Our planet Earth has an unusually large moon. So large it almost constitutes our system to be referred to a a double planet system.

Our planet Earth has its axis of rotation tilted 23.4º compared to the axis of the Sun and the rotational axis of the Solar System. We call the axis of rotation of the Solar System the Ecliptic Axis and the axis of rotation of Earth we call the Celestial Axis.

So we have to ask the question 'Why is Earth's axis tilted and how did it become tilted?' We need to look back 4.3 billion years to when the Sun and Solar System was forming.

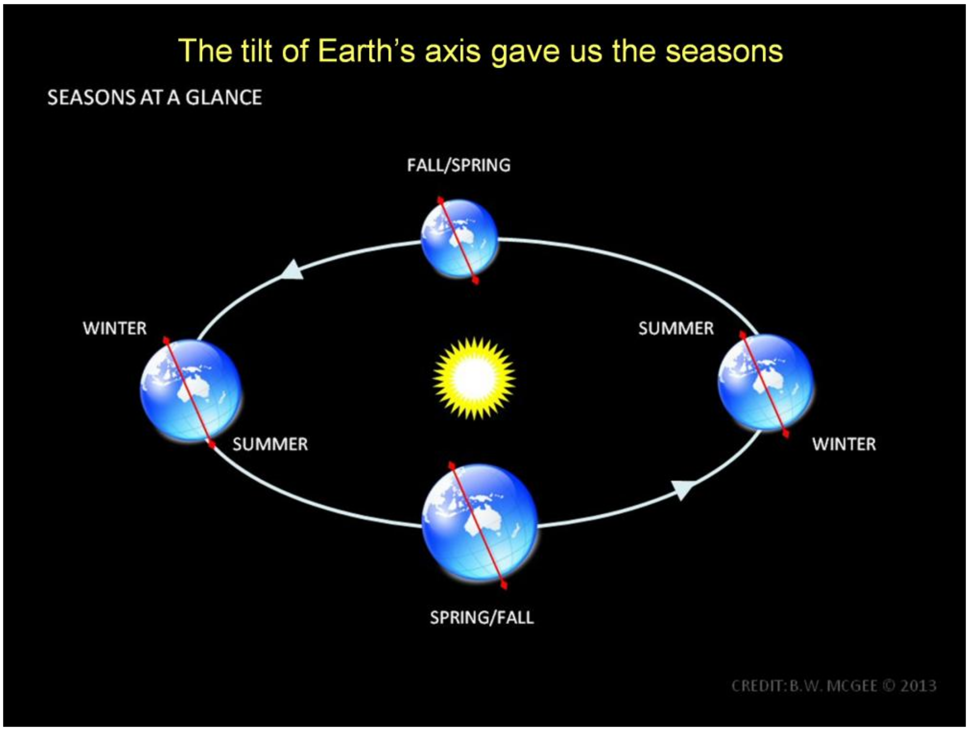
The Sun (our Star) was formed in a vast cloud of gas (mainly Hydrogen) and dust that we call a Nebula (pl. Nebulae). Our Sun is thought to have formed in this Nebula along with between 100 and 1000 other stars. As the gas and dust was pulled in to denser clumps by gravity the gravity of the clumps pulled in even more gas and dust. As the mass of the clumps increased they were pulled in and compressed into very dense spheres. The enormous pressure in the centre caused the temperature in the cores of the spheres to rise to millions of degrees. The temperature and pressure in the core caused the Hydrogen atoms to fuse together and create atoms of Helium gas in the process of Nuclear Fusion. Enormous amounts of heat was created and the spheres began to shine as stars. As the gas and dust was pulled into the forming stars, they began to spin and the gas and dust falling in formed into an accretion disc around the Protostar (forming star).

As the Accretion Disc grew in density the particles of dust and gas was pulled together and planet formed in the disc. It is thought that there would have been many more planets than we see today. As these young planets moved around the disc the cleared up the remaining dust and gas. The orbits of the young planets were not stable and were perturbed by the gravity of the other planets. Some orbits of planets were so badly disrupted that the planets may have been destroyed as they fell into the Sun. Others may have been thrown out of the Solar System altogether. Some unfortunate planets may have been involved in a collision with another planet and been badly damaged or even been destroyed in the impact.

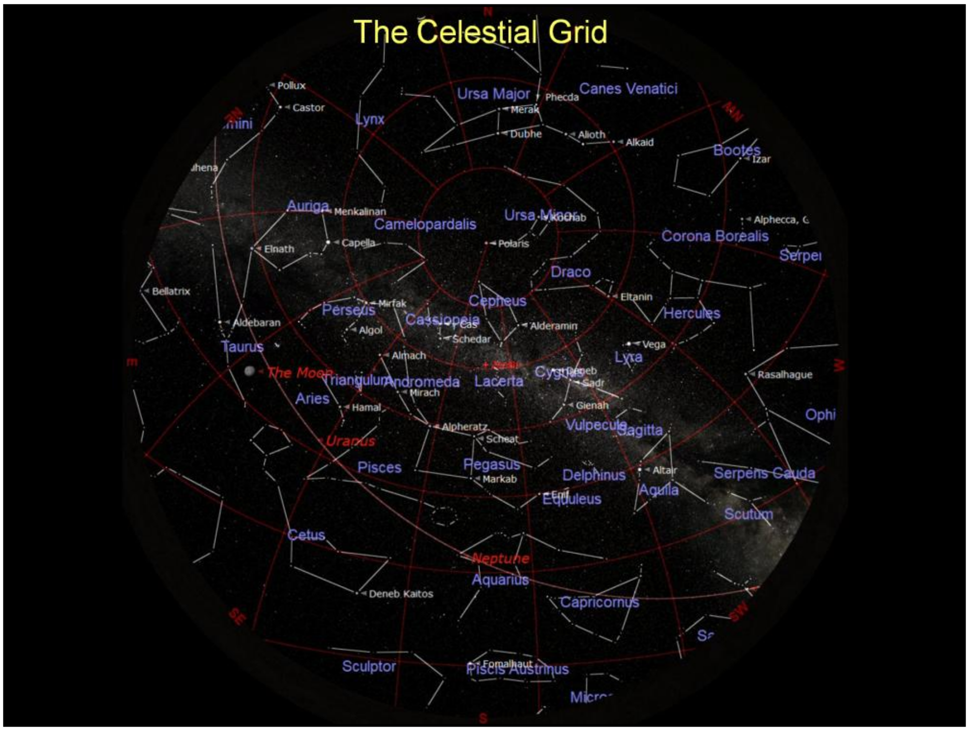
Our Moon is believed to have been originally a part of the Earth's crust smashed out by a collision between the Earth and another planet we call Theia was thought to be about the size of Mars.
Since the piece may have certainly come from the outer layer of the Earth (the crust), then this explains the lack of iron in the Moon. Furthermore, computer simulations also show how this theory is also consistent with angular momentum measurements.

The outer rocky part of Earth was smashed off and thrown into space by the impact. The whole of Theia crashed through the edge of Earth and most of it passed through and out the other side along with part of Earth's Iron core. All this debris looped out and around Earth in a low and unstable orbit. The heavy Iron soon crashed back on to Earth causing another massive impact on our Earth. The Iron Core combined with Earth's core quickly sank to the centre of Earth. Some of the rocky debris was thrown out into space but much of it coalesced together to form our Moon.

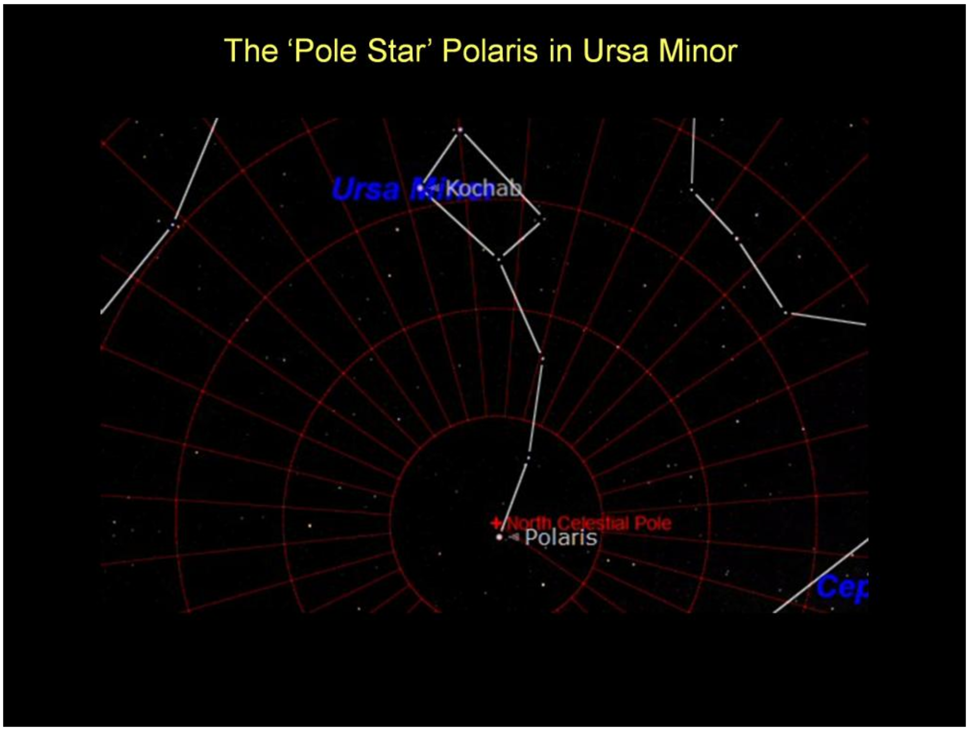
Both bodies were very hot and molten after this impact and quickly reformed into the two spherical bodies we see today. However the Moon is thought to have been about ten times closer than today and orbited much quicker. We now know the Moon has no Iron core and a rocky make up that very closely matches the rocks on Earth. These gives added weight to the Theia impact theory.



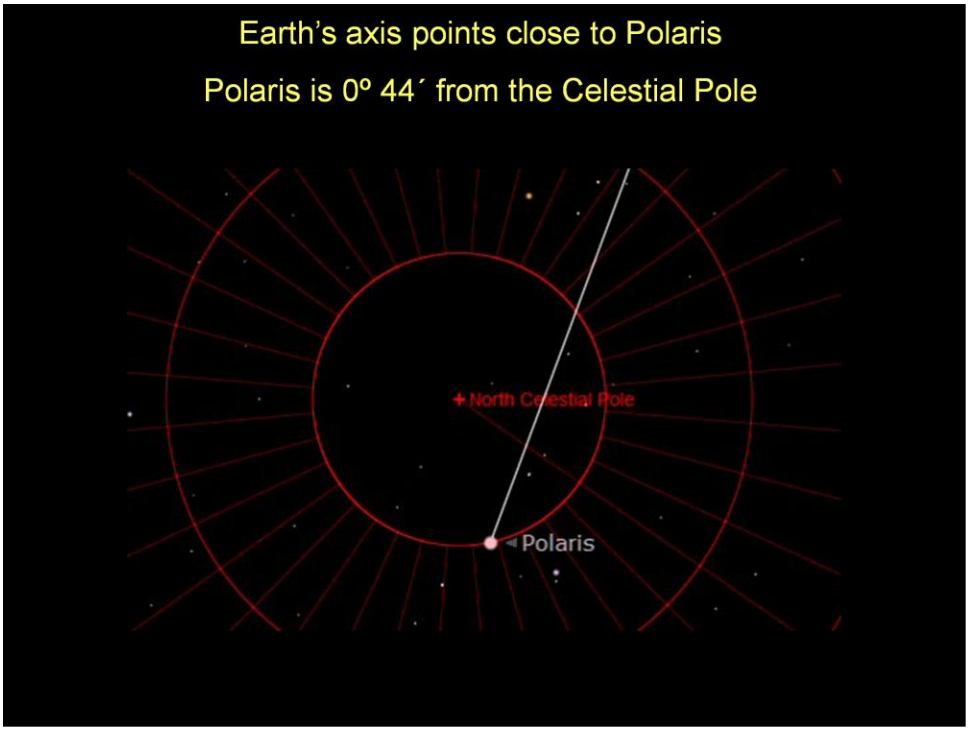
The tilt of the axis of Earth's rotation always points in the same direction as Earth moves around its orbit. Consequently a location on Earth (for instance the UK) effectively tilts toward and away from the Sun during the year creating Summer and Winter seasons.



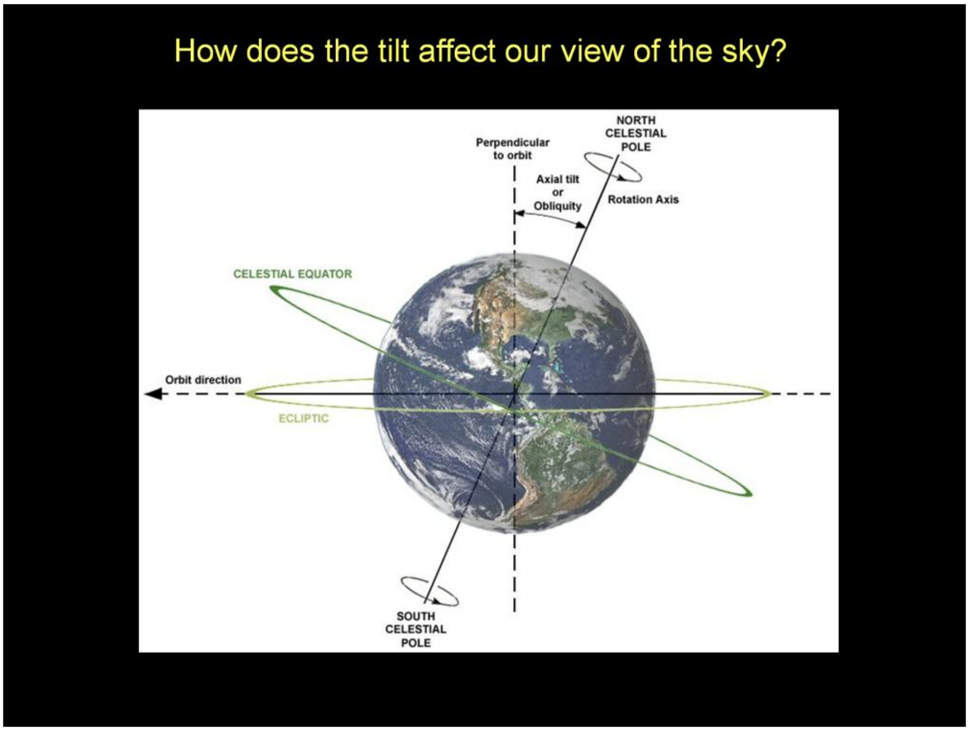
The tilt of the axis of Earth's rotation always points to the same point in the sky. In the northern hemisphere there is a star called Polaris in the constellation of Ursa Minor (the Little Bear). So as Earth rotates on its axis the sky appears to rotate around Polaris so we call it the Pole Star or the North Star. It is the only star that never appears to move in the sky all the other star appear to rotate around Polaris once every 24 hours (1 day).



If we draw imaginary grid lines from the South Pole to the North Pole and project those grid lines on to the sky we would see the lines converge on Polaris. They do not converge exactly on to Polaris but on to a point about 44 arc-minutes away from Polaris. To put this into context 44 arc-minutes is just less than the 30 arc minute diameter (half a degree) of the Full Moon.



Polaris is near enough to the North Pole to use for aligning a telescope for simple visual observing. We call the actual point in the sky where Earth's north axis of rotation points the ' North Celestial Pole.



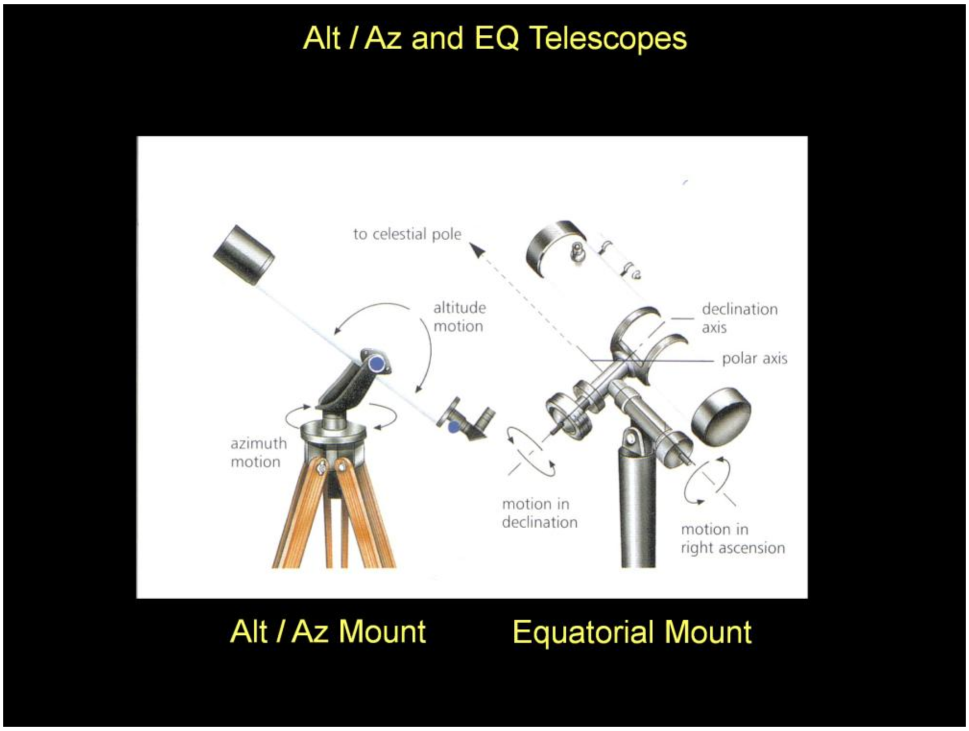
The diagram above shows the two equators that produce our tilted view of the sky. The 'Ecliptic' marked on the diagram is the equatorial plane of the Solar System. It is the equator of the Sun projected out a flat plane on which the planets, including Earth, orbit the Sun. The Celestial Equator is the Equator of Earth and is the plane through Earth half way between the north and south pole.

How does the tilt affect our view of the sky?

We have two ways to measure positions in the sky

1. Altitude / Azimuth (Alt / Az)
2. Celestial (Equatorial)

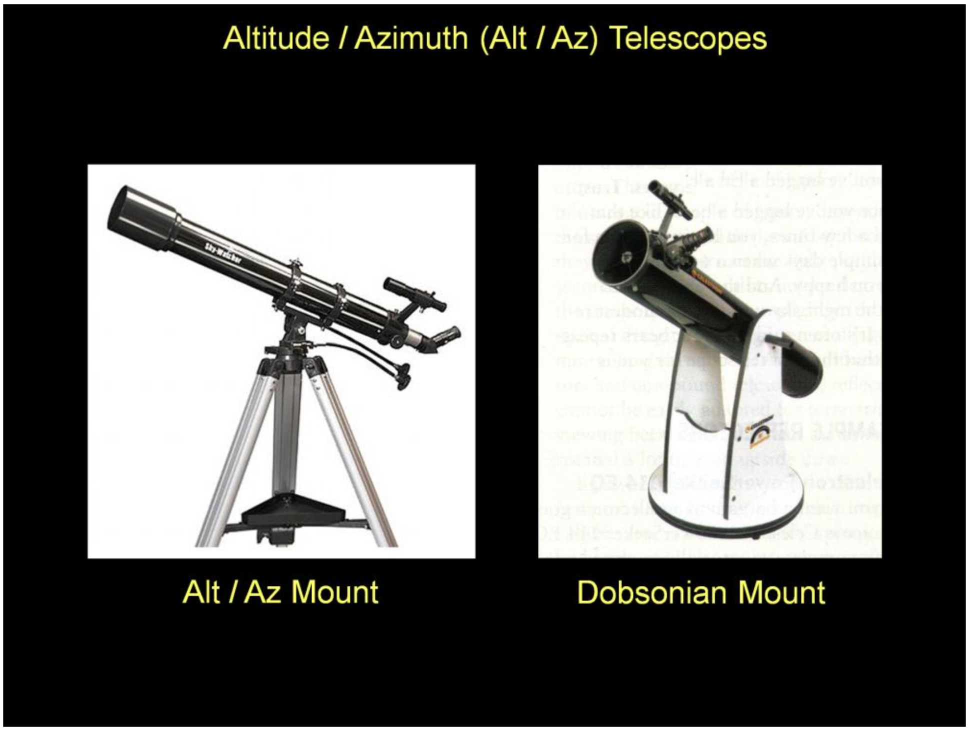
Right Ascension (RA) Declination (Dec)



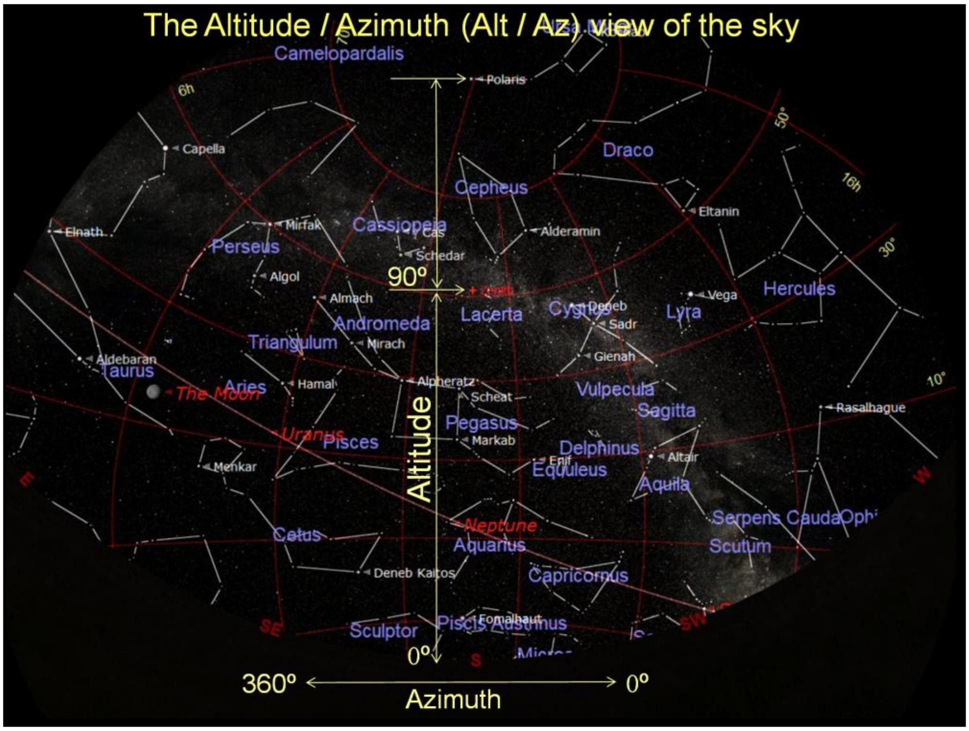
We have two kinds of telescope mounting: Alt-azimuth and Equatorial.

An Alt-azimuth mounting has a Horizontal rotational axis for rotation left or right (azimuth) and a vertical mounting to allow up and down motion (altitude).

An Equatorial mount has similar movements but the azimuth axis can be tilted to align in the Pole Star this called the Right Ascension (RA). The telescope can be raised or lowered using a Declination (Dec) axis.



The Alt Az is a simple up and down mount. There are two commonly used versions of Alt Az telescope mountings the Tripod mounted Alt Az and the Dobsonian Mount.



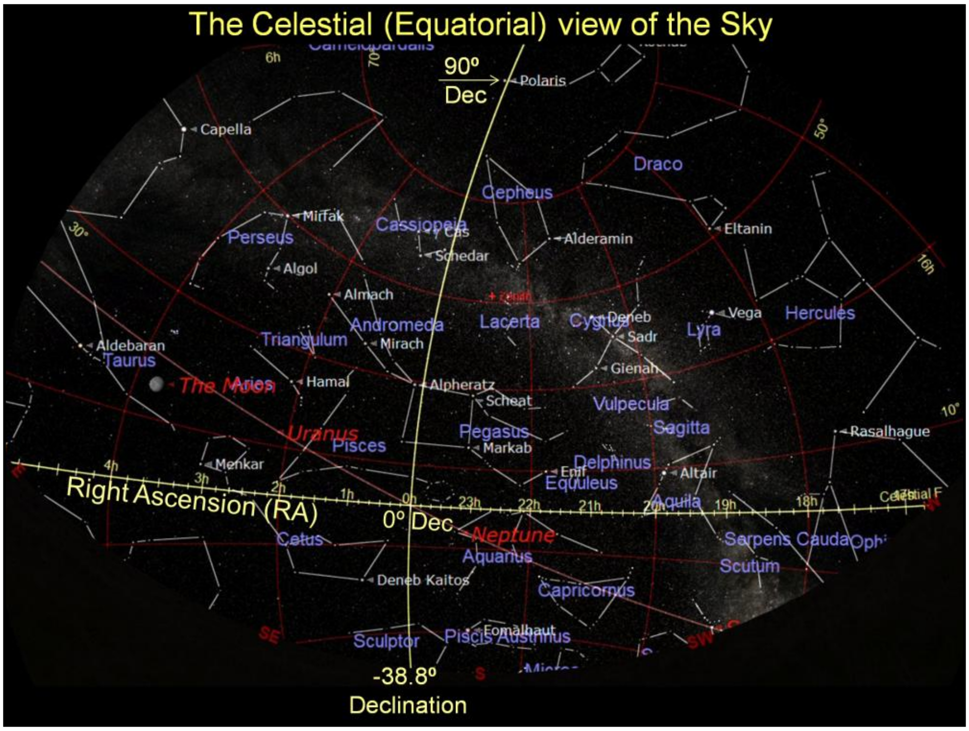
The Alt Az mount can be pointed around the sky from anywhere on the horizon and up (through 90º) to the Zenith (the point in the sky directly overhead).

The whole sky can be viewed but the tripod can prevent the sky directly overhead being observed. This is not a problem with the Dobsonian mount.

The disadvantage is the stars and planets appear to move in a arc across the sky due to Earth's tilt. It is necessary to adjust the telescope position in both directions simultaneously to track an object across the sky.

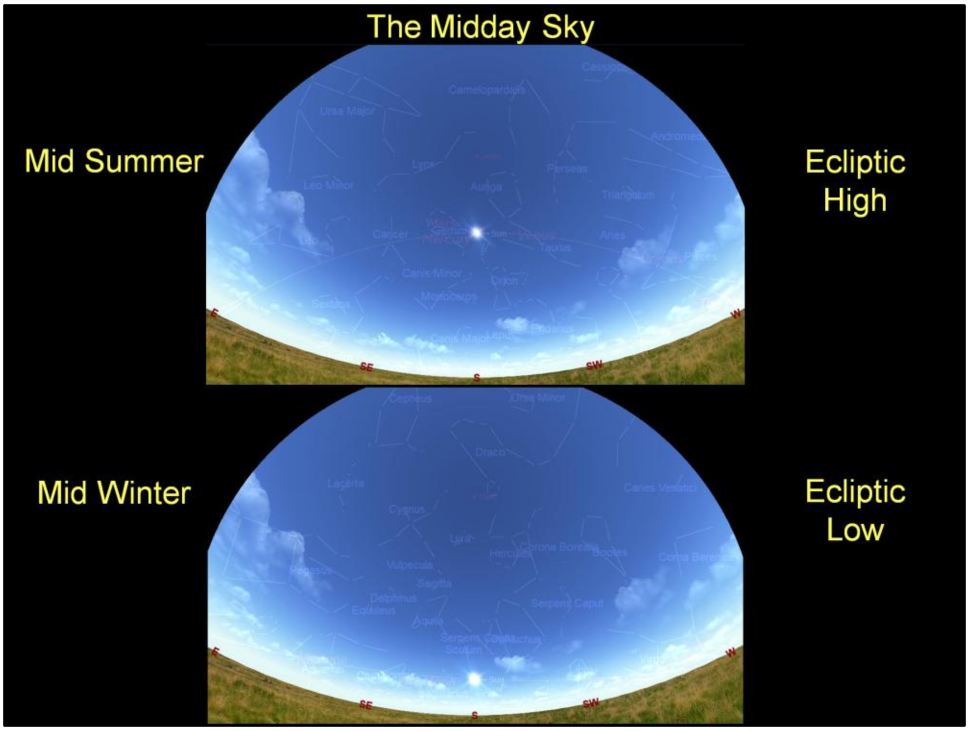
This is not a great problem for visual observing but tracking for astro-photography can be difficult.

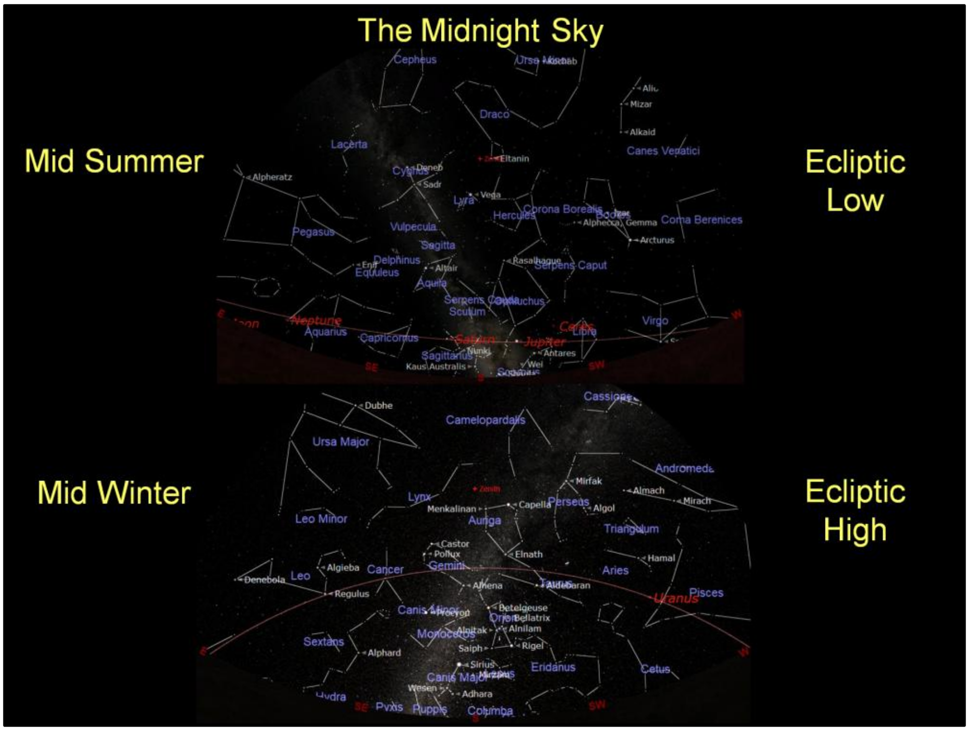
Equatorial (EQ) Telescopes



The Celestial (Equatorial) view of the Sky
90º
Dec
Polaris
Capella
Draco
Cepheus
Mirfak
Cassiopeia
Perseus
Eltanin
Alderamin
Schedar
Algol
Almach
Andromeda
Lacerta
Deneb
Vega
Hercules
Lyra
Sadr
Aldebaran
Taurus
Triangulum
Mirach
Gienah
The Moon
Aries
Hamal
Alpheratz
Scheat
Vulpecula
Sagitta
Uranus
Pisces
Pegasus
Markab
Rasalhague
Menkar
Delphinus
Altair
Equuleus
Right Ascension (RA)
Aquila
0º Dec
Neptune
Cetus
Aquarius
Serpens Cauda
Scutum
Deneb Kaitos
Capricornus
Sculptor
Fomalhaut
-38.8º
Declination

Equatorial (EQ) Telescopes


The Midday Sky
Mid Summer
Ecliptic
High
Mid Winter
Ecliptic
Low


The Midnight Sky
Mid Summer
Ecliptic
Low
Mid Winter
Ecliptic
High

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