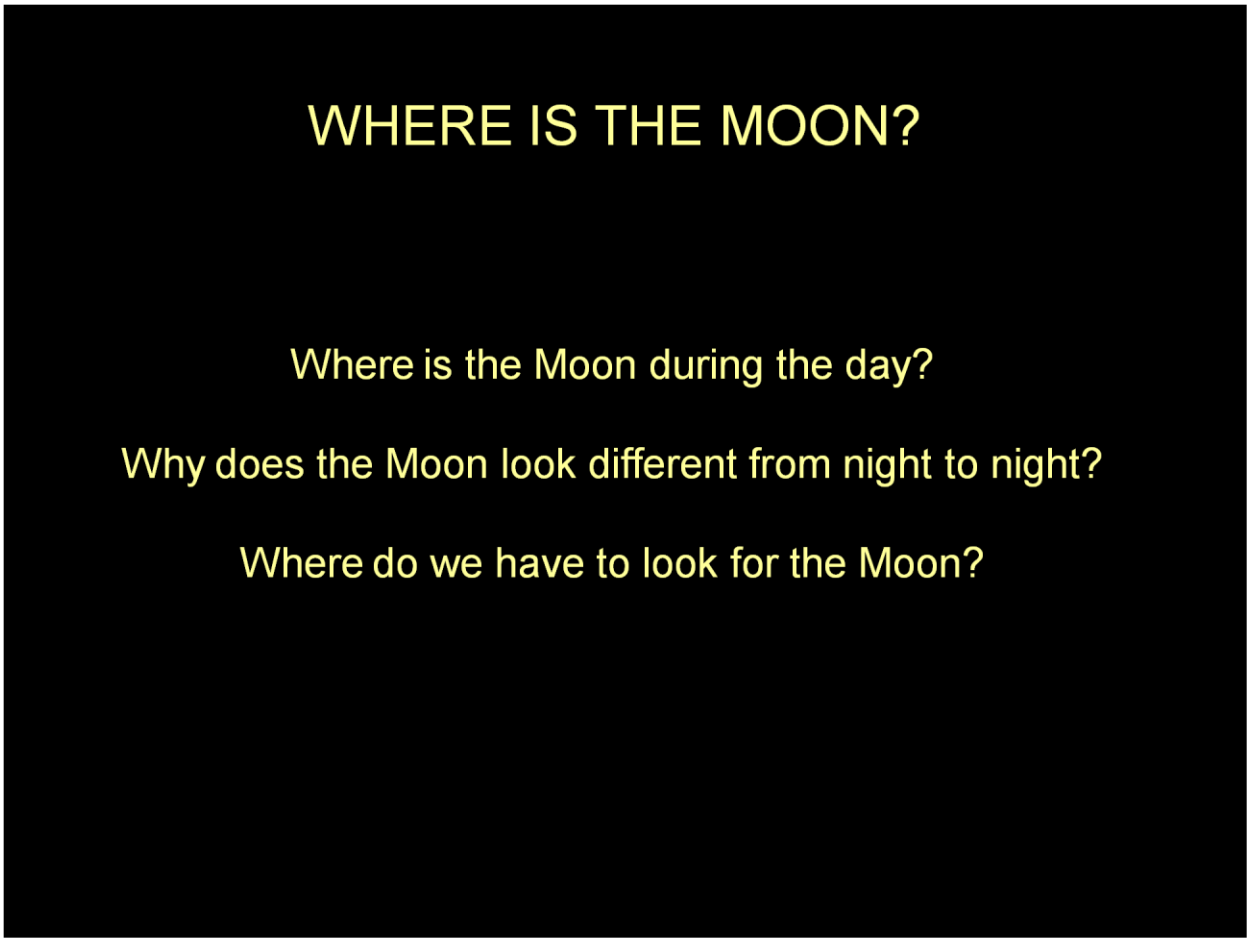
OBSERVING OUR MOON
Beginners 16th June 2021

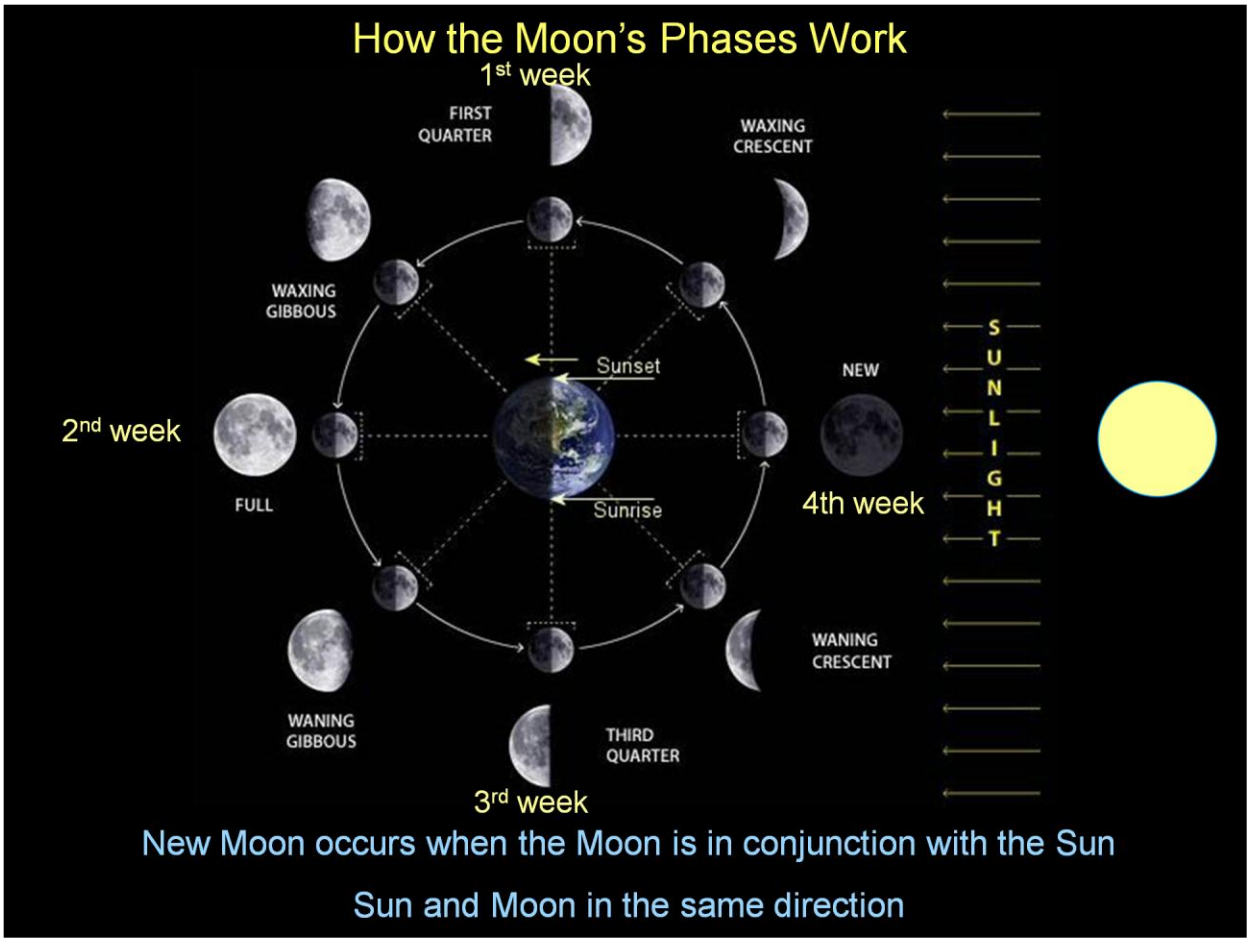
Presented by Steve Harris

We all know what the Moon is and that it is seen in the night sky but the reason for its changing position and shape is a little mysterious. This presentation has been produced to provide an insight into the mechanics of the Moon's orbit around our planet Earth.



We will consider how the orbit of the Moon around Earth gives us different perspective from night to night. We see the moon move across the night sky and we see it changing shape as it crosses the sky so we may ask: why does this happen?

As astronomers, who will want to observe our closest neighbour, will need to know when the Moon will be in the sky for us to see and where it will be located on any given night. We also need to know when it will be the best time to see the many interesting features on the surface of our Moon.



The diagram above shows the relationship of the Sun, Earth and the Moon. The Sun is shown on the right but its distance is not to scale, in reality the Sun would much further away.

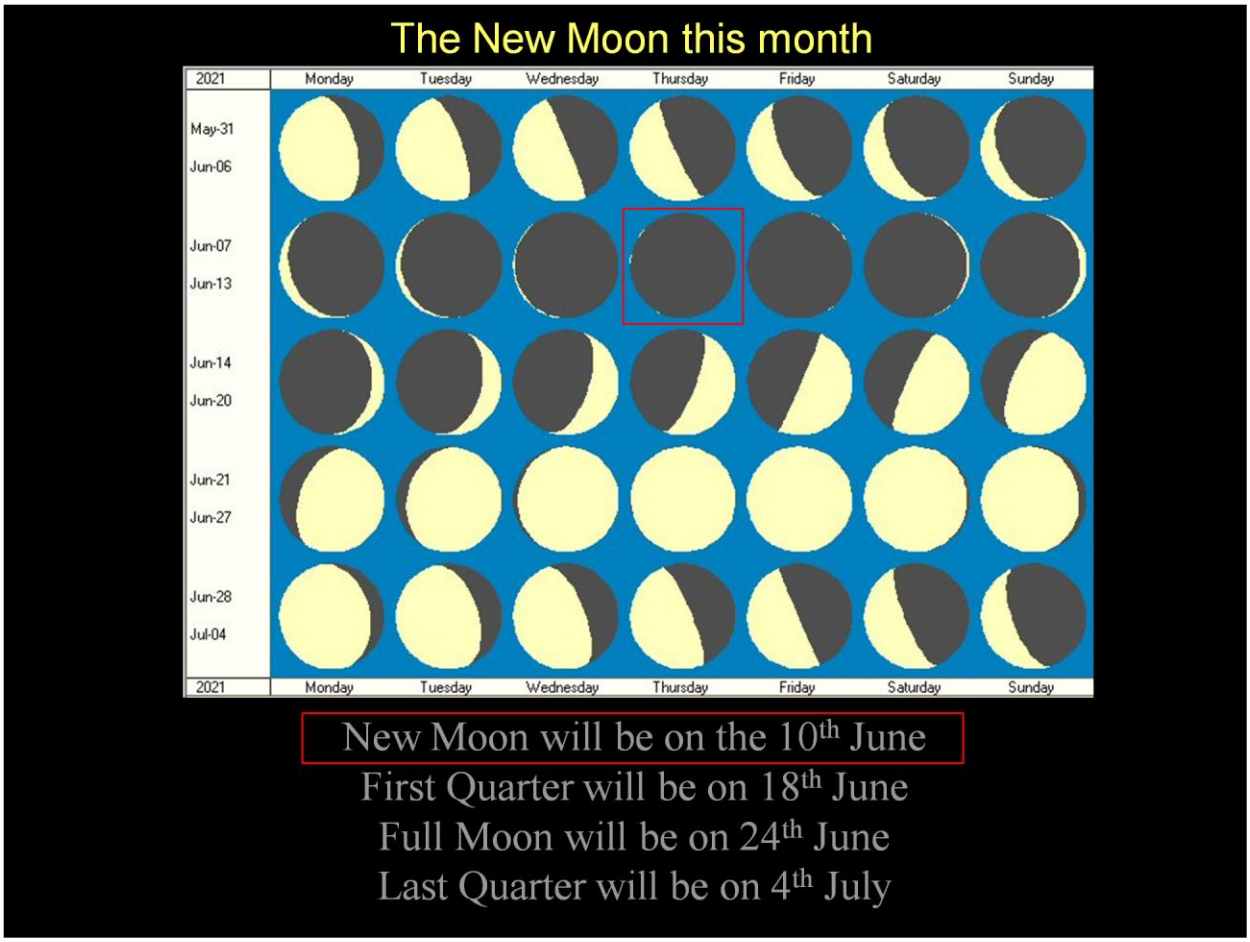
Earth is shown with the side facing the Sun illuminated by the Sun. As Earth rotates on its axis every day (24 hours) the surface passes though its day and night. The line between the night and day is called the 'Terminator'. So the point on the diagram marked 'Sunset' is where an observer would be at Sunset and where we would first see the Moon as darkness falls.

Earth rotates in the direction of the yellow arrow so the sky appears to move in the opposite direction. The observer will be carried around the night side of Earth until the point marked Sunrise is reached and the sky begins to brighten.

The inner circle of Moon images shows how the Moon is illuminated at eight positions around its 28 day orbit. Each quarter of the Moon's orbit around Earth takes 7 days (1 week) to reach.

The outer circle of Moon images shows how the Moon appears to the observer at each of the eight positions.

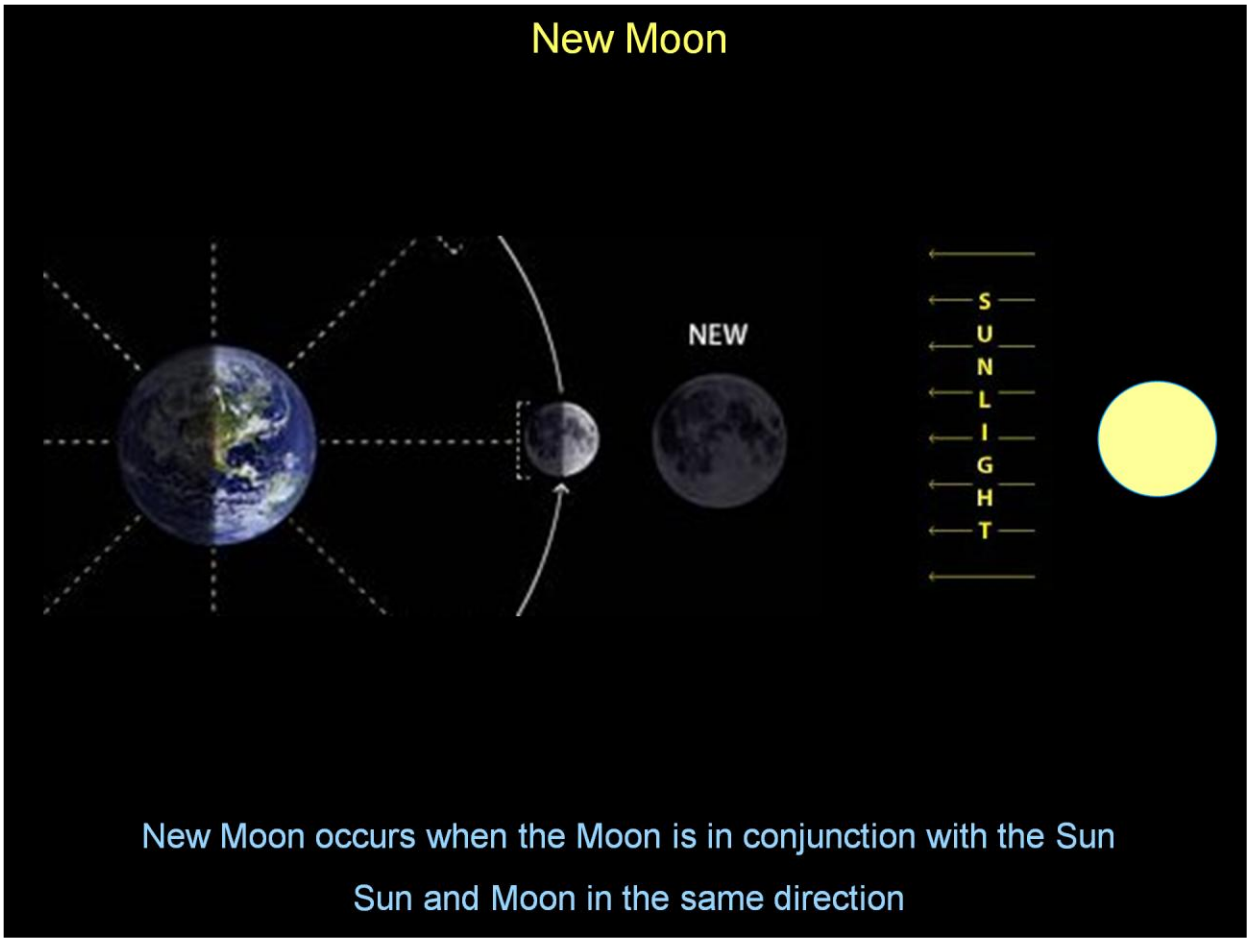
Now we will have a closer look at the view we have of the Moon at each quarter. It may be necessary to refer back to this diagram.



At the point on the diagram (on the previous slide) where the Moon is positioned directly between Earth and the Sun is called a conjunction. This is the point where we say the orbit of the Moon around Earth begins and we call this 'New Moon'.

At the New Moon position the side of the Moon facing the Sun is illuminated and the dark side (night on the Moon) is facing Earth and cannot be seen.

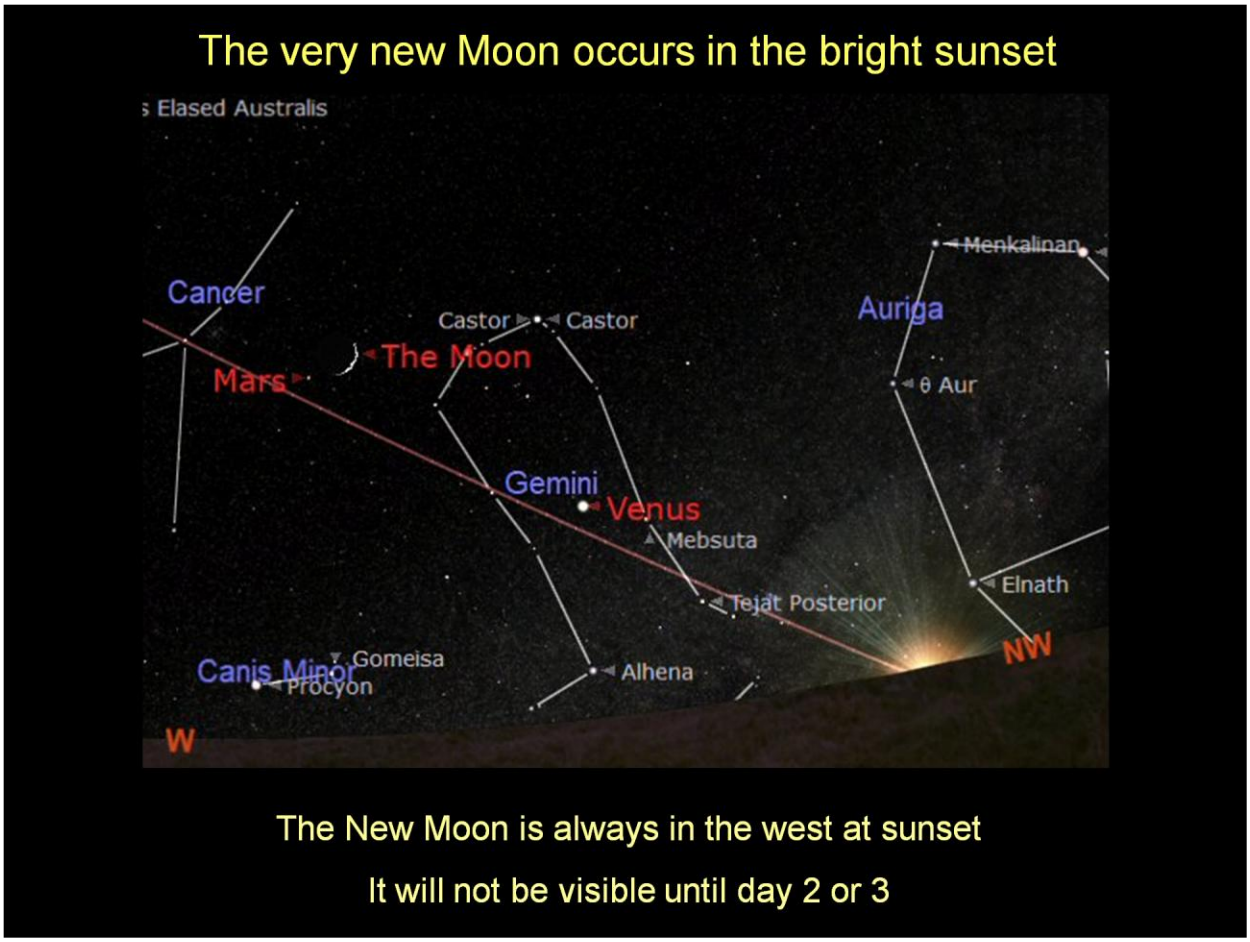
When the tilts of the orbits of Earth and the Moon are occasionally aligned the Moon will pass in front of the Sun and we will have a Solar Eclipse. Most months the Moon will pass above or below the Sun. This month (June 2021) New Moon occurs on 10th June as marked on the monthly Moon chart above.



The diagram above is an enlargement of the Moon's orbit around the Sun shown on the first diagram in the presentation.

At this point the Moon is positioned directly between Earth and the Sun that is called a conjunction. This is the point where we say the orbit of the Moon around Earth begins so we call this 'New Moon'.

At the New Moon position the side of the Moon facing Earth cannot be seen because it is in darkness (night) and the Moon will be lost in the glare of from the Sun. The Moon cannot be seen from anywhere on Earth and is shown darkened on the view from Earth.



The chart above shows the western sky three days after conjunction. The Moon has begun to move away from alignment with the Sun (conjunction) and a small slither of the side of the Moon that is illuminated by the Sun becomes visible. In reality this first view of the illuminated side of the Moon is not usually visible until the third day after conjunction because of the close proximity of the Moon to the Sun and its closeness to the western horizon.

The new Moon always appears in the west and is always in the bright sky and glare of the Sun. As the Moon moves away from the Sun the crescent shape of the visible illuminated side of the Moon (day light) widens and becomes more noticeable. We call the widening of the crescent the 'Waxing' phase or 'Waxing Moon'.

The New Moon 21st May 2020 (DSLR on Tripod)

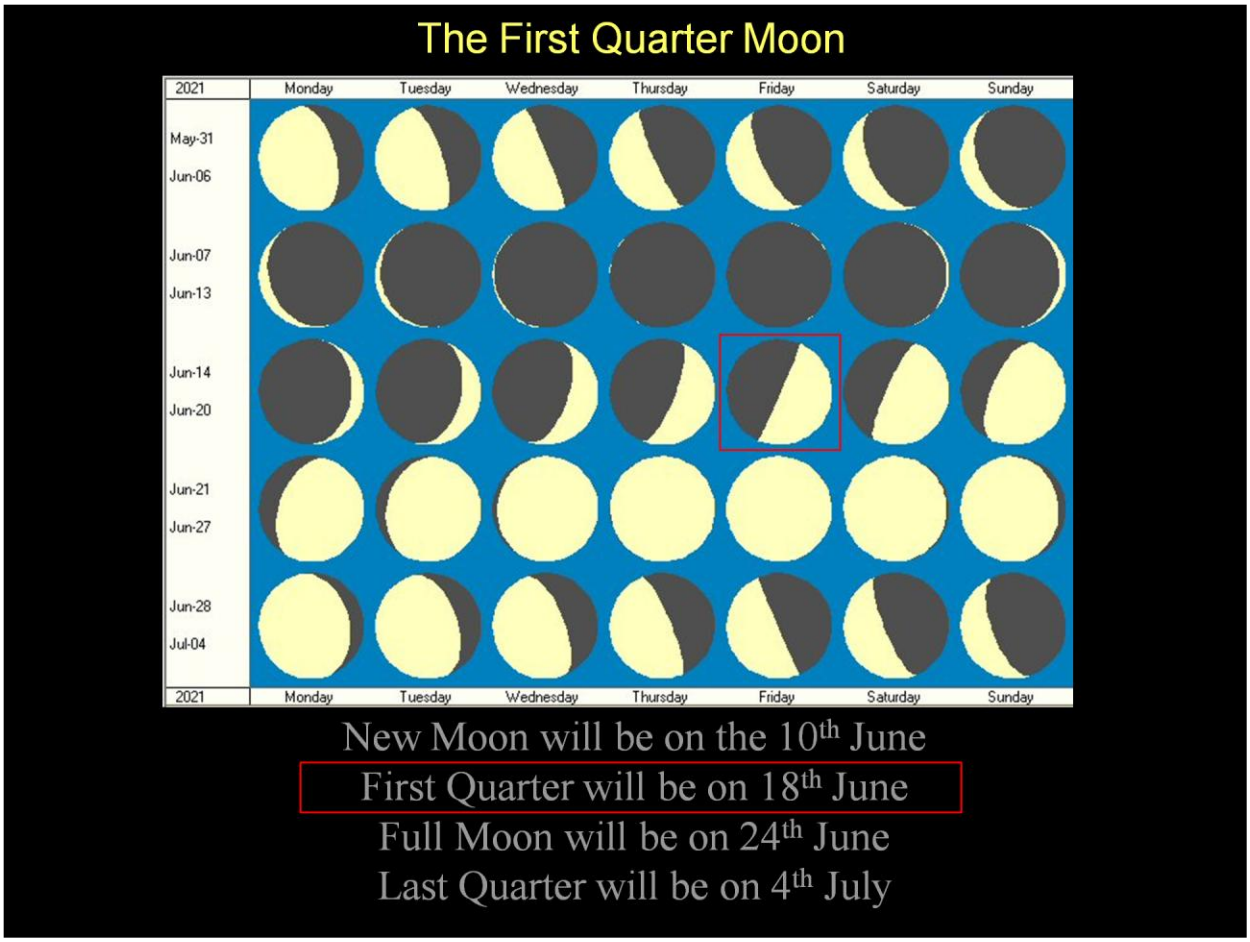
The image above was taken using a DSLR camera using maximum zoom on the 3rd day after conjunction. It can be seen that the sky was bright at sunset and the Moon was very low in the western sky.

It is important that we take care to ensure that the Sun has moved out of view before searching for the New Moon especially using binoculars or a telescope.

The New Moon can be very difficult to find

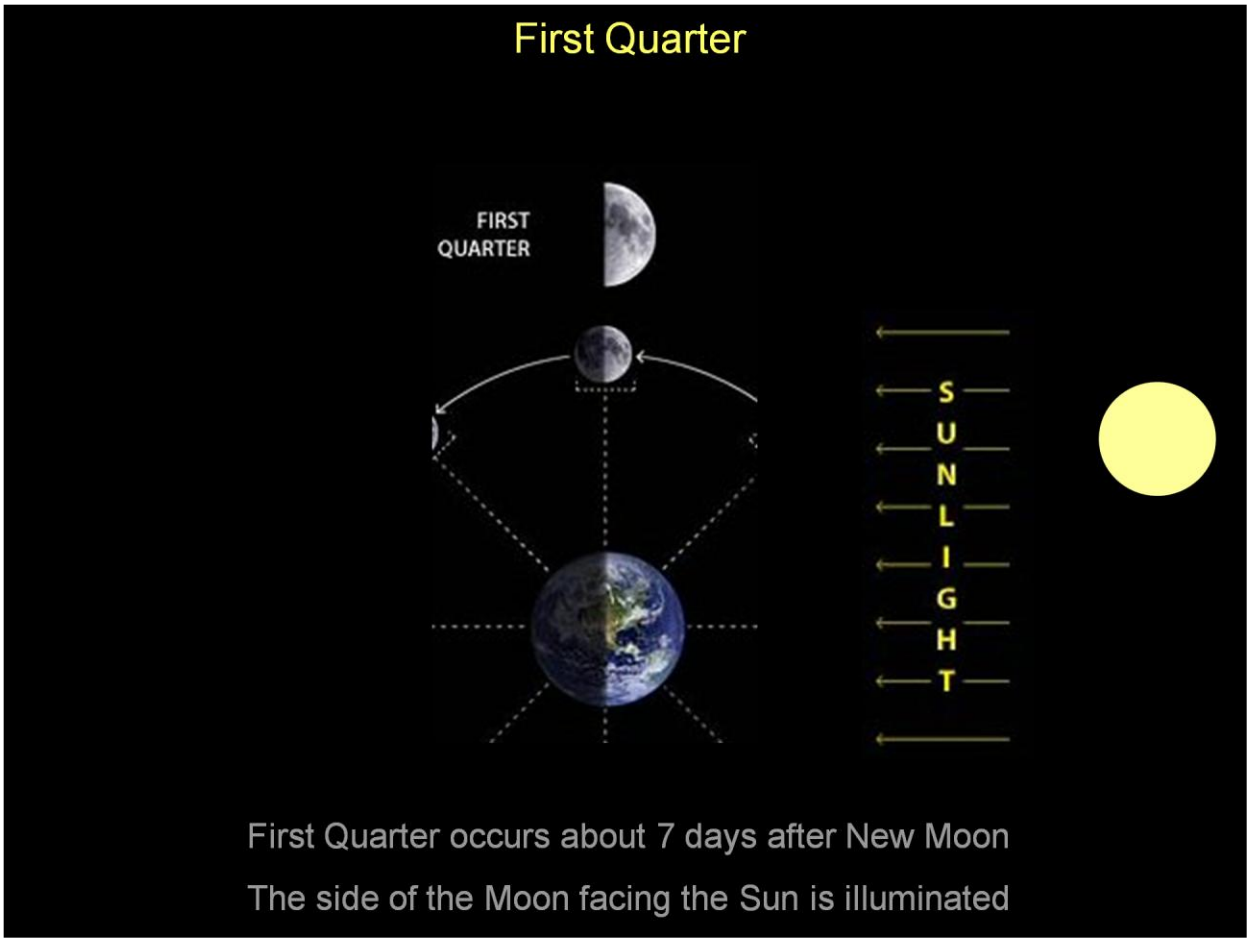
Some astronomers like to see the very early New Moon

It is not easy to see the New Moon before the 3rd day



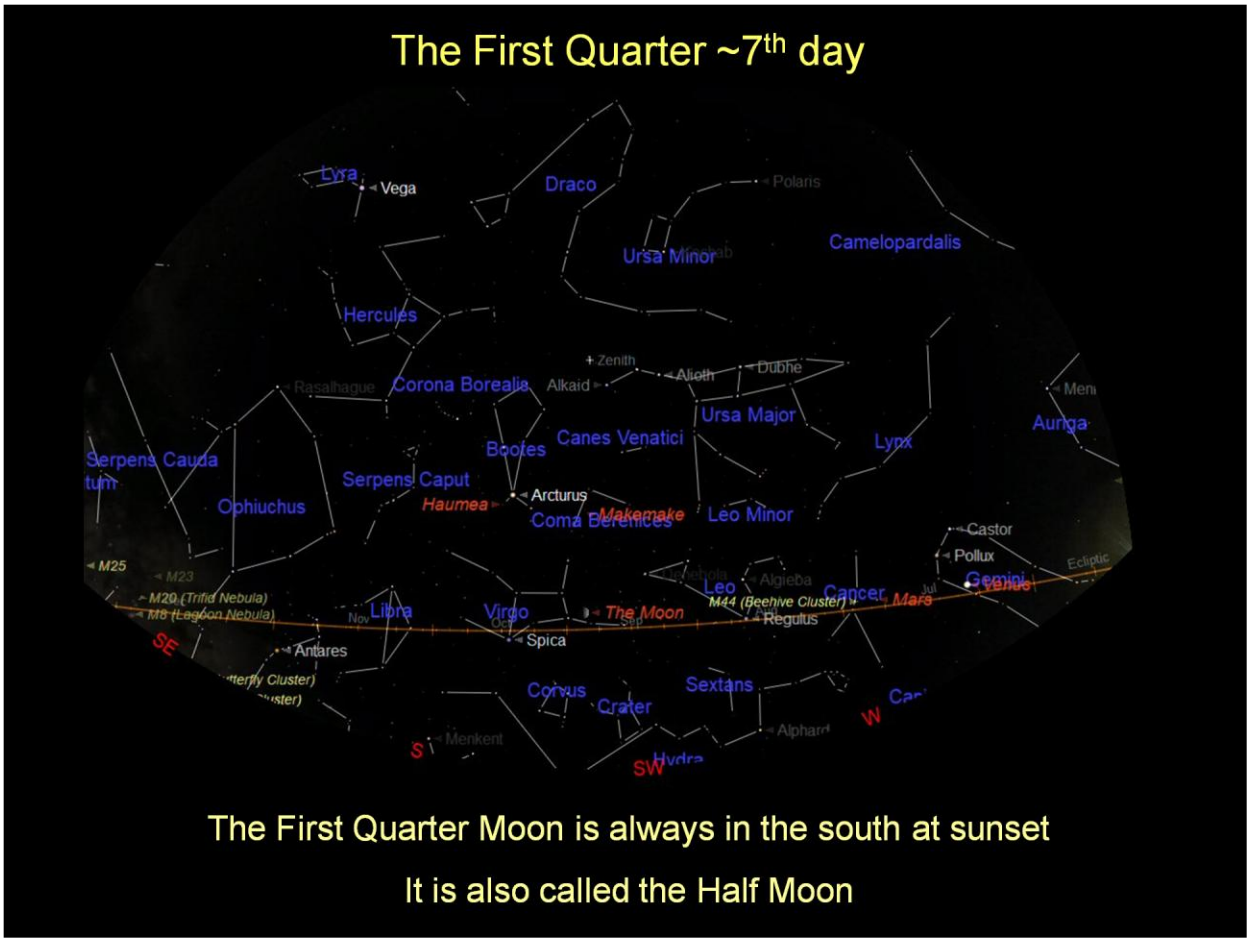
After about seven days the Moon will have reached its 'First Quarter' position.

This month (June 2021) First Quarter Moon (also known as 'Half Moon') occurs on 18th June as marked on the chart above.



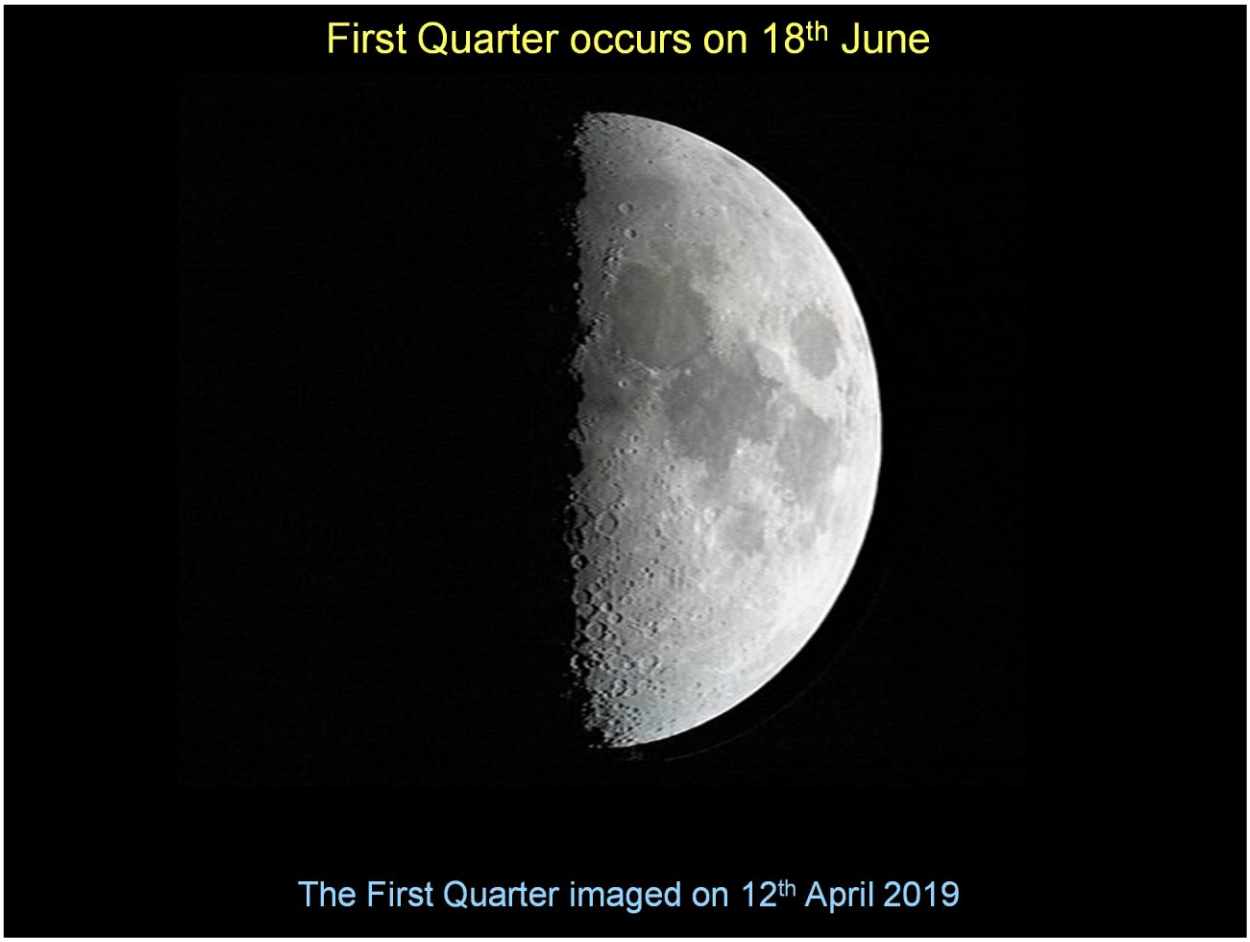
After about seven days (one week) the Moon will have reached its 'First Quarter' position when the half of the Moon facing the Sun is illuminated and the dark side is difficult to see. Under good conditions it may be possible to see the night side of the Moon faintly illuminated. This faint illumination is caused by sunlight being reflected off the surface of Earth and producing 'Earth Shine' on the night side of the Moon (like Moon Shine on Earth).

First Quarter occurs when the Moon is along side Earth and the same distance from the Sun. So we see half of the Moon illuminated hence this phase is also called the 'Half Moon' phase.

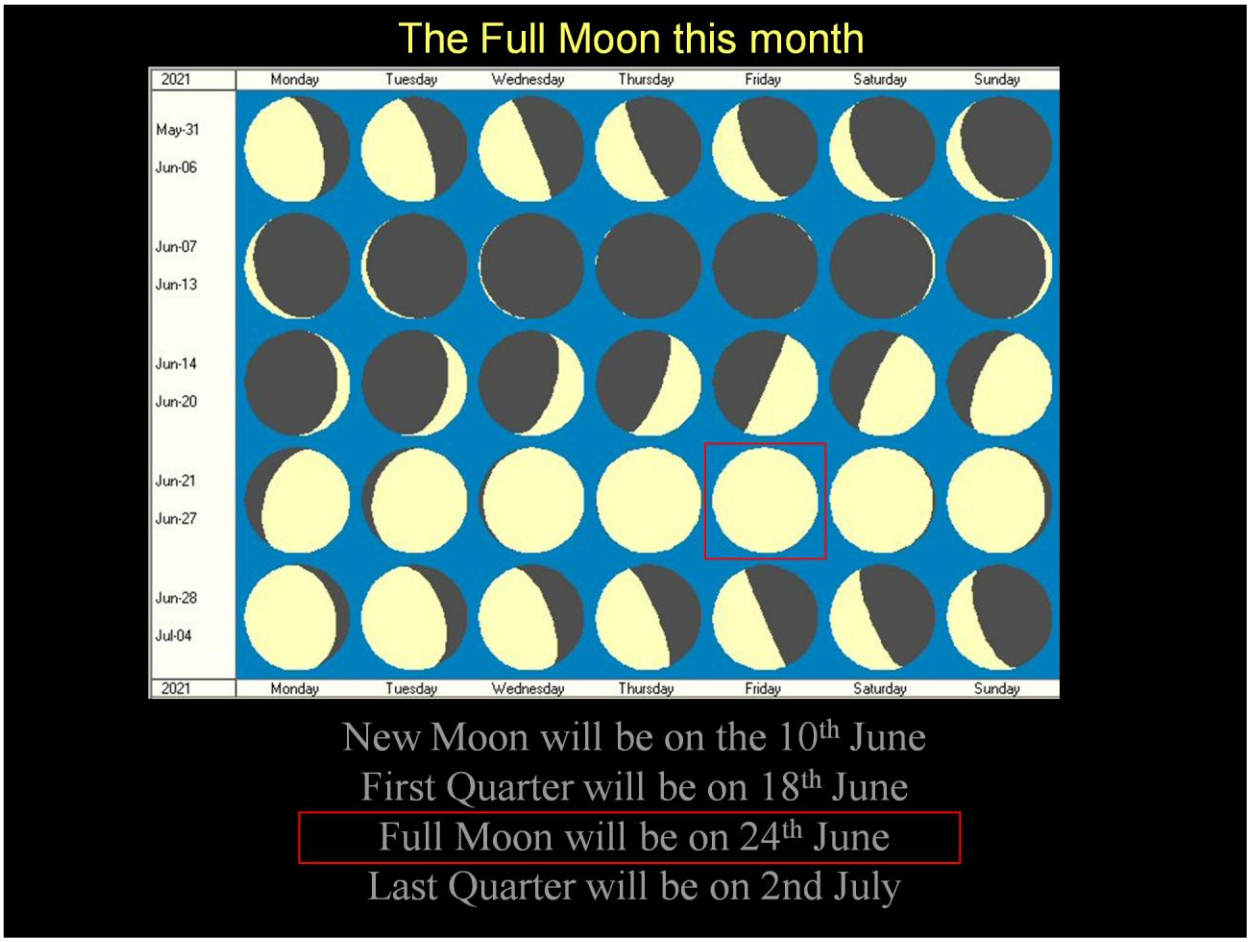


First Quarter is always seen in the south as the Sun is setting over the western horizon. After sunset the Moon will move towards the western horizon as Earth rotates on its axis. It will reach and disappear over the western horizon about six hours after sunset.

The chart above shows the First Quarter Moon in the south at sunset. The Moon is actually closer to South West than South on the chart above. This is because the Ecliptic (the imaginary line along which the Sun, Moon and planets appear to move across the sky) is low in the sky during the summer months.



This photograph of the Moon was taken at First Quarter using a DSLR camera and a small refracting telescope.

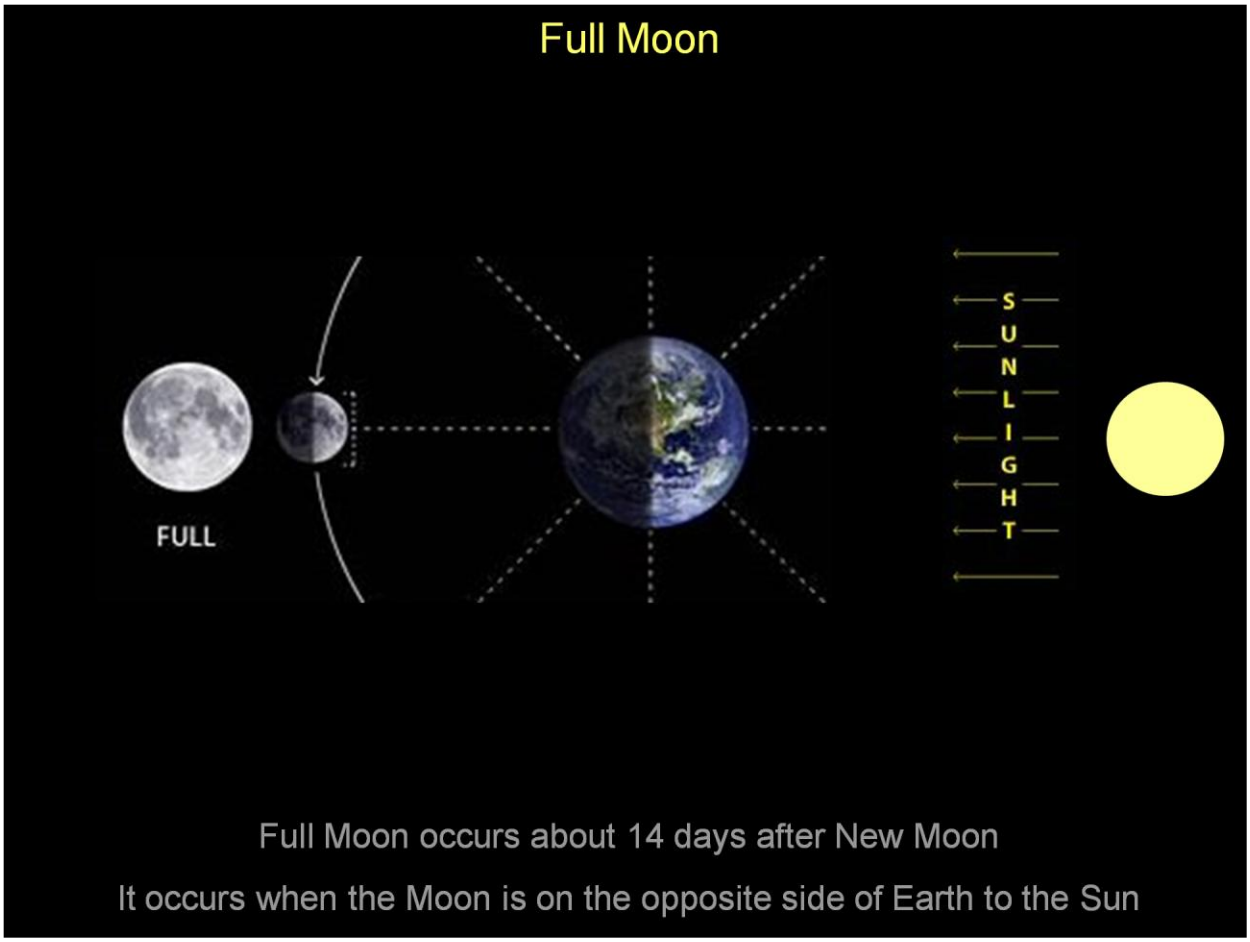


After about two weeks (14 days) the Moon will be positioned directly in line with Earth and the Sun with Earth in the centre in what is called a conjunction. This is the point where on the orbit of the Moon around Earth where the Moon is on the opposite side and fully illuminated we call this the 'Full Moon'.

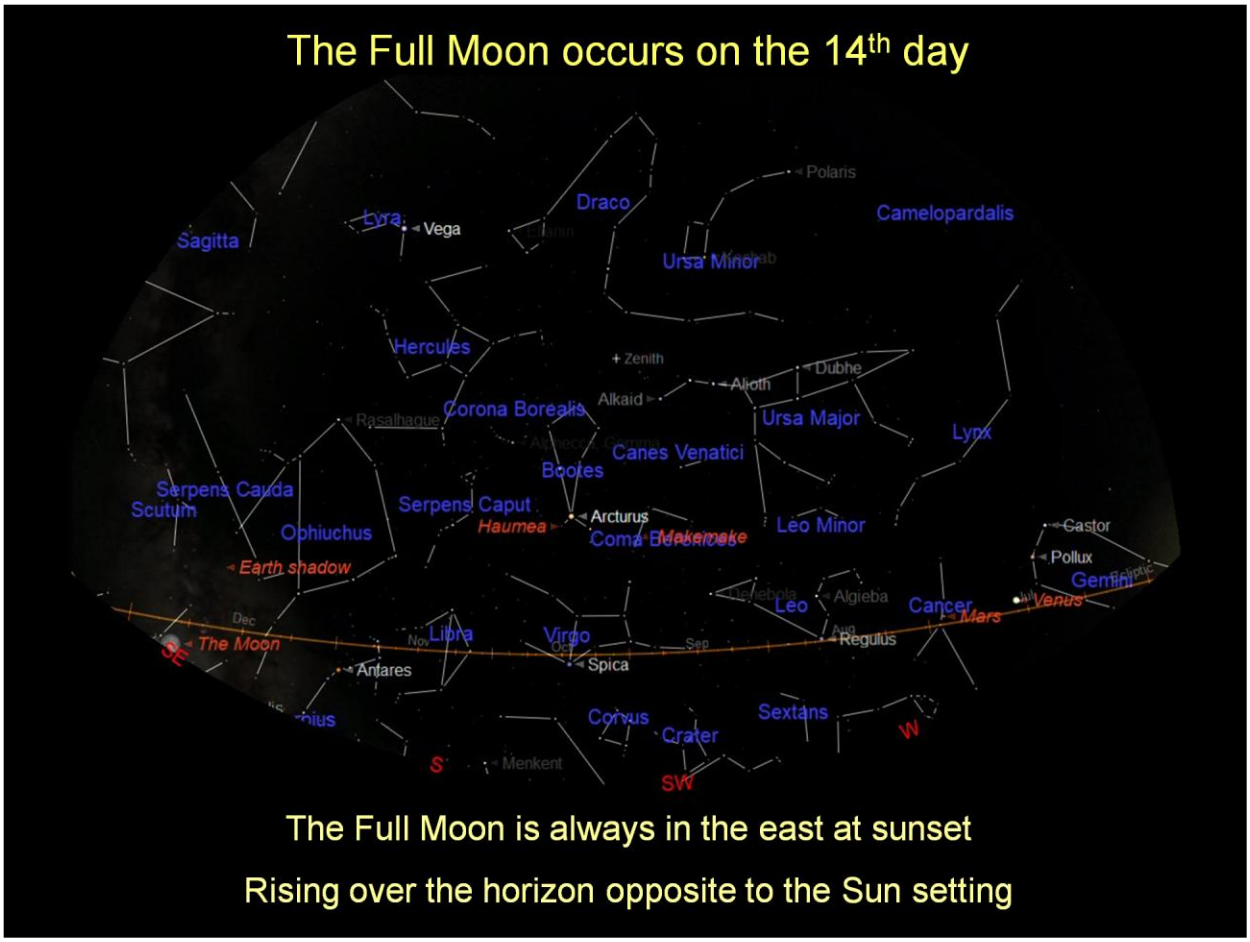
At the Full Moon position the side of the Moon facing the Earth is fully illuminated and none of the dark side (night on the Moon) can be seen.

When the tilts of the orbits of Earth and the Moon are occasionally aligned the Moon will pass through the shadow of Earth and we will have a Lunar Eclipse. Most months the Moon will pass above or below Earth's shadow and a Lunar Eclipse will not occur. As Earth's shadow is larger than the Moon a Lunar Eclipse will occur more often than a Solar Eclipse.

This month (June 2021) New Moon occurs on 24th June as marked on the chart above.



After First Quarter more than half of the illuminated Moon becomes visible and the illuminated portion is known as a 'Gibbous Phase' (wider than Half Moon). So as more than half of the Moon becomes illuminated this phase is called the 'Waxing Gibbous Phase'. Waxing is the term used when the illuminated part of the Moon is becoming wider than Half Moon. When the Moon is between First Quarter and Full Moon the phase is called the Waxing Gibbous Phase.



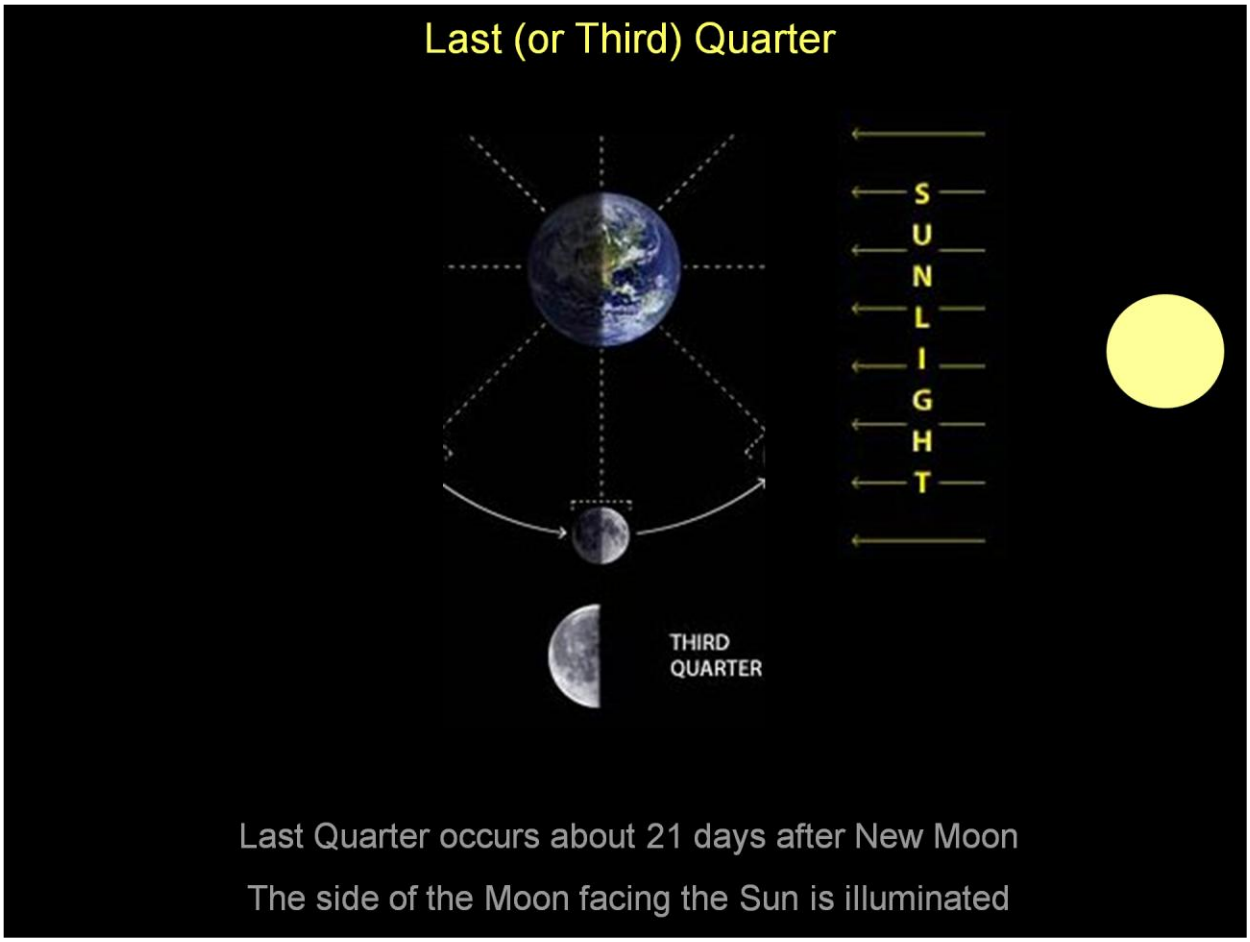
The Full Moon is always seen rising over the eastern horizon as the Sun is setting over the western horizon. As the Full Moon rises over the eastern horizon it looks particularly large due to an optical illusion. Our eyes are tricked into comparing the size of the Moon to objects on the horizon. As the Moon is at a great distance its size does not change significantly so it appears large when compared to buildings or other objects on the horizon.

After sunset the Moon will move westward across the sky as Earth rotates on its axis. It will take about 6 hours to reach the south position and another 6 hours to disappear over the western horizon in the early morning. At this time of the year the Moon will be low in the sky and close to the horizon. This is because the Ecliptic (the imaginary line along which the Sun, Moon and planets appear to move across the sky) is low in the sky during the summer months.

The chart above shows the Full Moon rising over the eastern horizon as the Sun is setting over the western horizon.

After about three weeks (21 days) the Moon will have reached its 'Last Quarter' (also called Third Quarter) position.

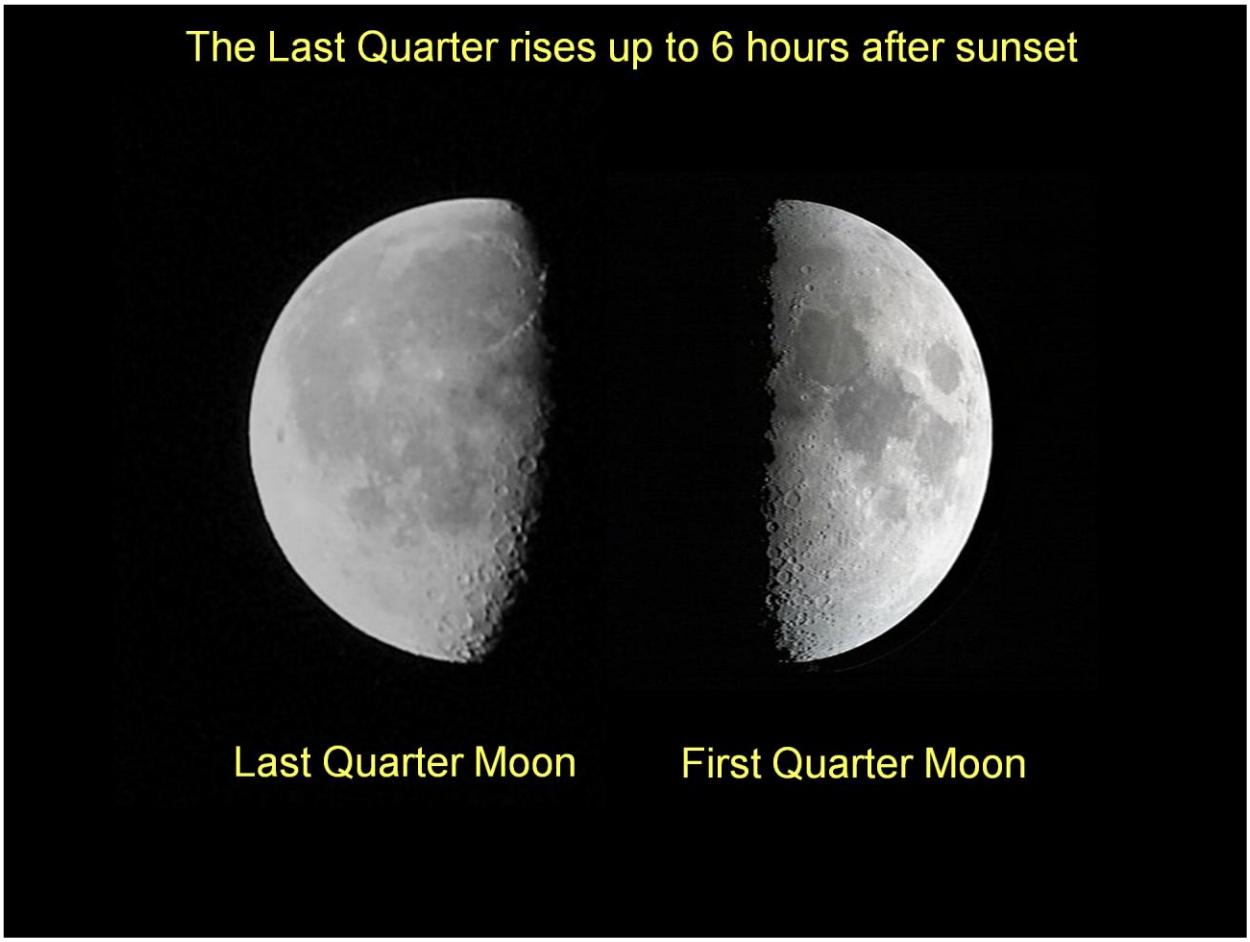
This month (June 2021) Last Quarter Moon (also known as 'Third Quarter') occurs on 2nd July as marked on the chart above.



After about 21 days (three weeks) the Moon will have reached its 'Third Quarter' position (also called Last Quarter) when the half of the Moon facing the Sun is illuminated and the dark side is difficult to see. The Third Quarter Moon is not often seen as it occurs during the night time hours so we are normally asleep.

Third Quarter occurs when the Moon is along side Earth and the same distance from the Sun. So half of the Moon is illuminated hence this phase also being called the 'Waning Half Moon' phase. Waning is the term used when the illuminated part of the Moon is becoming narrower. From the Full Moon Phase to the Half Moon Phase the shape of the illuminated portion is known as a 'Waning Gibbous Phase' (wider than Half Moon)

Under good conditions it may be possible to see the night side of the Moon faintly illuminated. This faint illumination is caused by sunlight being reflected off the surface of Earth and producing 'Earth Shine' on the night side of the Moon (like Moon Shine on Earth).



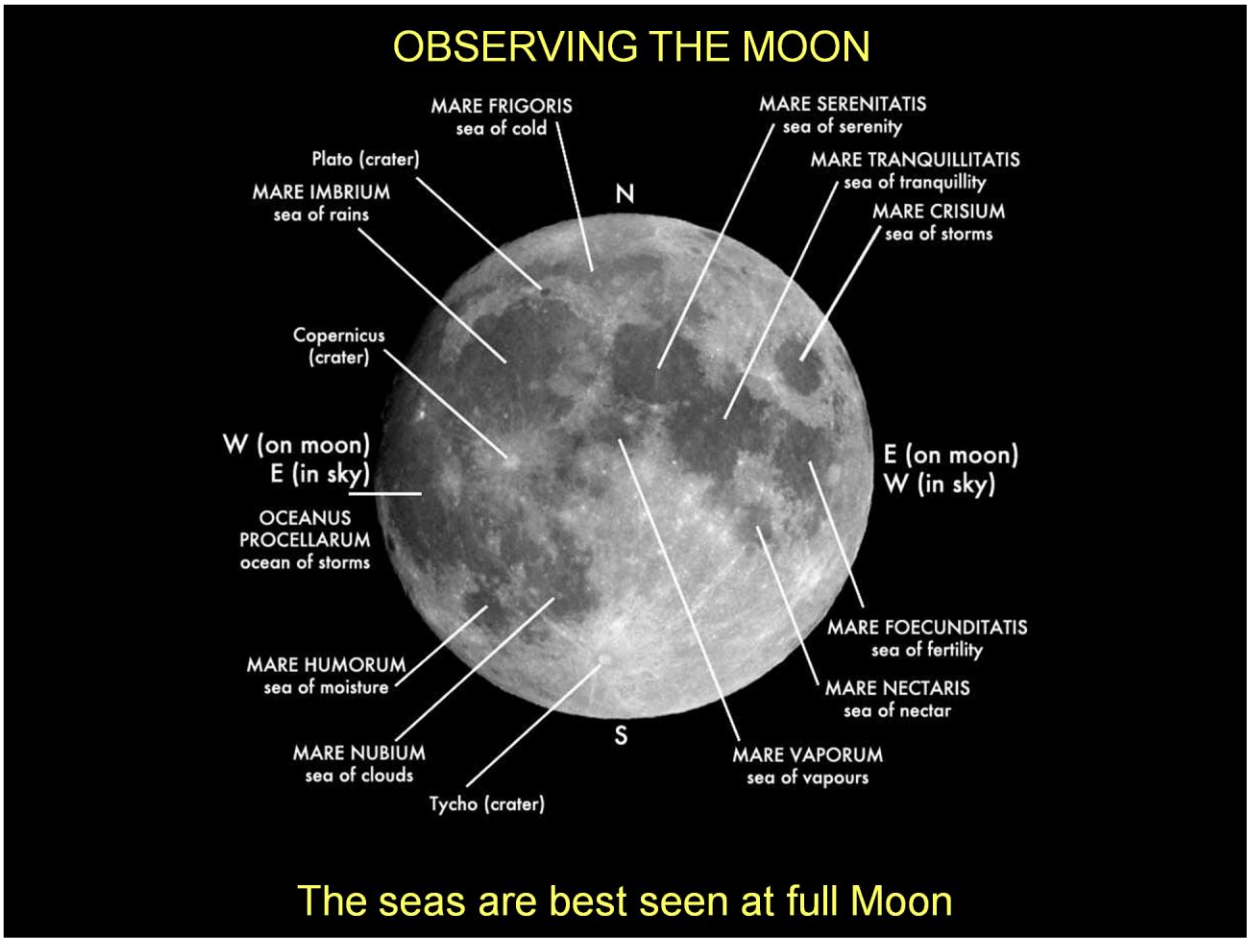
First Quarter and Third Quarter looks similar but opposite sides of the Moon are illuminated.

After Last Quarter the Moon continues to move back towards the Sun. As it moves closer to the Sun it becomes a crescent shape less than a half Moon. Over the next 7 days that takes to reach its next conjunction with the Sun the crescent shape narrows in what is called the 'Waning Crescent Phase'.

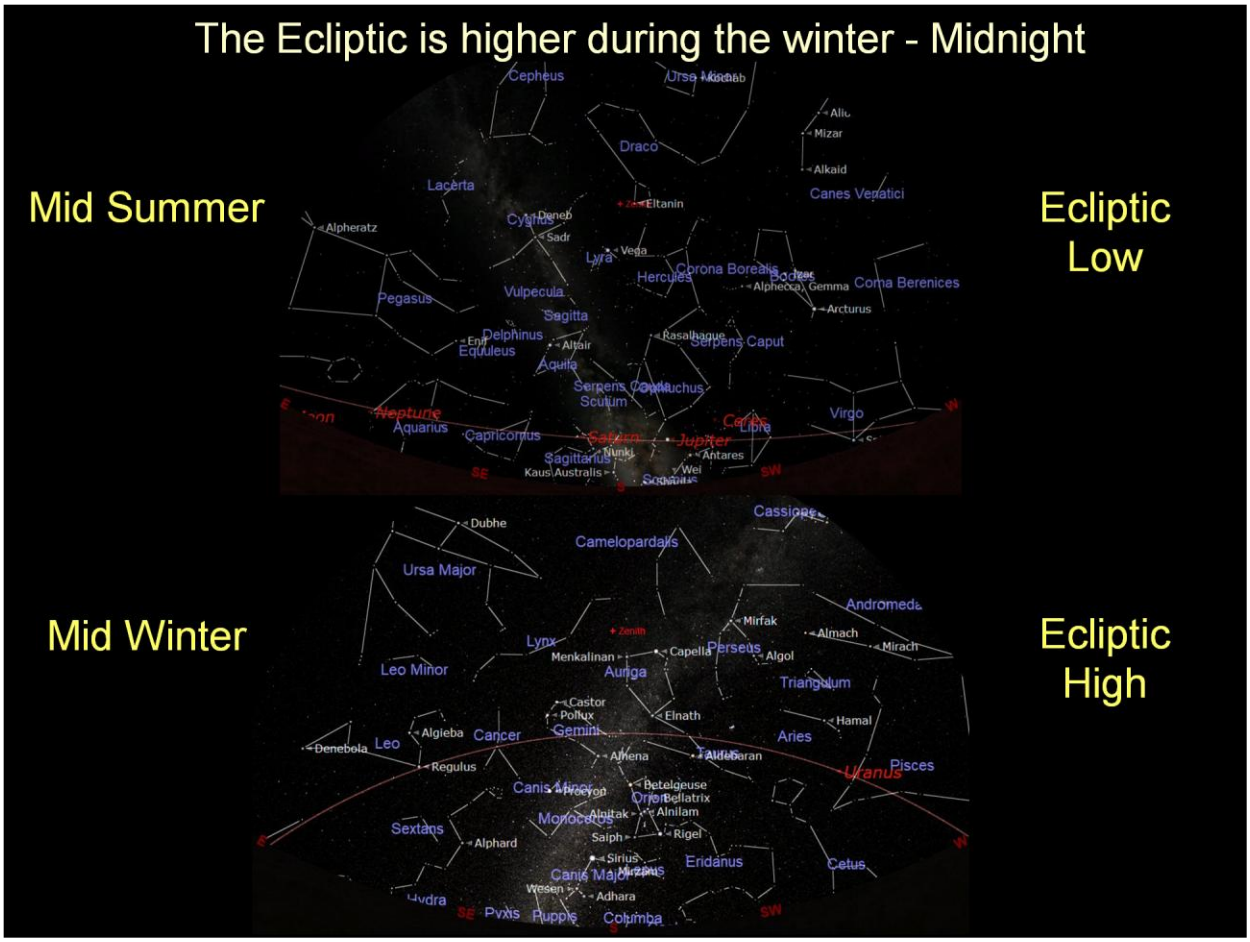
This photo of the 'Old Moon' was taken a 06:00 (in the morning) as the Sun was rising in the east. The Sun is coming up over the eastern horizon to the lower left of the photo. The Moon is moving towards the Sun and was two days away from conjunction with the Sun and the next New Moon.

Not many people get to see the Waning Crescent Phase because it occurs in the early hours of the morning before sunrise in the east.

The Full Moon is best for seeing the ‘Seas’ called Mare especially when using binoculars. For looking for surface details the Full Moon is not good because the Sun is shining directly down on the surface so there are no shadows to enhance the view.



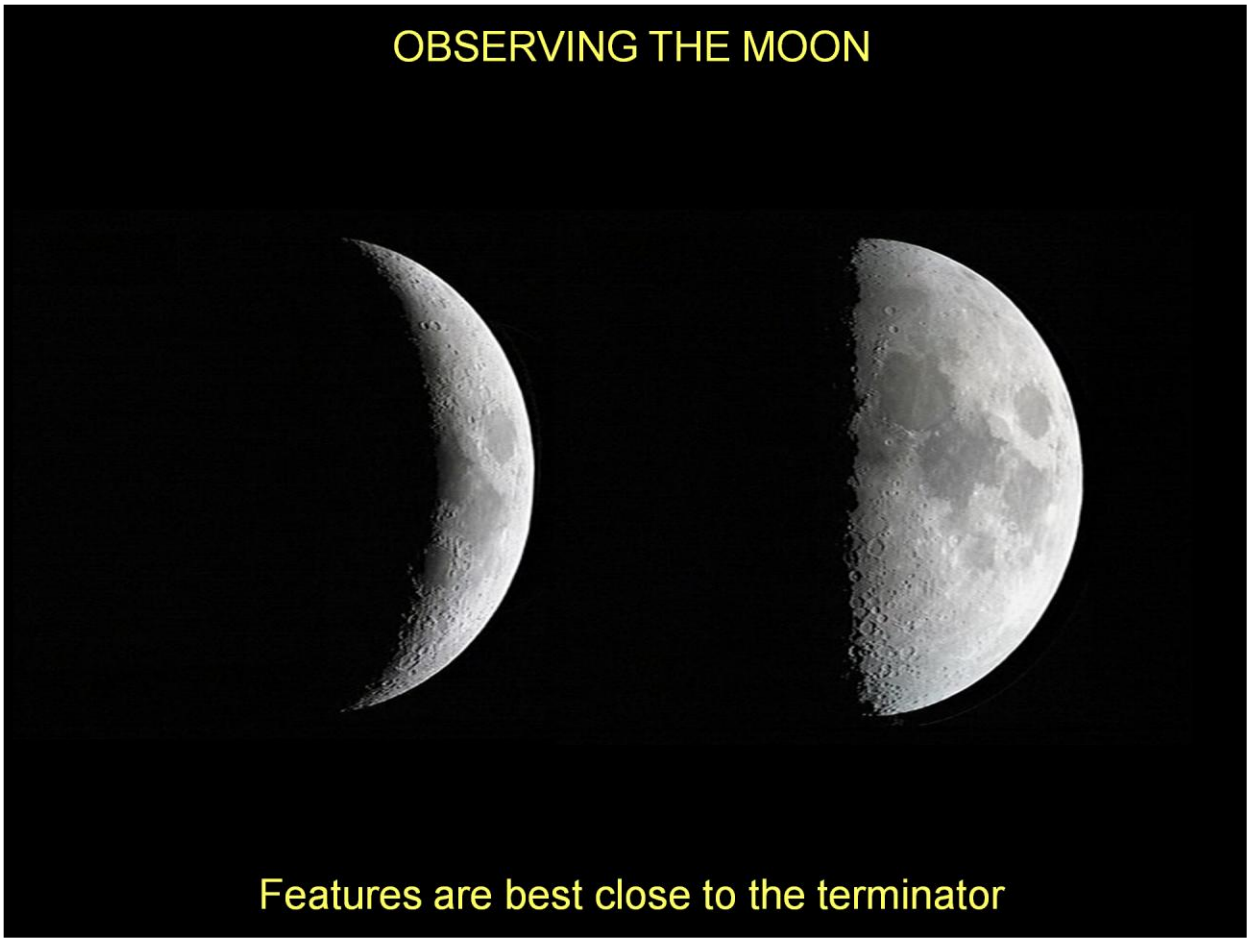
Mare are not seas of course they are just dark and smooth areas that are mainly ancient impact sites that filled with molten lava from below the surface when the Moon was still hot and active. They formed during or after the Late Heavy Bombardment (of comets and asteroids) that occurred between 4.2 and 3.8 billion years ago.



As Earth rotates on its axis once every 24 hours (1 day) that point on the surface of Earth (the UK) will rise up due to the tilt of its axis and the Sun will appear high in the sky. At midnight when the UK is looking away from the Sun the Ecliptic will be at its lowest point in the sky. The Moon and the planets will also appear low in the night sky.

The upper image above shows the how the Ecliptic appears low in the sky at midnight on Midsummer Day (Summer Solstice) when it had been high in the summer sky during the day. The Moon appears low in the sky during the summer nights and appears large as it rises over the horizon giving us the Harvest Moon and Super Moon effects.

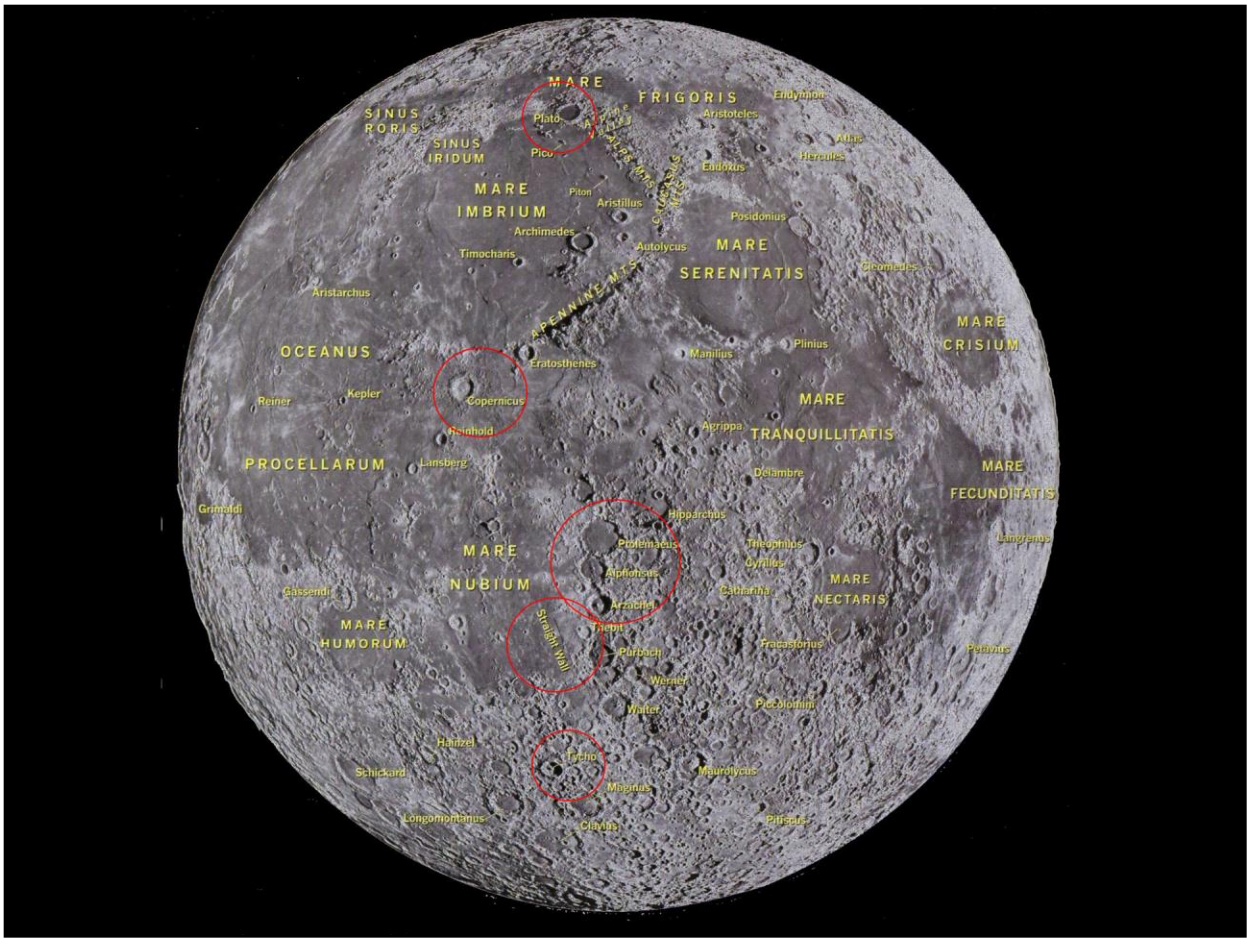
During the winter nights the Ecliptic appears very high in the night sky as can be seen in the lower image above. The Sun also appears low in the winter midday sky producing shorter and colder days. In the northern hemisphere the north pole of Earth's axis is tilted away from the Sun during the winter season. This gives the effect of a point on the surface such as the UK being further away from the equator of the Solar System (the Ecliptic) during the day and closer to the north pole of the axis of the Solar System.



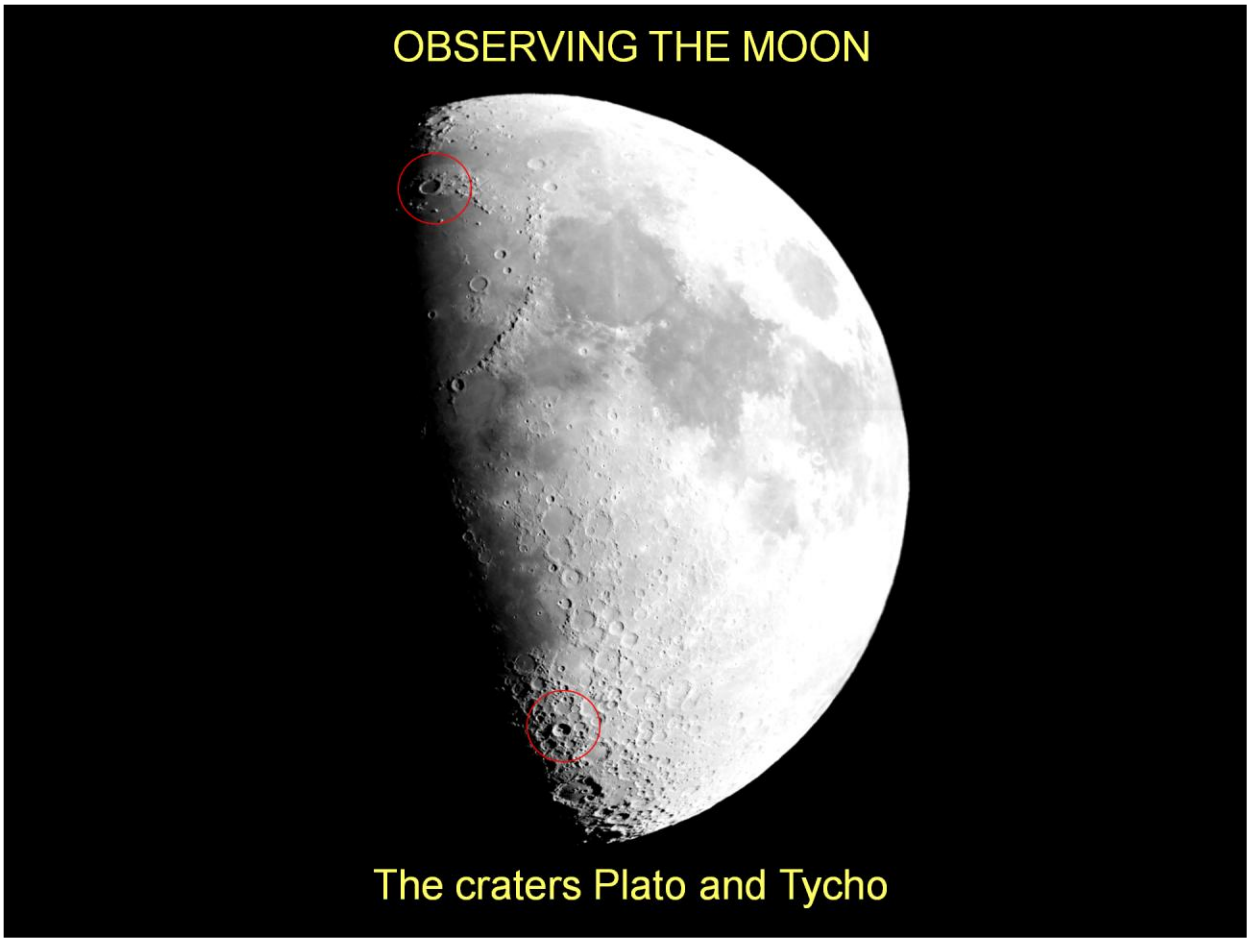
The line between the light side (day) on the Moon and the dark side (night) is known as the 'Terminator'. The Terminator after New Moon and up until Full Moon is the sunrise line and the terminator after Full Moon until New Moon is sunset on the Moon. On the terminator the Sun casts long shadows as it does on Earth. Shadows near the terminator give relief to the lunar terrain and produce an almost 3D perspective. So it is always best to observe an object when it is in daylight and close to the Terminator.

There are two ways of deciding what to observe on particular evening. The first is to check your Moon chart on the evening to see what is best placed, close to the terminator, at that time. If a computer generated chart is used a copy can be printed and used to identify all the things of interest on that observing session.

The other option is used when a particular feature is to be observed or studied in detail. On this occasion it might be better to use the chart to find which evenings would be best to see this feature. Depending on the particular feature it may be possible to predict two or three evenings when it is close to the terminator and good for observing. Using a Moon Filter can make looking at the Moon more comfortable by reducing the glare and gives the Moon more contrast to improve the view.



The chart above identifies some of the more prominent features on the Moon. These are the seas, craters and mountain ranges.



The prominent craters Plato and Tycho positioned close to the Terminator.

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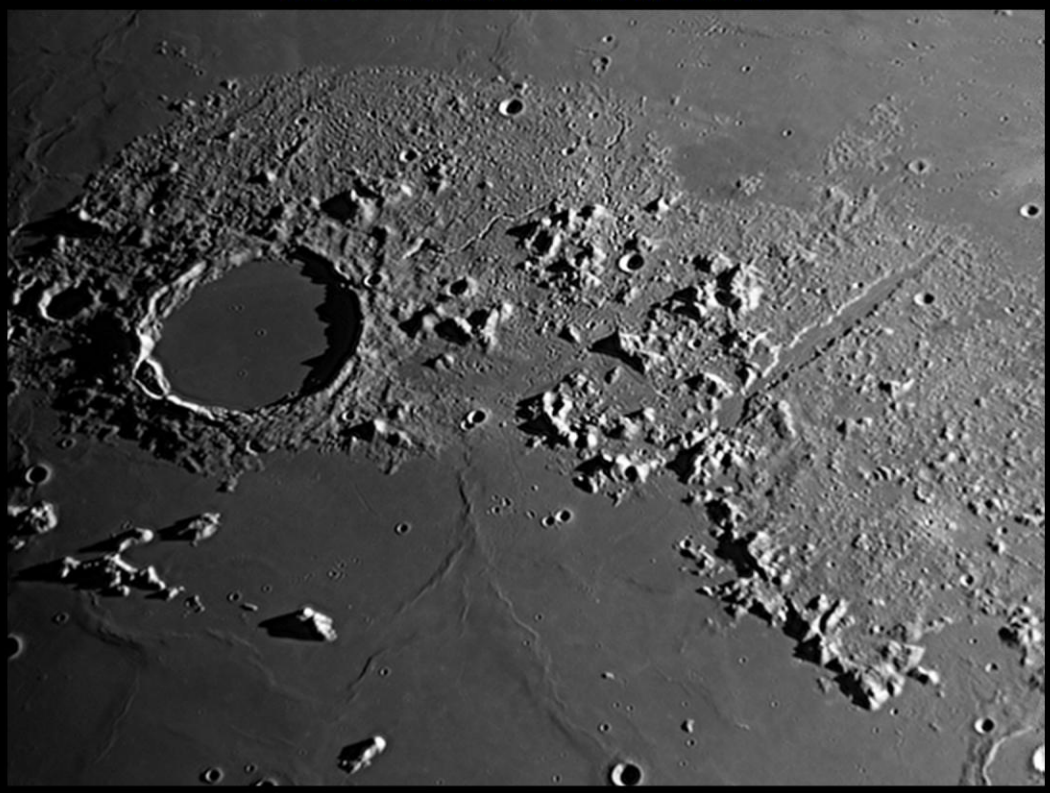

Plato, with Vallis Alpes (Alpine Valley)

Some areas of the Moon are more cratered than others. There are large areas that have so many craters that there appear to be no smooth areas at all. Other areas, particularly Maria, have almost no craters.

There are also mountain ranges that are often named after mountain ranges on Earth. Most of these mountain ranges appear to be the walls of vast craters that have all but disappeared under ancient lava flows and the effect of later meteor impacts. There are however some that appear to be natural mountain ranges.

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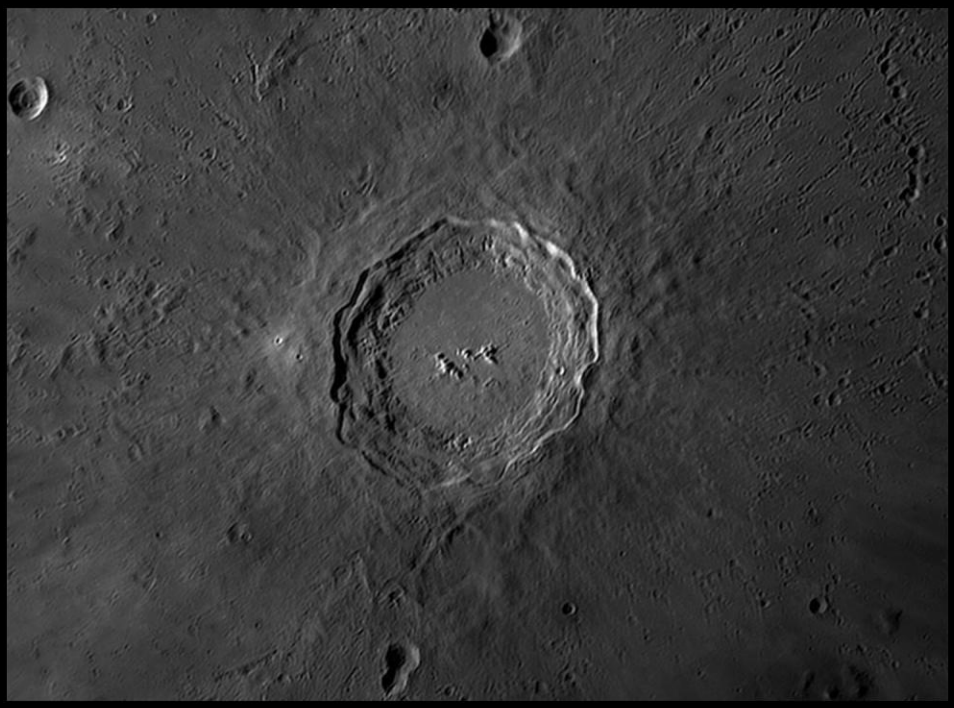
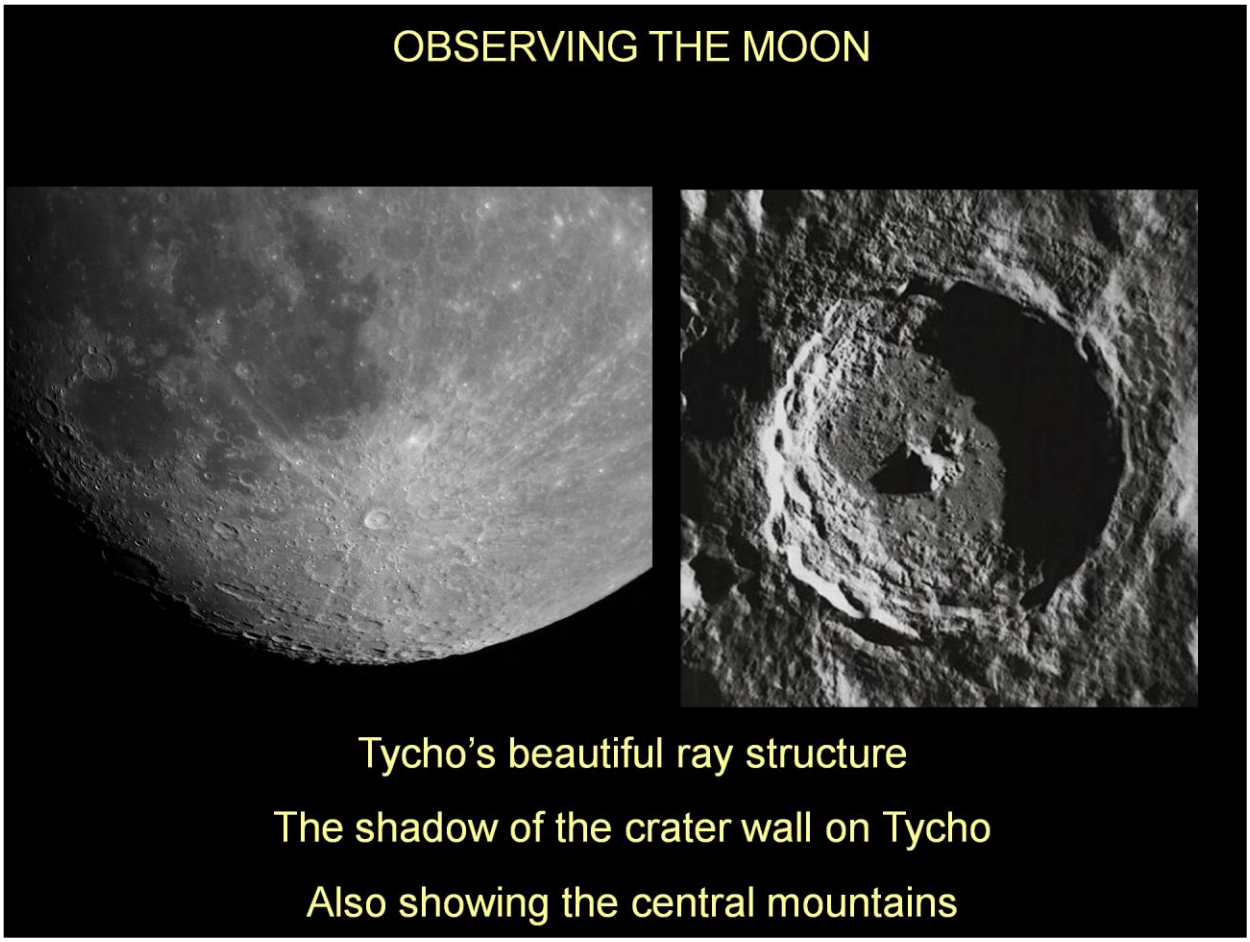


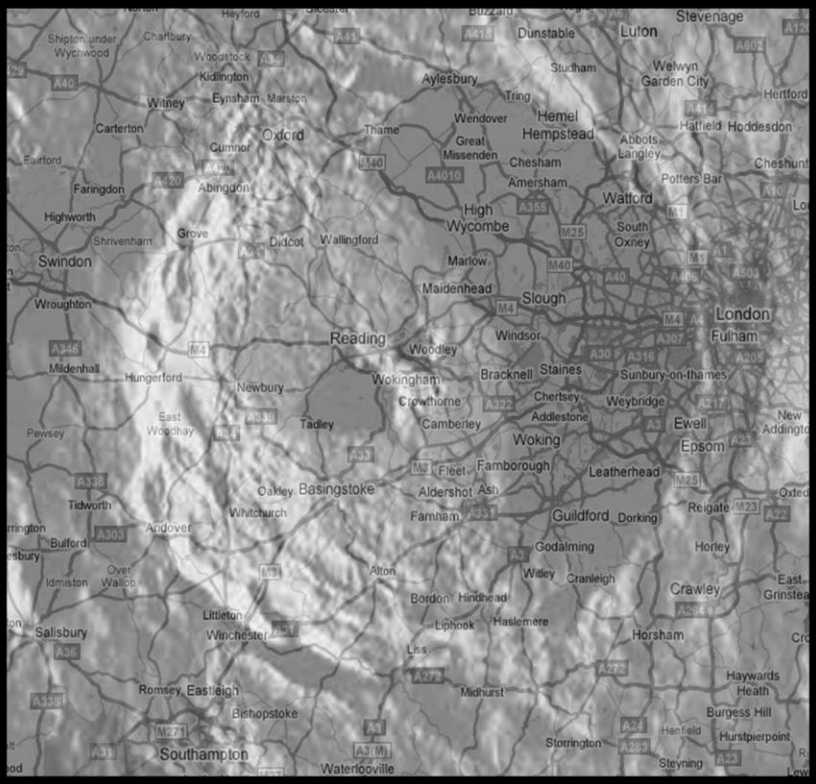
Copernicus showing the terraced walls

Copernicus is a large and beautifully formed crater showing terraced walls and central peaks.



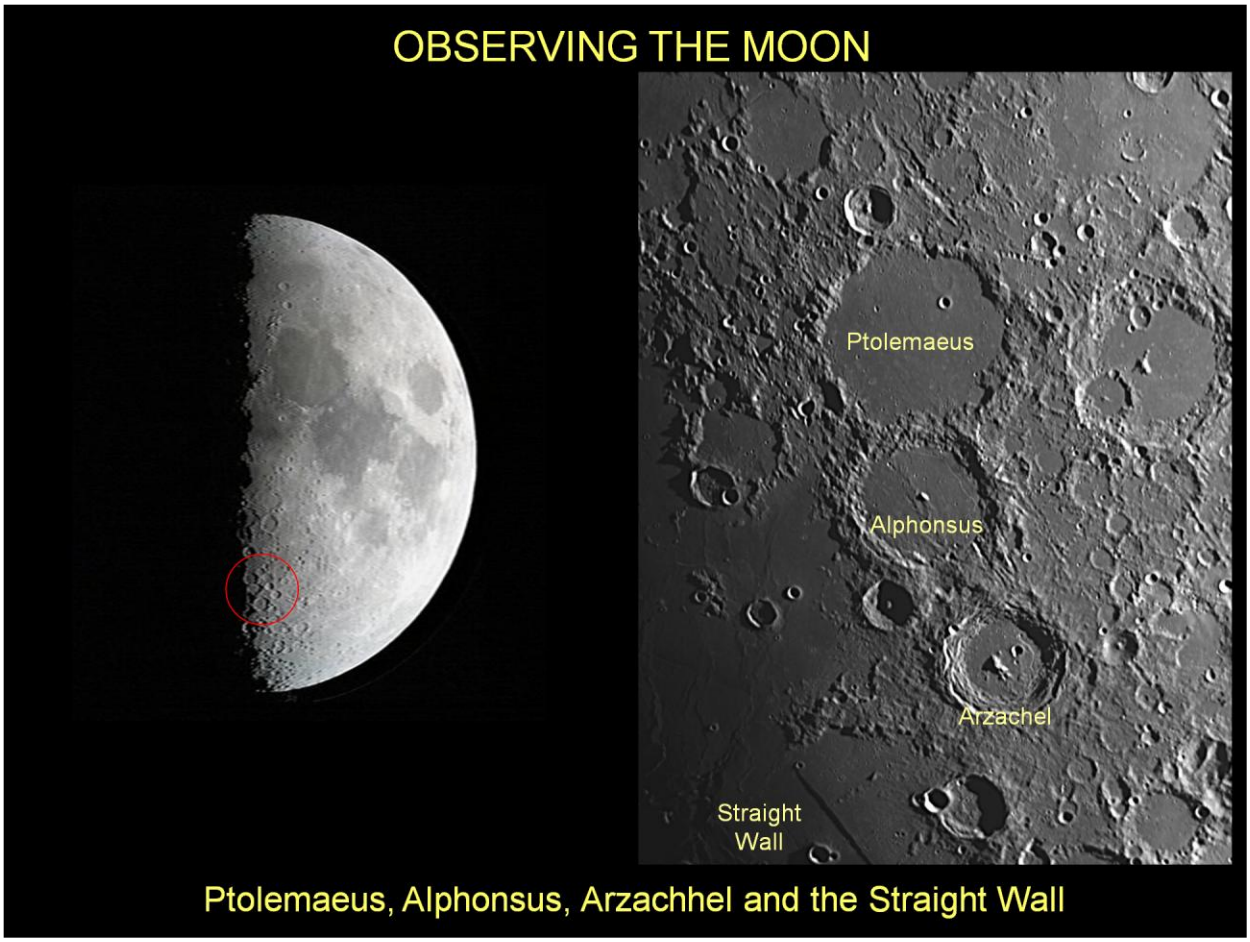
Other craters have radial lines called rays stretching for many hundreds of kilometres where debris was thrown out by the impact when these craters were created. Crater Tycho is one of the best and has a very prominent ray structure.

OBSERVING THE MOON



Comparison of the size of Tycho

The image above has Crater Tycho superimposed on a map of the local Berkshire area to demonstrate the size of the crater. The crater covers an area from Aylesbury in the north to Winchester in the south and from Hungerford in the west to central London in the east.



Craters are especially spectacular when viewed using a telescope (see the images above). Some of the larger craters may have terraced walls both inside and outside the main rim. There may even be smaller craters on the floor of the large crater or another craters may cut through the wall of a large crater. It is possible to work out the relative age of some craters. If one crater has cut through the wall of another then it must be younger than the one that has had its wall damaged. See the crater at the bottom of the image on the right.

OBSERVING THE MOON

The effect that shadows have on surface features

The Straight Wall in Mare Nubium (Sea of Clouds)

In the image above is a feature called the Straight Wall. This is a common type of feature known as a 'Rill' and appears to be a vast cliff face caused by a crack in the ground.

In the left image the Sun is shining from the left illuminating the cliff face.

In the right image the Sun is shining from the right so the cliff face is casting its shadow to the left. There is a similar effect with the walls of the craters.

This presentation is available

(with notation) on the:

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