Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *How the Sky Works*.

Let's start with the basics. The Sun rises in the east and sets in the west, right? Well… of course that's not what is really happening. In fact the Earth is rotating from west to east, bringing the Sun into view in the morning and leaving it behind at night and then bringing it back into view again next morning.

That period, from one sunrise to the next sunrise, is 24 hours – at least it is outside of Earth's polar regions. But, does it take the Earth 24 hours to rotate once on its axis? No, it takes 23 hours and 56 minutes. Similarly, although it takes the Earth 365 and a quarter days to orbit the Sun –it actually rotates each year is 366 and a quarter – every orbit or every year.

These small discrepancies are explained by remembering that the Earth not only spins on its axis but it also orbits the Sun in an ellipse that has an average diameter of 150 million kilometres. Our orbital motion gives the Sun an extra apparent movement in our sky from west to east. So, although the rotation of the Earth should make the Sun look as though it moves from the eastern horizon to the western horizon in 11 hours and 58 minutes, it actually takes a full 12 hours – because the Sun has shifted backwards slightly and, for much the same reason, each night also takes 12 hours. Or at least that's all true in you live on the Equator.

Over the course of a year, those daily 4 minute delays add up to a delayed day – so, although the Earth rotates more than 366 times a year, we only get 365 sunrises a year – except of course for leap years.

Having dealt with the Sun, the next most obvious thing in the sky is the Moon. Like the Sun the Moon also seems to move west to east as a result of Earth's rotation, but unlike the Sun, the Moon is actually in orbit around the Earth. So, during the period when the Moon appears in the evening sky and you pop out each night at the same time to see where it is, you will discover that its orbit carries it slowly from west to east. In other words, although the Earth's rotation gives the Moon a fast *apparent* motion from east to west, but its *proper* motion is from west to east. So although the time from one full Moon to the next full Moon is 29 and a half days, the Moon actually completes one full orbit of the Earth every 27 and a third days.

Hopefully you can see that the first step in understanding how the sky works is to understand that you live on a rapidly-spinning planet which makes everything in the sky appear to move rapidly in the other direction. To discover if things in the sky have a proper motion of their own you need to go out and observe them at same time each night. Once people began doing this on a regular basis they discovered that although the stars have relatively-fixed positions in the sky, the Moon and five other objects visible to the naked eye have a proper motion of their own.

These other five wanderers, or planets in ancient Greek, all closely follow the same line in the sky that the Sun appears to move along each day. Of course, the Sun doesn't really move at all and that line that the Sun seems to move long, and that the planets all appear to cluster about, the ecliptic, is actually the orbital plane of the Solar system – the plane around which of all the planets, including the Earth, orbit the Sun.

As for the other planets, if they are visible at all, Venus and Mercury will only be visible for an hour or two – on the ecliptic – either just after sunset, or just before dawn – since they are both in a closer solar orbit than the Earth is. Other planets visible to the naked eye, Mars, Jupiter and Saturn, being further out from the Sun than Earth, can often be seen quite in the late night sky when they are in those parts of their orbit that are behind Earth.

There's a long tradition of naming the seven days of the week after the seven visible objects that move along the ecliptic. In English we still have Saturday for Saturn, Sunday for the Sun and Monday for the Moon, but for some reason we gave up the other days to a bunch of Norse gods. However, in the Latin languages, such as Spanish, the tradition has continued so that, in Spanish, Tuesday is Martes (for Mars), Wednesday is Miercoles (for Mercury), Thursday is Jueves (with a J, for Jupiter) and Friday is Viernes (for Venus).

Of course, now we know there's Uranus and Neptune too – but we didn't even know they were there until 1781 and 1846 respectively, long after everyone had agreed that we'd have seven days in a week.

The choice of seven days seems to be largely a religious one, where every seventh day was designated a holy day, such as the Sabbath of Jewish origin, although this tradition of sevens probably started earlier with the Babylonians. In any case, attempts were made to align a cycle of seven days with the Moon's orbit, so that, starting off with a New Moon, the next holy day aligned with the waxing half Moon, which is traditionally called first quarter. The next holy day aligned with the full Moon and the one after that with the waning half Moon, which is traditionally called third quarter and finally the cycle would end with the new Moon again, although this whole alignment thing never quite worked since the period of time from one new Moon to the next new Moon is 29 days, not 28 days.

Later on, more rigid calendar systems took over, but the cycle of repeating seven day periods stayed remained a fixture. The best explanation is that doing things in a seven day cycle just seems to sit well with most people.

Anyway, that's the Sun and the Moon and the planets covered. Another complexity we need to grapple with if we want to understand how the sky works, is that we live on a spinning planet with its axis tilted 23.5 degrees to the orbital plane of the solar system.

This means the line of the ecliptic, being the apparent path of the Sun through the sky, shifts throughout the year. In January, in the southern hemisphere, the ecliptic is high in the sky, which means the Sun stays higher in the sky for a longer period, leading to the long, hot days of Summer. However, at the same time, in the northern hemisphere – the path of the Sun will be low in the sky, which means the Sun isn't visible for as long each day, which gives the northern hemisphere folk the short, cool days and the long cold nights of Winter.

On the positive side, those long nights are the best time we get to look at the stars, because you are temporarily on the side of the Earth that is facing away from the Sun – temporarily staring out into the cold vacuum of space. It's the warm embrace of our circulating atmosphere that prevents you from immediately dying almost. In fact, you may get anything from 8 to 16 hours of

such death-defying viewing time before the Earth spins you back into line with the Sun – although (again) that's only if you don't live near the poles.

Over the full year that the Earth takes to travel through its orbit around the Sun, all the while spinning on its axis, you witness a changing view of the night sky. On one side of Earth's solar orbit in January we get to admire Orion's belt in the evenings, quite regardless of whether its summer or winter where you happen to live. Then, come July Earth will be on the other side of the Sun and the Sun's glare will now block any chance of viewing Orion's belt. Instead, on these July evenings, we all get to look at the constellation Scorpius in the evening – regardless of whether we are shivering with cold in the southern hemisphere or all hot and sweaty in the north.

And folks, if you've got your head around all that, you pretty much understand how the sky works.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website for when you're lying in the gutter, looking up at the stars. No ads, no profit, just good science. Bye.