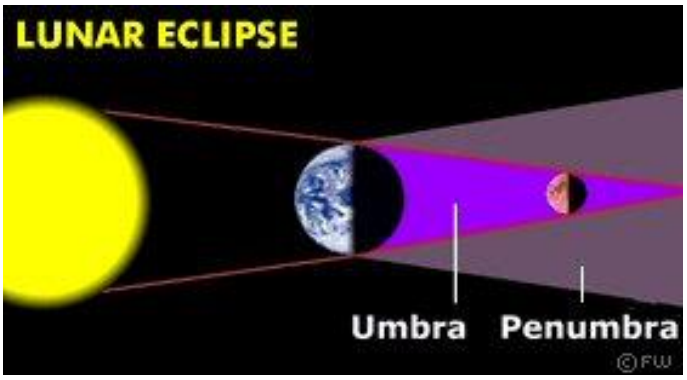
Eclipses

There is a penumbral lunar eclipse on 18th October, '13 so I thought I would briefly explain what eclipses are and how they happen. There are two kinds of eclipse, lunar and solar. Both are dependent on the Earth, Sun and Moon aligning in a particular way, with one body being affected by the shadow cast from another body. This special alignment is called syzygy. During a lunar eclipse the Moon is obscured the shadow of the Earth, but during a solar eclipse the Sun is obscured by the Moon, casting the shadow of the Moon onto the surface of Earth.

Lunar Eclipses

A lunar eclipse occurs when the Moon enters into the shadow of the Earth. Because of the relative size of the Earth compared to the Moon, lunar eclipses last several hours from first contact to last contact.

The geometry of a Lunar Eclipse (Picture taken from GSCE Astronomy online text book)

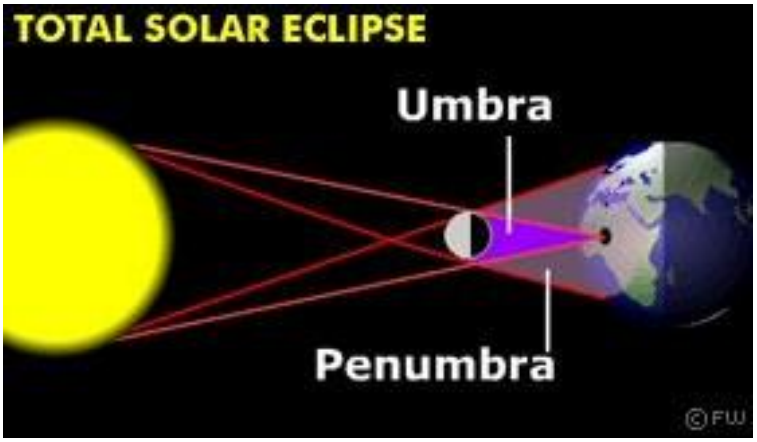


The diagram above shows the alignment of the Sun, Earth and Moon during a lunar eclipse. Because this exact alignment is required, a lunar eclipse can only occur during a full moon. As a total lunar eclipse begins, the Moon first passes into the penumbra. This is called first contact. At this stage the Moon looks slightly darker or greyer. The next stage is second contact, when the Moon enters into the Umbra, and into the totality phase of the eclipse. Due to the refraction of light from the sun by Earth's atmosphere, the Moon usually appears red in colour during this period, but atmospheric conditions at that time will determine exactly how the Moon will look during totality, ranging from copper, burgundy or orange. Next comes third contact, when the Moon leaves the umbra and passes into the other side of the penumbral shadow. Once again, the Moon will appear greyer in appearance. Finally comes fourth contact, when the Moon leaves the penumbra and the colour returns to normal. During a total lunar eclipse, totality lasts around 1 hour 40 minutes, but the whole event lasts several hours. A partial or penumbral lunar eclipse is when the Moon only passes into the penumbral shadow, and this is what we will be able to observe from the UK on 18th October. A lunar eclipse is visible from anywhere on Earth that is facing the Moon at that time. There is a full moon every month, so why don't we get a lunar eclipse every month? This is because the Moon's orbit around the Earth is tilted at a slight angle, so the correct alignment only occurs approximately twice a year.

Solar Eclipses

A solar eclipse occurs when the Moon passes in between the Sun and the Earth and casts its shadow on the surface of the Earth. It is by chance that the Sun is 400 times larger than the Moon, but it is 400 times further away so when they are in the correct alignment, the Moon fits perfectly over the disc of the Sun, allowing us to observe the Sun's tenuous upper atmosphere. We are extremely fortunate because we are in the only place in our entire solar system where this perfect geometry occurs!

The geometry of a Solar Eclipse (Picture taken from GSCE Astronomy online text book)



The above diagram shows the alignment that is necessary in order for a solar eclipse to occur. Unlike a Lunar eclipse which can only occur during a full moon, a solar eclipse can only occur during a new moon. Solar eclipses are much shorter in duration than lunar eclipses, with totality only lasting 7½ minutes from a particular location. At first contact the penumbra is projected onto the observer's location. The limb of the Moon begins to pass in front of the Sun, and it looks like a small black chunk has been taken out of the solar disc. Towards the end of first contact, the sky will darken, the temperature will drop and often the birds will stop singing. As second contact approaches, the craters in the lunar surface allow a few last rays of sunlight through, and this produces the "diamond ring" effect, also known as "Bailey's Beads". Then the Sun becomes completely obscured by the Moon during totality. During this period the sky becomes completely black and the stars become visible. It is one of the only times where amateur astronomers can observe the Sun's upper atmosphere called the Corona, something which usually requires a coronagraph mounted on a space telescope! At third contact, the Diamond Ring effect is seen once again as the Moon begins to move away from the Sun. At this stage the Sun once again looks like there is a black circular chunk taken from it, but this time on the other side. At fourth contact the Moon leaves the disc of the Sun completely. The umbral region is much smaller during a solar eclipse, so the area where the total eclipse is visible from, also called the path of totality, is much more restricted. Whilst there are often several solar eclipses per year, those which are observable from populated areas on Earth are relatively rare. Very often, the path of totality is located out at sea.

A partial solar eclipse is where the Sun and Moon are not completely aligned, so the Moon only obscures part of the Sun's disc. An annular eclipse is where the Sun and Moon are aligned correctly, but the apparent size of the Moon is smaller, therefore a ring of light from the Sun remains visible

during totality. This type of eclipse occurs because the Moon's orbit around the Earth is elliptical. If you look at the diagram above once again, but imagine what would happen if you moved the Moon closer to the Earth or further away from the Earth. When the Moon is at its closest point to Earth in its orbit, the point called *perigee*, it would appear larger than the Sun, therefore would successfully block out the Sun's disc during totality. If, however, the Moon was at its furthest point from Earth in its orbit, the point called *apogee*, its relative size would be slightly smaller, and therefore it could not completely cover the Sun's disc. The Moon is moving away from the Earth at a rate of approximately 4cm per year. In another 1.4 billion years time, the Moon will be further enough away from Earth that total solar eclipses will no longer be possible. So we are extremely fortunate to be able to witness them in our lifetime!