have observed Saturn's rings from the vicinity of the planet. Pioneer 11's closest approach to Saturn occurred in September 1979 at a distance of 20,900 km. Pioneer 11 was responsible for the discovery of the F ring. Voyager 1's closest approach occurred in November 1980 at a distance of 64,200 km. Images from the spacecraft provided unprecedented detail of the ring system and revealed the existence of the G ring. Voyager 2's closest approach occurred in August 1981 at a distance of 41,000 km. Voyager 2 observed the ring system at higher resolution than Voyager 1 and discovered many previously unseen ringlets. Cassini entered into orbit around Saturn in July 2004. Cassini's images of the rings are the most detailed and are responsible for the discovery of yet more ringlets and many 'Shepherd Moons'.



The shepherd moon Daphnis imaged by Cassini

The 'shepherd' moon, Daphnis, is featured in this view, taken as NASA's Cassini spacecraft made one of its ring-grazing passes over the outer edges of Saturn's rings on 16th Jan 2017. This was the closest view of the small moon obtained at that time. Daphnis is 8 kilometres across and orbits within the 42 kilometre wide Keeler Gap. The little moon's gravity raises waves in the edges of the gap in both the horizontal and vertical directions.

THE NIGHT SKY - MAY 2017



The Southern Night Sky during May 2017 at 22:00 BST (10:00 pm)

The chart above shows the night sky looking south at about 22:00 BST on 15th May. 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 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 constellations through which the ecliptic passes are known as the constellations of the 'Zodiac'.

Constellations through which the ecliptic passes this month are: Taurus (the Bull) but low in the west, Gemini (the Twins), Cancer (the Crab), Leo (the Lion), Virgo (the Virgin), Libra (the Scales) and Scorpius (the scorpion) just appearing over the south eastern horizon.

The Milky Way (our Galaxy) appears to rise up from the south western horizon. It continues up through the constellations of Monoceros and Gemini then off the right of the chart.

The winter constellation of Orion and the winter constellations have all but set over the western horizon. The constellation of Gemini (the Twins) is easy to find by looking for the twin stars Pollux and Castor. There is a lovely Messier Open Cluster M35 in Gemini just off the end of the line of stars emanating from the bright star Castor. Castor is a double star when seen in a telescope with a third more distant companion nearby.

To the east of Gemini is the faint and rather indistinct constellation of Cancer (the Crab). The asterism (shape) of Cancer looks quite uninteresting but the Open Cluster Messier 44 (M44) Praesepe or the Beehive Cluster looks beautiful and like a swarm of bees around an old style hive when seen using binoculars.

Following Cancer is Leo (the Lion) with is distinctive 'hook' shaped asterism looking like a sickle or a back to front question mark (?). The pattern that the brightest stars trace out is the very obvious shape of a resting lion or the Sphinx in Egypt. It is thought the Sphinx was carved into the shape of the lion from a similar looking natural rock formation in ancient times to represent the star formation of the lion, in the sky, on Earth. The original lion's head was replace by the pharaoh's head we see today later during the reign of Pharaoh Khafre 2558 to 2532 BC

To the east of Cancer along the ecliptic is the constellation of Virgo (the Virgin). The constellation shape is comprised of mainly fairly faint stars except Spica which is easy to find. Jupiter is located in Virgo just above Spica so the bright planet can be used to locate Virgo. The constellation of Virgo is the Constellation of the month last month. Just rising over the eastern horizon is the constellation of Libra (the Scales).

Above and to the east of Virgo is the spring constellation of Boötes conspicuously identified by the bright red star Arcturus. The star pattern of Boötes looks like a traditional kite with Arcturus at the bottom where the tail would be attached. To the east of Boötes is the constellation Hercules, named after the hero from Greek mythology.

Directly overhead this month is the best known of all the constellations Ursa Major (the Great Bear) also known as the Plough or the Big Dipper to the Americans. The main asterism (shape) actually looks most like a saucepan. The star half way along the saucepan handle is called Mizar and is a naked eye double star. The companion star to Mizar is called Alcor and is just visible to most people but can be easily seen using binoculars.

THE SOLAR SYSTEM - MAY 2017

MERCURY will not be visible this month.

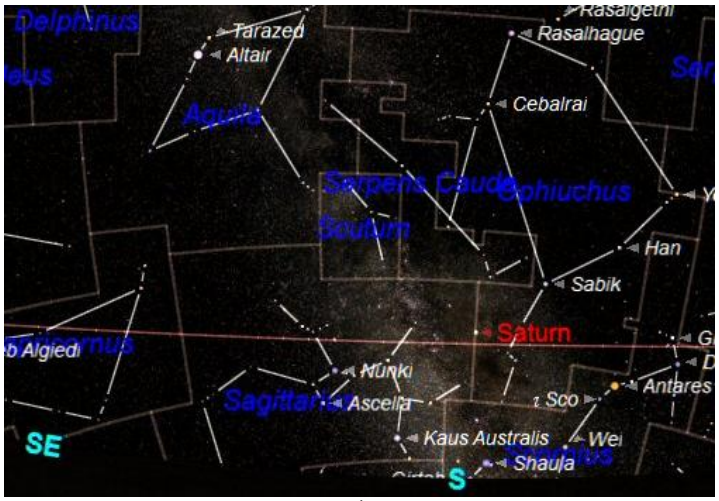
VENUS has disappeared out of the evening sky but is now making its appearance in the early morning sky before sunrise in the east at about 03:00. It will appear very bright and sparkling in the turbulent air close to the horizon.

MARS will be lost in the bright sky in the west as the Sun is setting and will not be visible.

JUPITER is now at its very best for observing. It rises over the eastern horizon at 15:30 so will be observable in the south east as soon as it is dark. See the chart on page 7. A good pair of binoculars will reveal the four brightest of Jupiter's moons, Io, Europa, Ganymede and Callisto. .The table below shows Transits and Shadow Transits this month (best views shown in bold).

Date	Moon	Start	End	Start	End
4	Eur	19:47	**22:12**	**21:02**	**23:29**
4/5	Io	**23:28**	01:39	00:05	02:16
6	Io	17:54	**20:05**	**18:33**	**20:44**
11/12	Eur	**22:07**	**00:33**	**23:39**	02:05
13	Io	19:41	**21:51**	**20:27**	**22:38**
20/21	Io	**21:28**	**23:39**	**22:22**	00:32
27/28	Gan	18:15	**20:39**	**22:22**	**00:40**
27/28	Io	**23:16**	01:27	00:16	02:26
29	Eur	16:04	18:32	18:12	**20:37**
29	Io	17:44	**19:54**	18:45	**20:55**

SATURN will be visible in the brightening dawn sky close to the south eastern horizon. The ringed planet rises at about 23:00 at the beginning of this month and by 21:20 at the end of the month. The ring will appear wide open and easy to see however the view of Saturn will not be very good as it is quite close to the horizon and in turbulent, dirty air. It is observable in the south east from about 01:00 until the sky begins to brighten before sunrise. A medium sized telescope (100 to 150mm aperture and 150x magnification) will be required to see the rings well. See pages 5 and 6.



Saturn in the south on 20th May at 03:00 (3 o'clock)

URANUS will still be too close to the Sun to be seen.

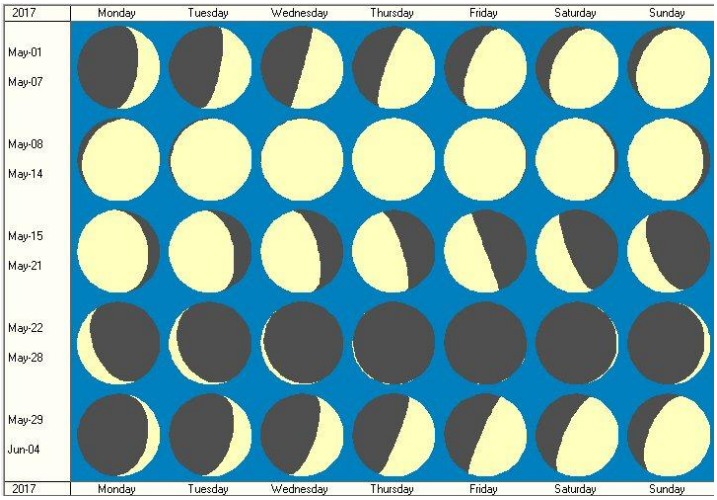
NEPTUNE rises in the east at 02:00 so will, in theory, be observable before the Sun rises. However it will be close to the south eastern horizon and very difficult to see.

THE SUN

There are still occasional sunspots to see even though the active phase of the Solar Cycle is all but over.

The Sun rises at 04:30 at the beginning of the month and at 04:00 by the end of the month. It will be setting at 19:35 at the beginning and 20:00 at 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



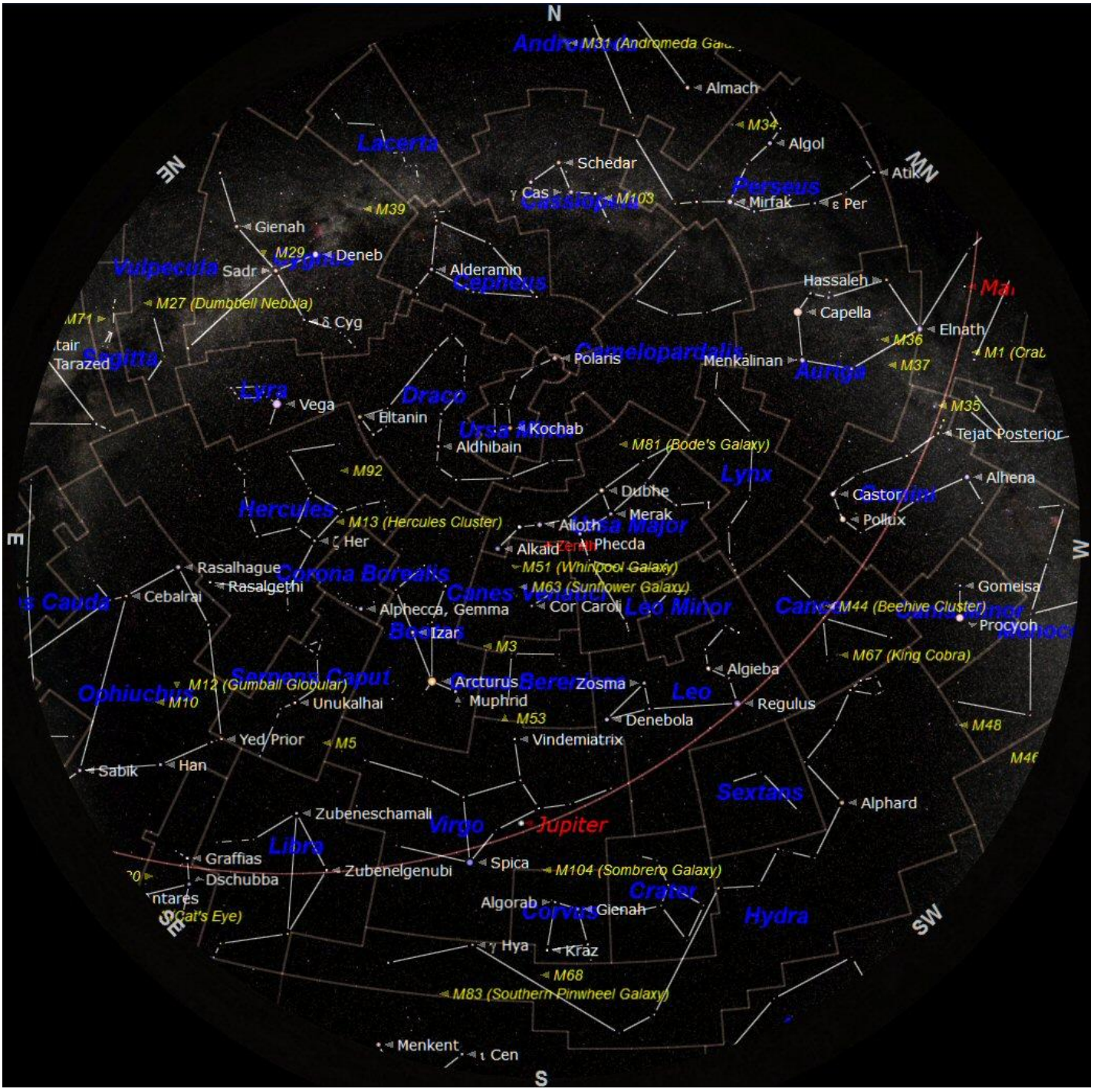
First Quarter will be on 3rd May
Full Moon will be on 10th May
Last Quarter will be on 19th May
New Moon will be on 25th May

It is possible to take pictures of the Moon with basic equipment or even just a DSLR camera. Some people have even taken pictures through the eyepiece of a small telescope using a compact camera or a mobile phone. It is even possible to take a reasonable image using a hand held DSLR.

The image below was taken by Pat Gamalatge from her garden in Newbury using her new Nikon Coolpix P900 DSLR that was just hand held. This camera does have a very high zoom capacity and a special Moon scene setting so is ideal for 'snapping' the Moon.

The Moon imaged by Pat Gamalatge using her DSLR

THE NIGHT SKY THIS MONTH



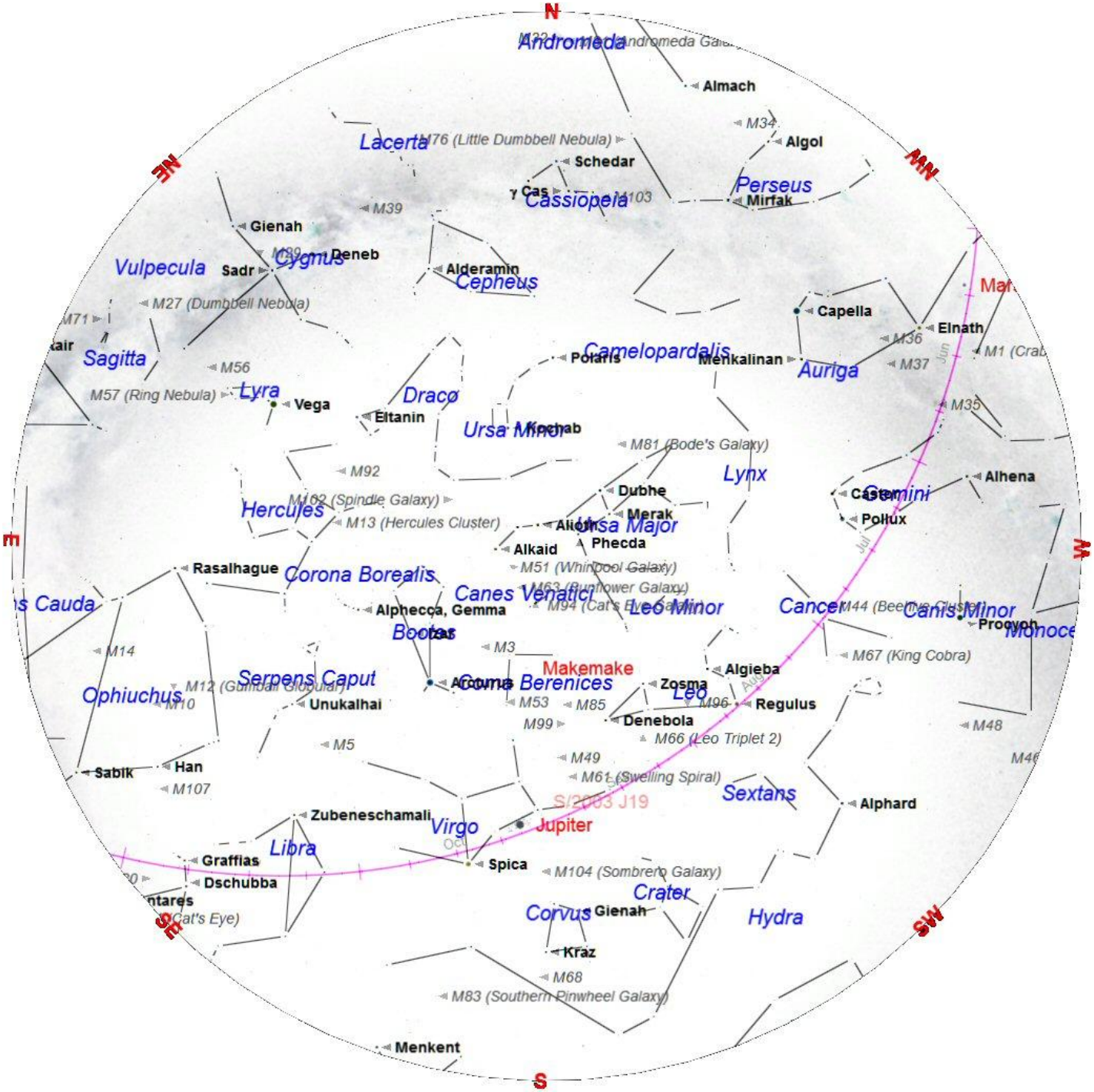
The chart above shows the whole night sky as it appears on 15th May at 22:00 (10 o'clock) in the evening British Summer Time (BST). As the Earth orbits the Sun and we look out into space each night the stars will appear to have moved across the sky by a small amount. Every month Earth moves one twelfth 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 sky appears to rotate from east to west around the Pole Star (Polaris).

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.

Planet observable in the evening sky: Jupiter. Saturn and Venus are visible in the morning before dawn.

THE NIGHT SKY THIS MONTH

This chart below is included for printing off and use outdoors



Position yourself looking south and hold the chart above your eyes with south at the bottom.

The chart shows the sky at 22:00 on 15th May 2017