Astronomers are usually only interested in observing partial or total lunar eclipses, and in fact these are the only ones listed in most handbooks. Those eclipses when the Moon only enters the penumbral shadow offer little scope for any proper observations, quite apart from the fact that the reduction in the brightness of the Moon is usually so small that without prior information one would not generally realize that any eclipse was taking place. When the Moon is partially or completely immersed in the Earth's umbral shadow, however, it is far more interesting. Due to the refraction of the Sun's light within the Earth's atmosphere, the boundary between the penumbra and the umbra is never completely sharp; neither is the umbra absolutely dark, the Moon's surface usually being illuminated to a greater or lesser degree by light refracted into the umbral cone. This atmospheric refraction also gives rise to a dispersion of colours, so that occasionally the edge of the umbra appears to show an indistinct spectrum with the blue tint furthest away from the centre of the umbra, which may still be receiving some long-wavelength, deep red light.

There are very great variations in the overall brightness of the Moon when in the umbra, and also in the general tint of the surface. There are a few occasions on record when the eclipses have been very dark indeed and the Moon has completely disappeared for a while in mid-eclipse, but these events are infrequent. The visibility of individual lunar features such as the maria and craters can vary very considerably from eclipse to eclipse, and is not simply linked to the overall darkness of the eclipse.

There seem to be three primary factors which cause these effects: (i) changes in the clarity of the Earth's atmosphere, (ii) fluctuations in the level of solar activity, and (iii) the variation in the luminescence of the lunar surface from place to place.

The most important factor in the Earth's atmosphere seems to be the presence of volcanic dust injected into the higher layers by particularly violent explosive eruptions. This obviously absorbs light directly, and thus leads to a darker eclipse. Similarly, dust from particularly strong meteor showers is thought to have caused dark eclipses, but positive confirmation of this must await a greater number of occurrences.

The luminescence of the lunar surface material will obviously vary with the composition at any given point; however, as luminescence is caused by the flux of energetic particles from the Sun, it is also related to the number of solar-wind particles arriving at any particular area of the Moon at the time of the eclipse. A relationship with solar activity (or more properly, with the latitude of the most active areas on the Sun's surface) was demonstrated by the French astronomer André Danjon, who established that the brightest eclipses (presumably those with the greatest luminescence) occurred just before sunspot minimum – that is, when the active areas were closest to the solar equator. It is now known that the supply of the most energetic solar wind particles is largely controlled by the existence of

Copernicus, seen here in an Apollo photograph, is one of the brightest ray craters on the Moon, and can frequently be seen from Earth during lunar eclipses.