

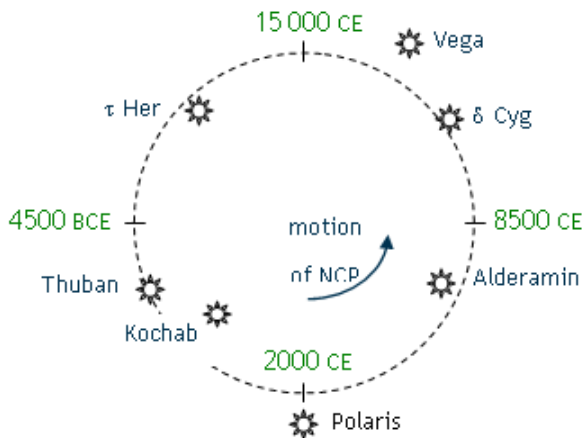
# Astronomy Summary Knowledge Organiser – Chapter 7 (Topic 7) Early models of the Solar System

Lunar phase cycle (from New Moon to next New moon) = 29.5 days  
Earth's axial tilt = 23.5 degrees  
Earth's axis precession cycle = approx. 26000 years  
Earth's precession rate = 1.4 degrees per century (50" per year)

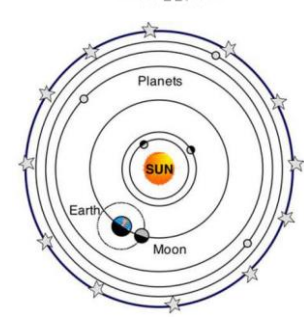
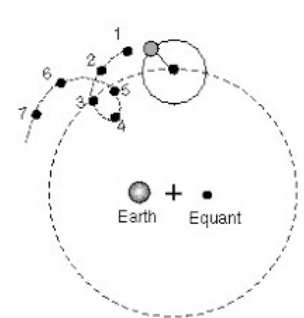
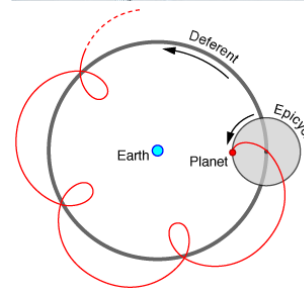
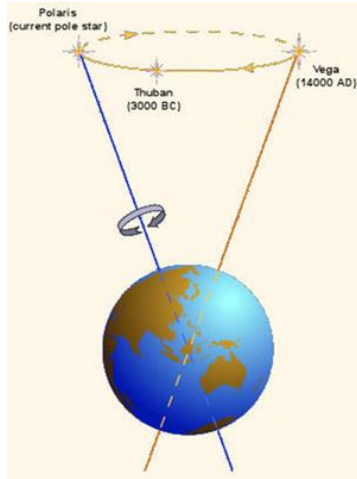
Ancient civilisations were very aware that the positions of the planets, stars, the Sun and the Moon followed a regular timescale. They used the positions of certain celestial objects to predict when events would or should happen, eg. when to sow or harvest crops, to make calendars or when to hold religious festivals. The Egyptians predicted when the Nile would flood from when the bright star Sirius rose after sunset! Many ancient monuments or temples were built to align with the annual **position of key stars** or with the **rising of the Sun** on key dates of the year (such as the **summer solstice** or **autumnal equinox**).

Those monuments and temples are **now misaligned** with the stars they once aligned with due to precession. The Earth's axis of rotation is not fixed and it wobbles on a circular path. The Earth is like a gyroscope, slowly wobbling over a 26000 year period. This wobbling (precession) is caused by the gravitational pull of the Moon and Sun on the Earth's equatorial bulge!

As shown below, precession means that over a 26000 year cycle **different stars** will be seen at the **North Celestial Pole (NCP)**.



CE = Current Era BCE = Before Current Era



Astronomy is one of the oldest sciences. Ever since the first person had time to stop and gaze at the night sky, people have wondered about the nature of the cosmos and **developed models** to **explain** what they observed.

The first models were based on the idea that the Earth is flat and fixed. Greek ideas placed all the stars on a **large sphere** that surrounded the Earth, known as the **Celestial Sphere**. There were only seven objects, in addition to the stars, visible to the ancients. These were the Sun and the Moon, plus the five planets, Mercury, Venus, Mars, Jupiter

and Saturn. It was obvious that the **planets were not on the Celestial Sphere** since the Moon clearly passes in front of the Sun and planets, whilst Mercury and Venus can be seen to cross in front of the Sun (transit). **Plato** proposed that the planets follow perfectly circular orbits around the Earth, within the celestial sphere, developing further the **GEOCENTRIC** solar system model (**Earth is at the centre of the Universe**).

A **weakness** of the geocentric model was that it **could not explain the observed retrograde motion** of planets. To help solve this problem each planet was placed on a small rotating circle, called an **EPICYCLE**. Planets moved around this epicycle as the centre of the epicycle itself revolved around the Earth following a path called the **deferent**. It was getting complicated!!! (as shown on the image to the left)

The addition of epicycles to the model still didn't fully explain the motion of planets seen in the night sky and so **Ptolemy** added further modifications. He made 2 changes to the model, he **moved the Earth slightly away from the centre of the deferent** and identified an imaginary point called the **EQUANT** from which the angular motion of the centre of each epicycle was uniform. Ptolemy's modifications meant the model much better predicted the speeds, positions and directions of the observed planets. However, now it was a **VERY complicated** model!!! This is never a good sign in Science.

Ptolemy's geocentric model was accepted for **almost 1500 years** until a Polish monk called **Nicholas Copernicus** used some mathematical modelling and developed a **HELIOCENTRIC (Sun centred)** model of the Universe. Copernicus was reluctant to present his model to the world for fear of causing conflict with the Church. He finally agreed to publish his work when lying on his death bed and soon his **ideas gained support** from the **scientific community**! The eccentric Danish astronomer **Tycho Brahe** **precisely plotted the position of the planet Mars over 20 years** until his sudden death in 1601. His assistant **Johannes Kepler** then analysed the Mars data and eventually formulated his **3 laws of motion** that supported the heliocentric model. Finally, in 1609 the Italian astronomer **Galileo Galilei** used his 'optick tube' (telescope) to prove that **Venus had PHASES** and that **Jupiter had 4 MOONS**. Galileo's findings provided evidence for the heliocentric model of the Universe & it was finally accepted!