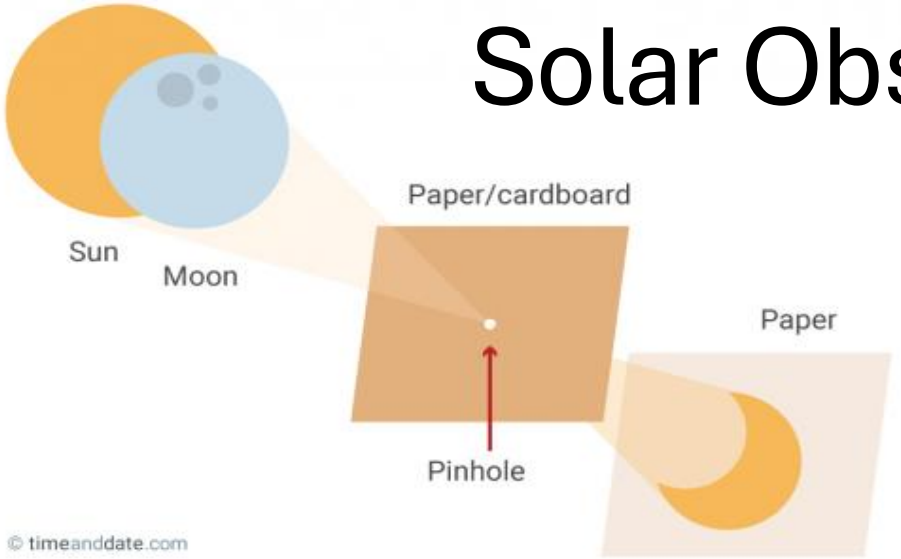
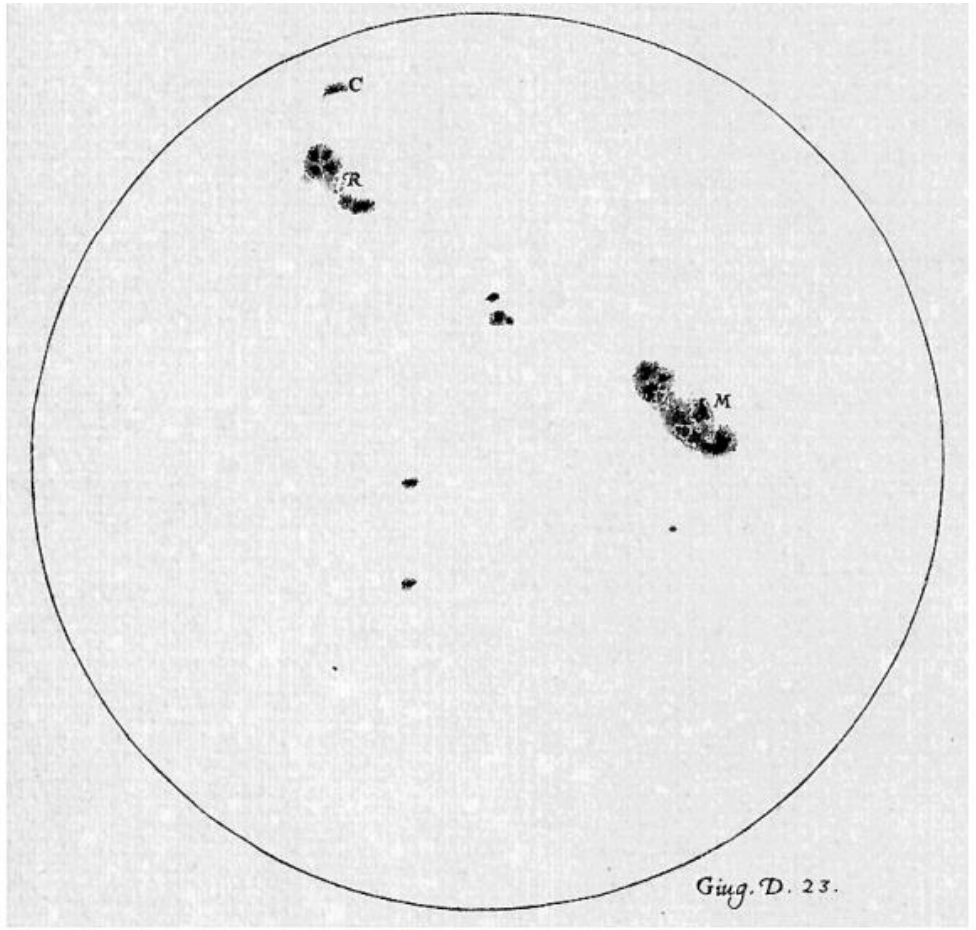
Topic 5: Solar System Observations Part One

Solar Observations



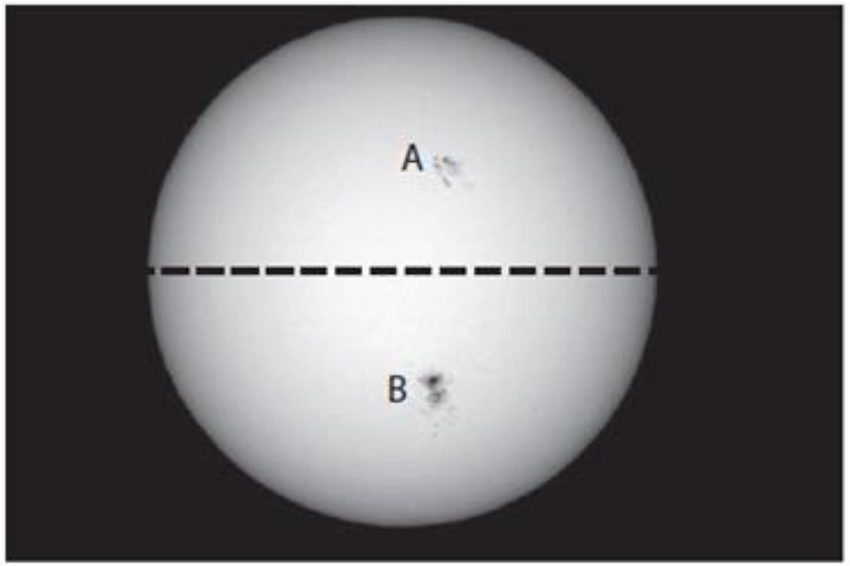
YOU MUST NOT EVER LOOK DIRECTLY AT THE SUN ESPECIALLY WHEN LINING UP YOUR PINHOLE PROJECTOR!



Galileo Galilei (left) and sunspot drawings (above) from The Galileo Project. http://es.rice.edu/ES/humsoc/Galileo/

Planning Solar Observations

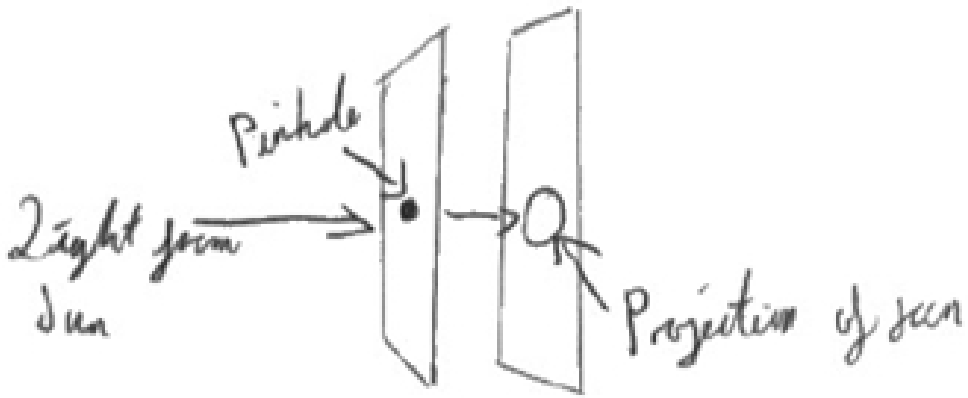
Figure 2 shows two large sunspot groups on the surface of the Sun, labelled A and B.
The dotted line indicates the position of the solar equator.



(Source: © NASA)

Figure 2

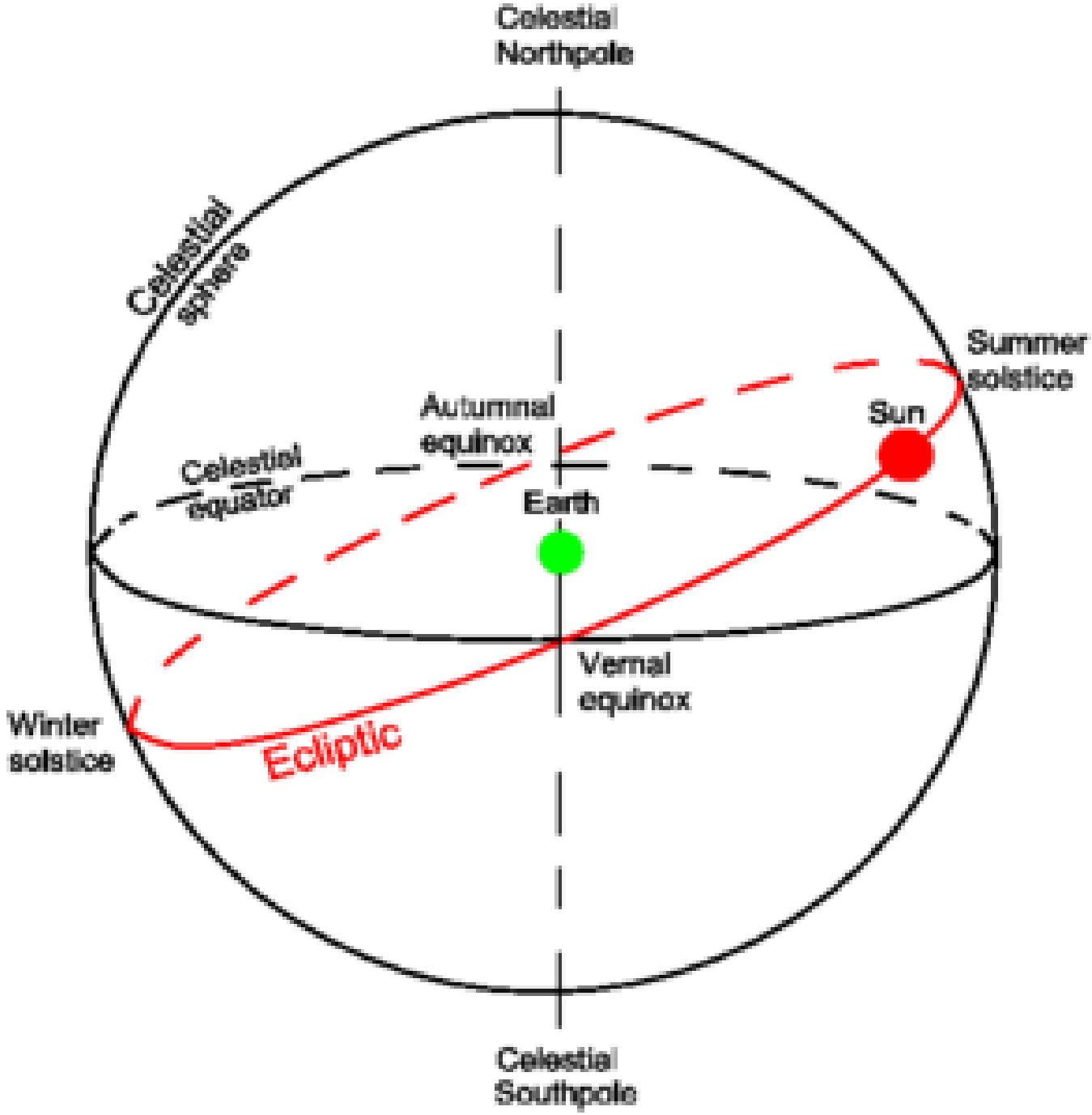
* Describe a method for using a telescope to observe sunspots safely. Use a clearly labelled diagram as part of your answer.



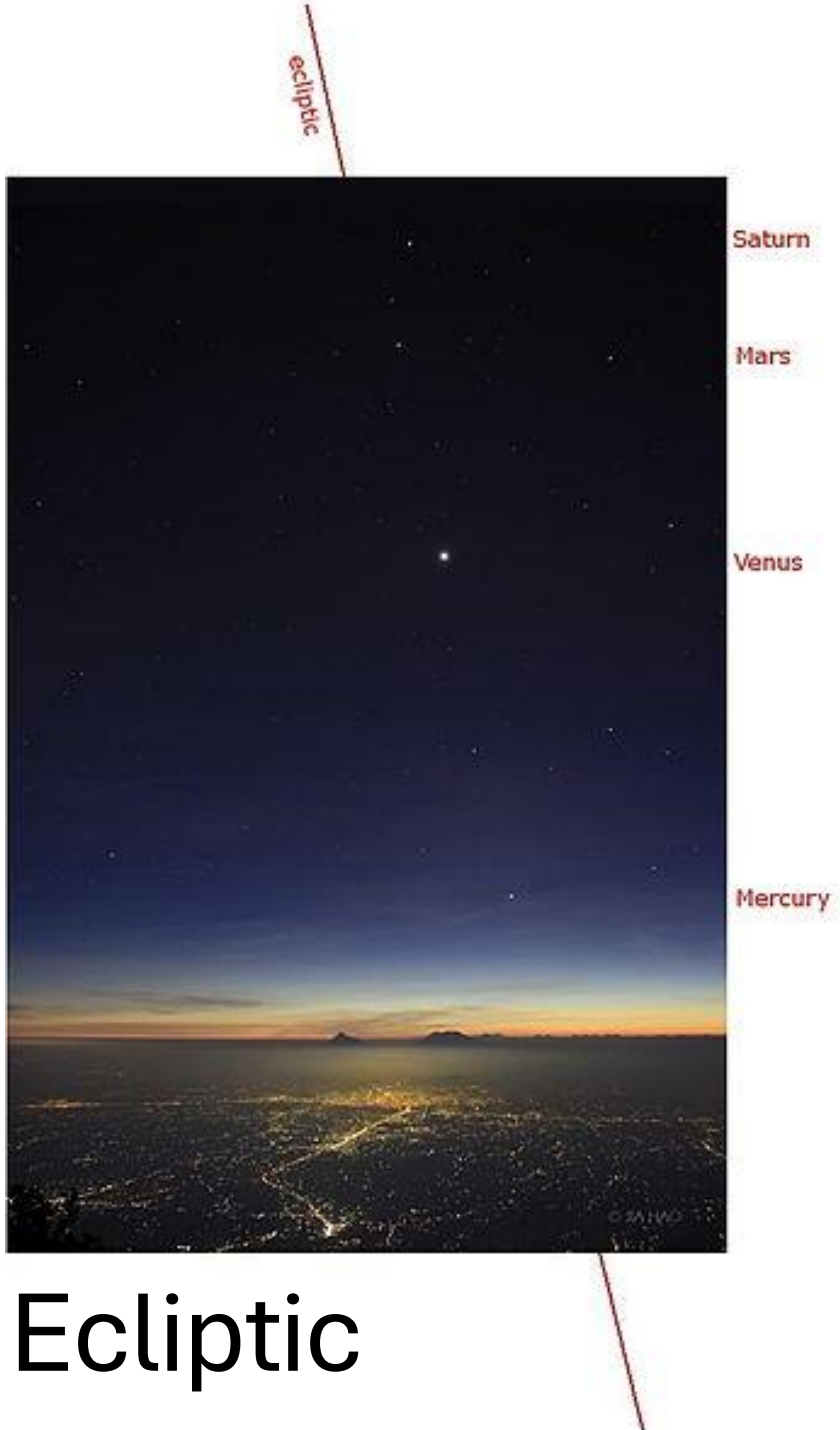
When the ~~weather is~~ sky is clear. Put a hole through a piece of paper. Position a 2nd sheet behind and ~~adjust~~ adjust distance between them to bring the Sun into focus.

The Ecliptic

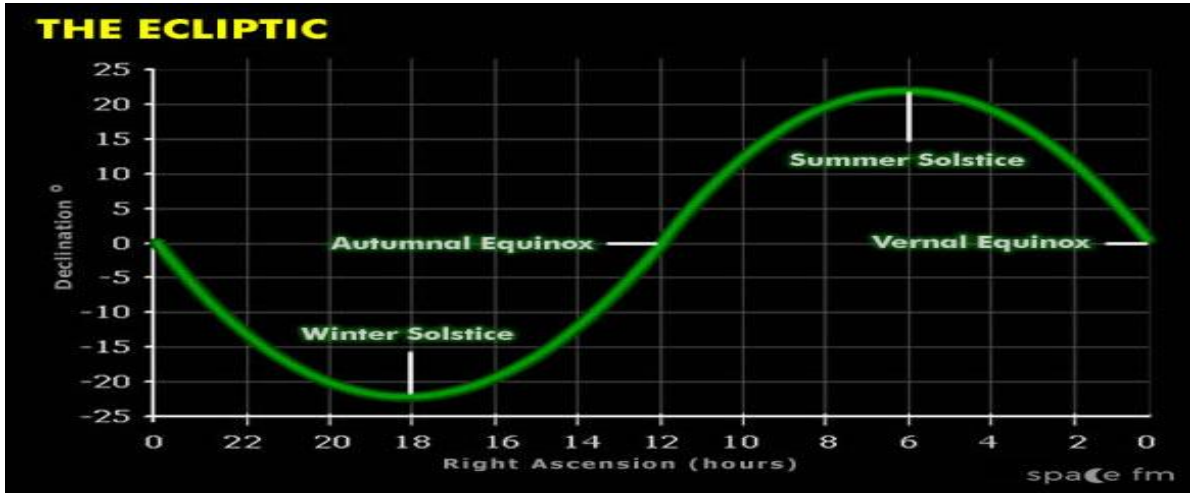
The Sun appears to follow a path across the sky throughout the year, known as the **ecliptic**.
This motion is due to **Earth's orbit around the Sun**.



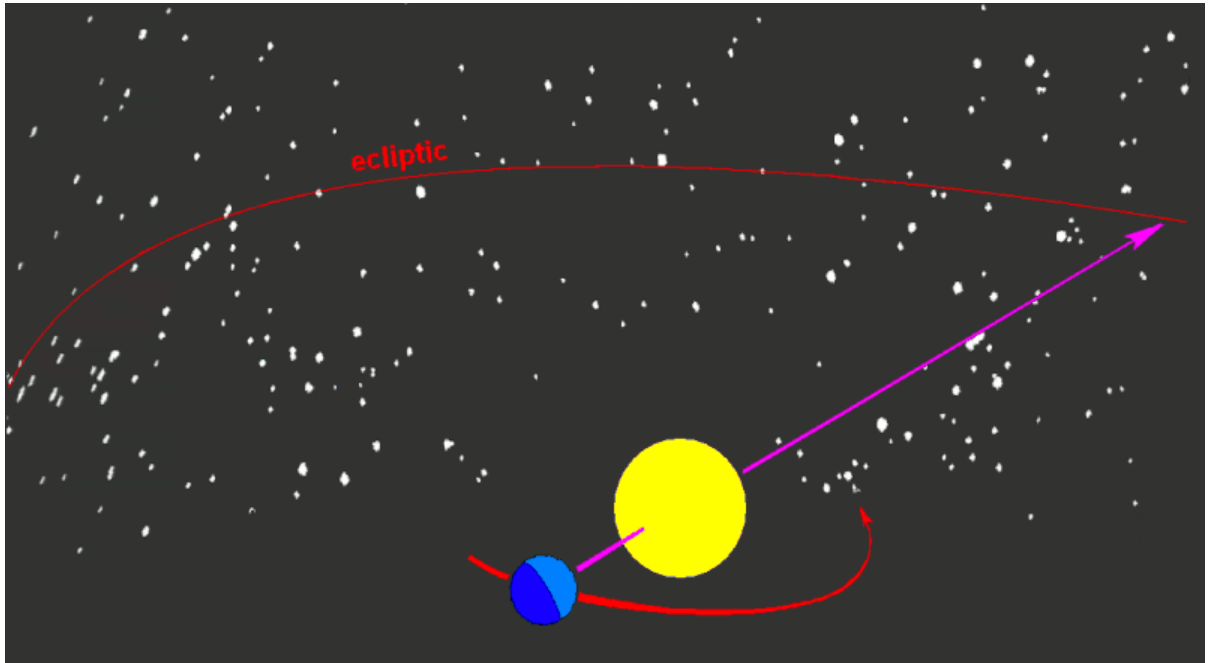

12.10.2000 00:00:00UT
Virgo
Libra
Capricornus
quarius
Sagittarius
Scorpius



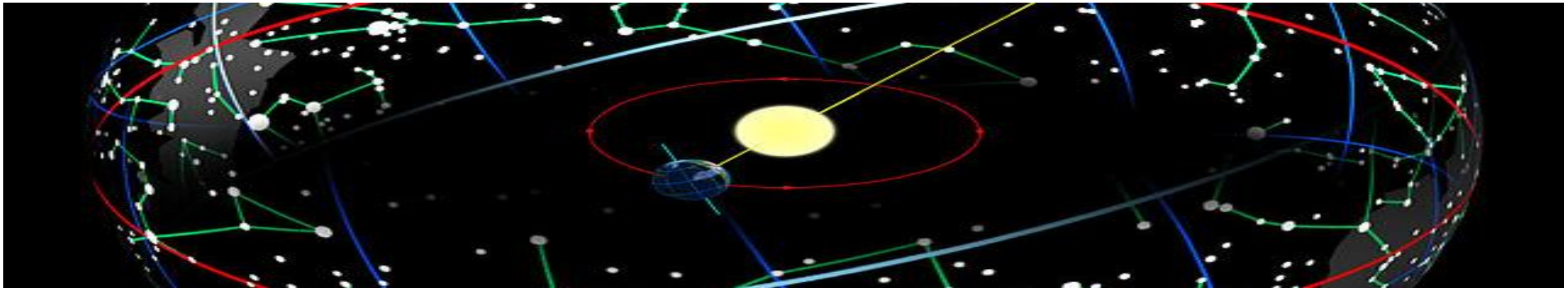
The Ecliptic



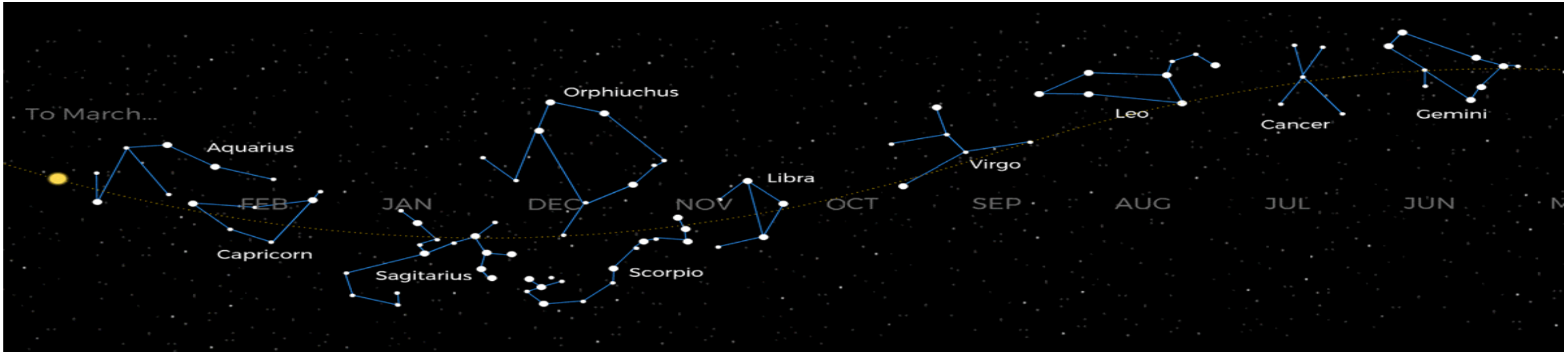
The planets also travel along this ecliptic.
The ecliptic is the starting point for the celestial coordinate system for all other stellar objects.



The Zodiac

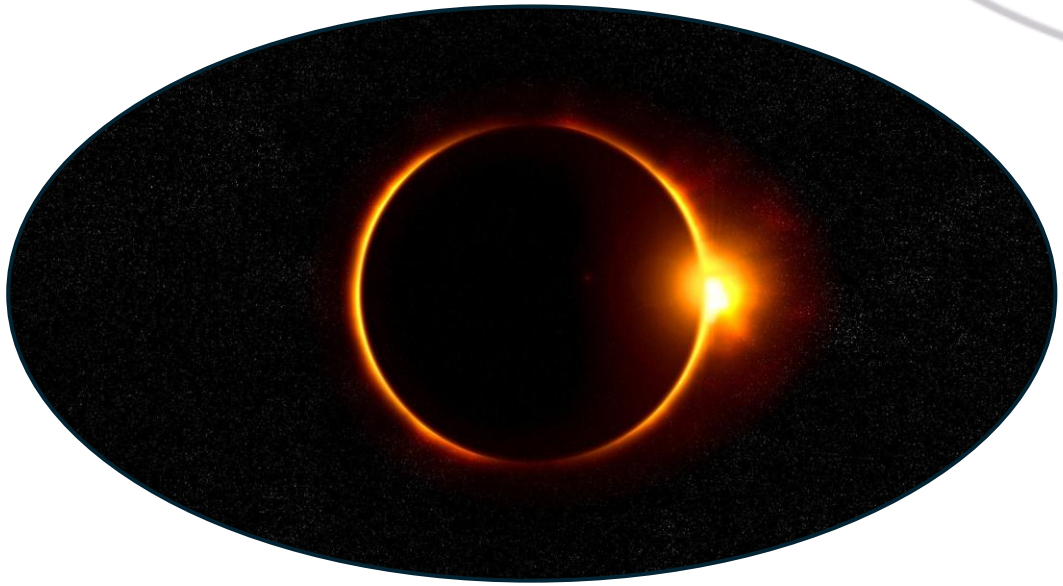


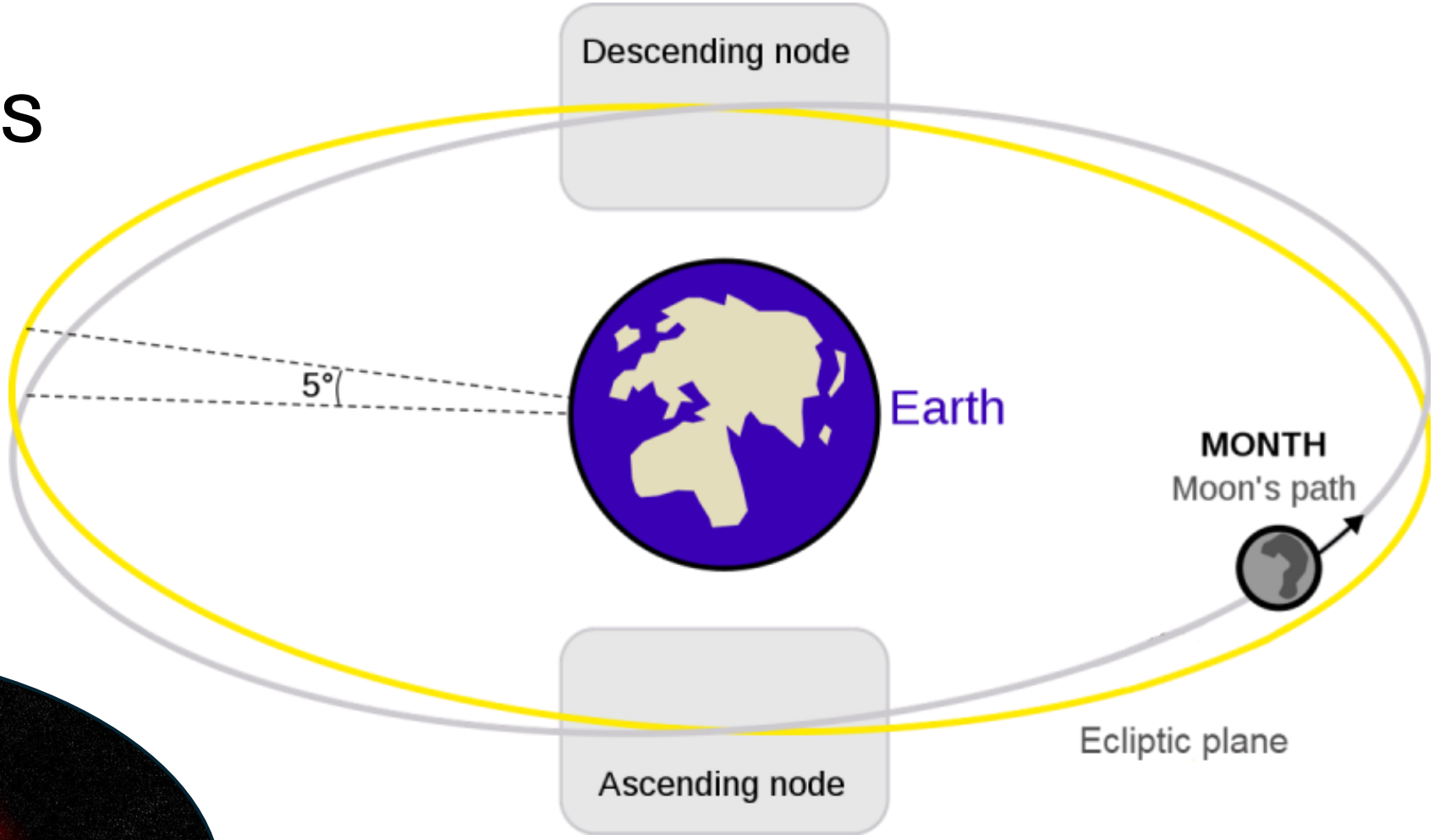
- All constellations of the **zodiac** are found along the ecliptic.
- There are **13** zodiacal constellations, the 12 astrological signs and Ophiuchus (the Serpent-bearer) which is only partially located along the ecliptic (between Scorpius and Sagittarius)



Lunar Dynamics

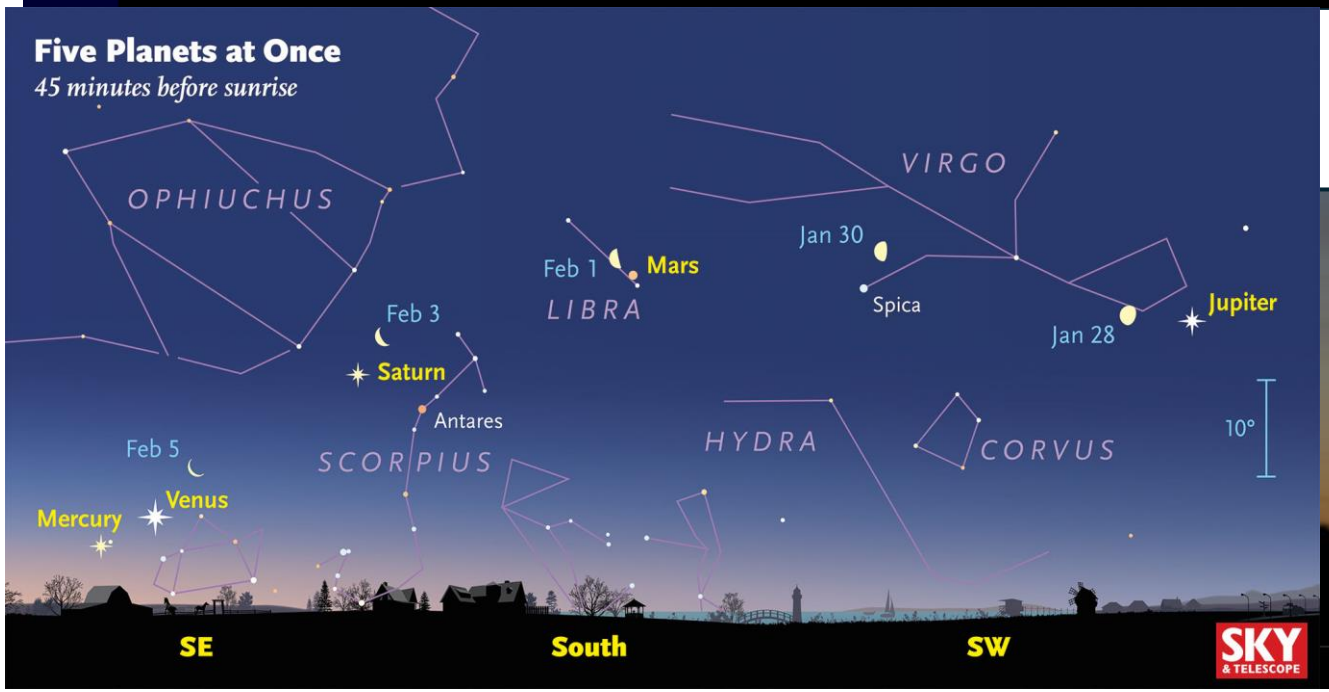
The moon is close to the ecliptic but slightly tilts (approx. 5.7 °) which is why we don't have monthly eclipses





The moon crosses the ecliptic twice a month, but only if the moon is full or new will this transit lead to eclipses.

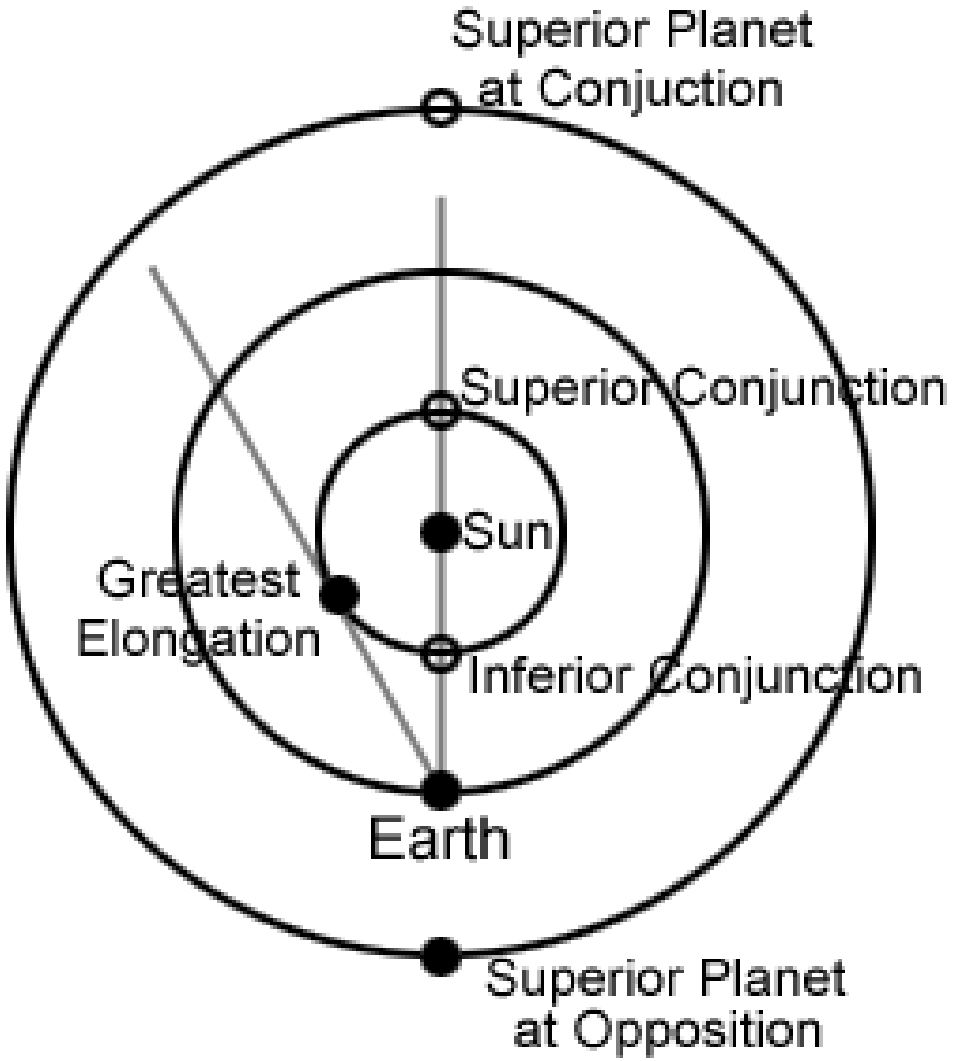
2025	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mercury	Dawn	Dusk	Dusk	Dawn	Dawn	Dusk	Dusk	Dawn	-	Dusk	Dus Daw	Dawn
Venus	Eve	Eve	Dusk	Mor	Mor	Mor	Mor	Mor	Dawn	Dawn	-	-
Mars	AN	Eve	Eve	Eve	Eve	Eve	Eve	Eve	Eve	Dusk	-	-
Jupiter	Eve	Eve	Eve	Eve	Dusk	-	Dawn	Mor	Mor	Mor	Mor	Mor
Saturn	Eve	Dusk	-	Dawn	Mor	Mor	Mor	Mor	AN	Eve	Eve	Eve
Uranus	Eve	Eve	Eve	Dusk	-	Dawn	Mor	Mor	Mor	Mor	AN	Eve
Neptune	Eve	Eve	-	Dawn	Mor	Mor	Mor	Mor	AN	Eve	Eve	Eve



Planetary Observations

Since the planets are in approximately the same plane as the Earth, the ecliptic serves as a good guide for finding the “Naked-Eye Planets” in the Sky.

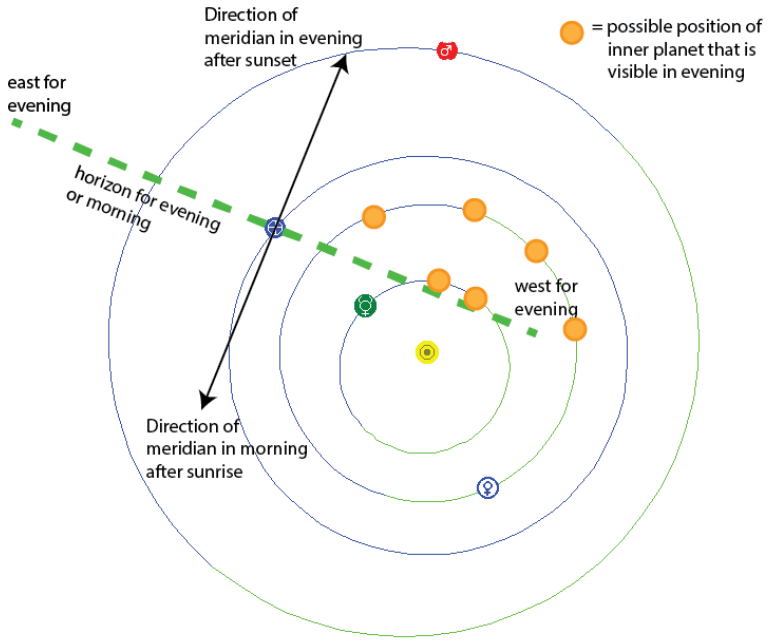
Key Terminology



- **Conjunction:** When two celestial objects appear **close together** in the sky.
  - **Inferior Conjunction:** When an inferior is between Earth and the Sun.
  - **Superior Conjunction:** When an inferior planet is on the opposite side of the Sun from Earth.
- **Transit:** When a planet passes **directly in front of the Sun** from Earth's perspective.
- **Opposition:** When a planet is directly **opposite the Sun** in the sky.
- **Elongation:** The angle between a planet and the Sun as seen from Earth.
- **Occultation:** When one celestial object passes **in front of another**, blocking its view.

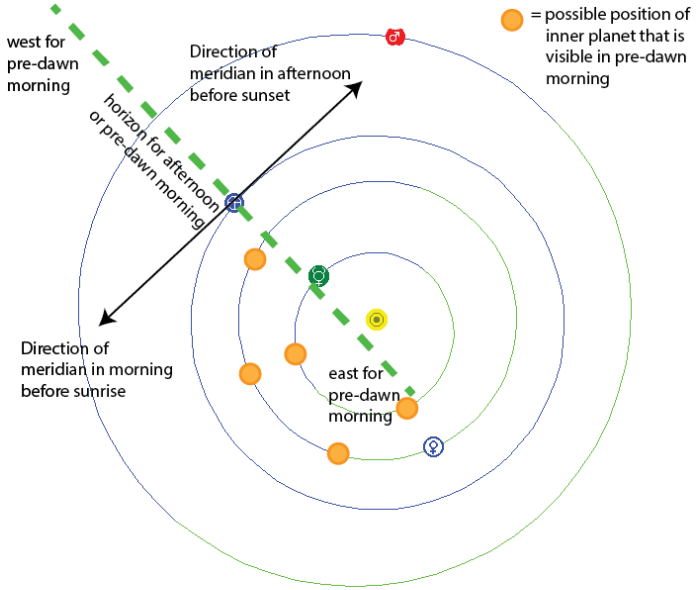
The Inner (Inferior) planets

The '**Inferior**' planets are best seen at dawn and dusk



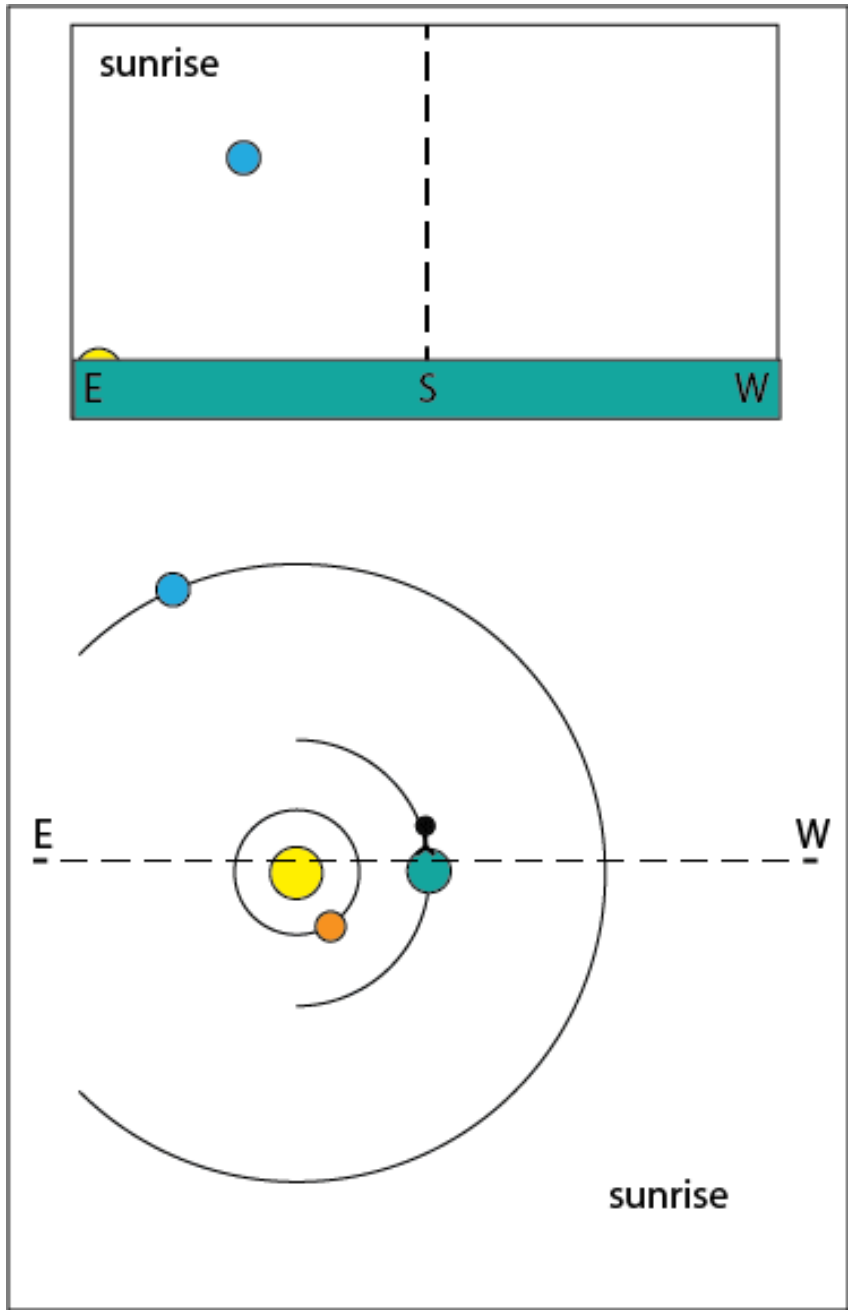
In the evening after sunset, we can see inner planets in the western sky.

(Planet positions plotted for February 8, 2021 from Solar System Live at www.fourmilab.ch.)



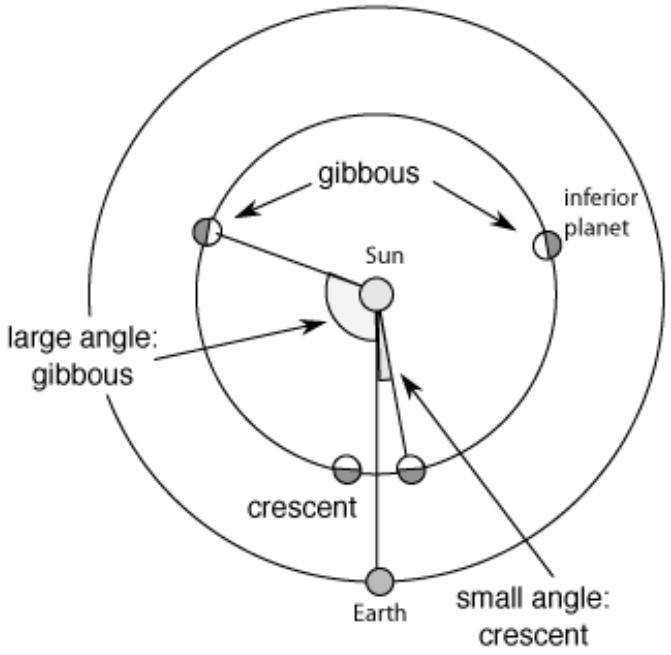
In the pre-dawn morning before sunrise, we can see inner planets in the eastern sky.

(Planet positions plotted for February 8, 2021 from Solar System Live at www.fourmilab.ch.)

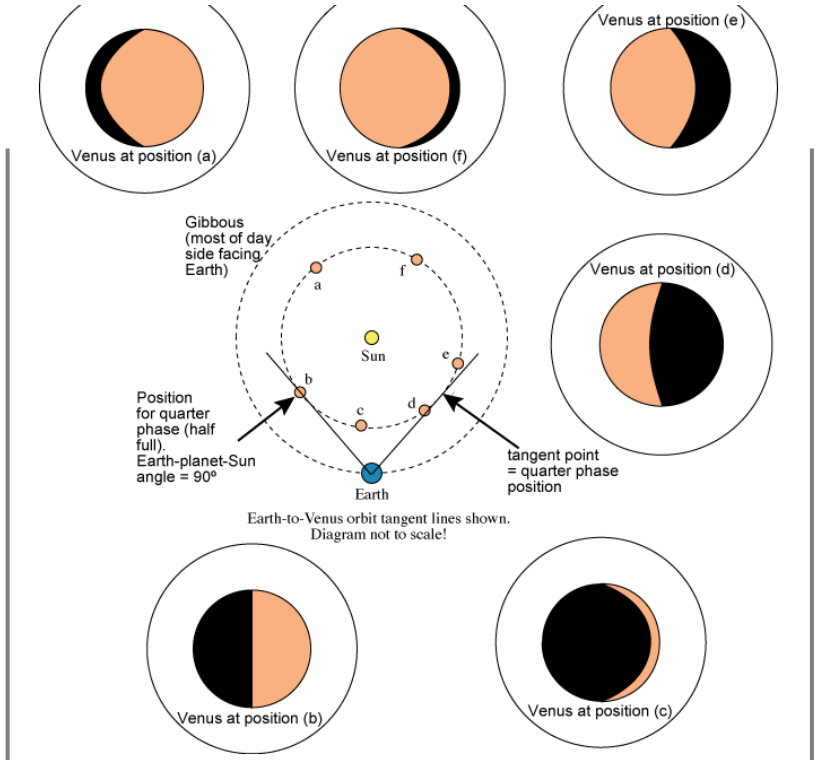


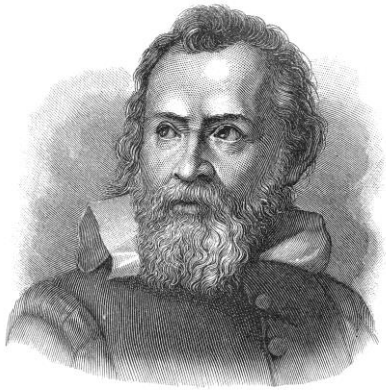
Both planets are easiest to see at **greatest elongation** or during a rare **transit** (which we only see with inferior planets)

The observation of Venus' Moon-like phases was an important discovery because it provided clear evidence supporting of the 'Copernican' Solar System.



The inferior planets (Venus and Mercury) go through a complete set of phases. The phase depends on the planet-Sun-Earth angle.





Galileo Galilei.

Observing Venus

Mercury is an inferior planet.

An astronomer wishes to make some **naked-eye** observations of the planet Mercury.

Design a suitable observing programme that will allow her to make these observations safely.

Question number	Indicative content	Mark
	Indicative Content: • Safety use of filters etc • Brightness of Sun – observing near sunrise or sunset • Small and unreflective nature of Mercury • Need to observe near elongation to observe crescent phase • Need to select specific days in advance as Mercury too close to Sun for much of its orbit • (very) occasional possibility of observing Mercury in transit	**(6)**

Topic 5: Solar System Observations Part Two

The Outer (Superior) planets

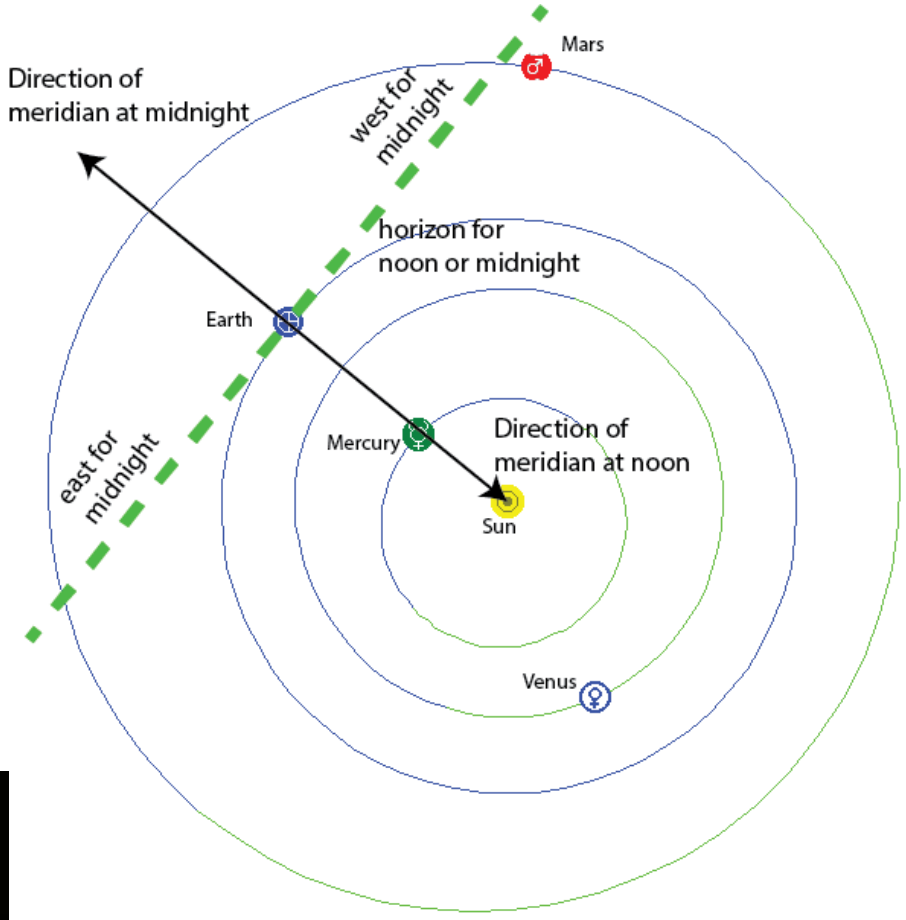
For Mars and beyond (the **Superior** planets) an apparition is measured from visibility at dawn to disappearance at dusk.

This can make a conjunction difficult to observe.

Mars is easily recognised since it has the most distinctive coloration of all the naked eye planets. It rarely appears red but varies from pale orange-yellow to orange-red.

Jupiter appears bright white and is a very obvious sight in the night sky.

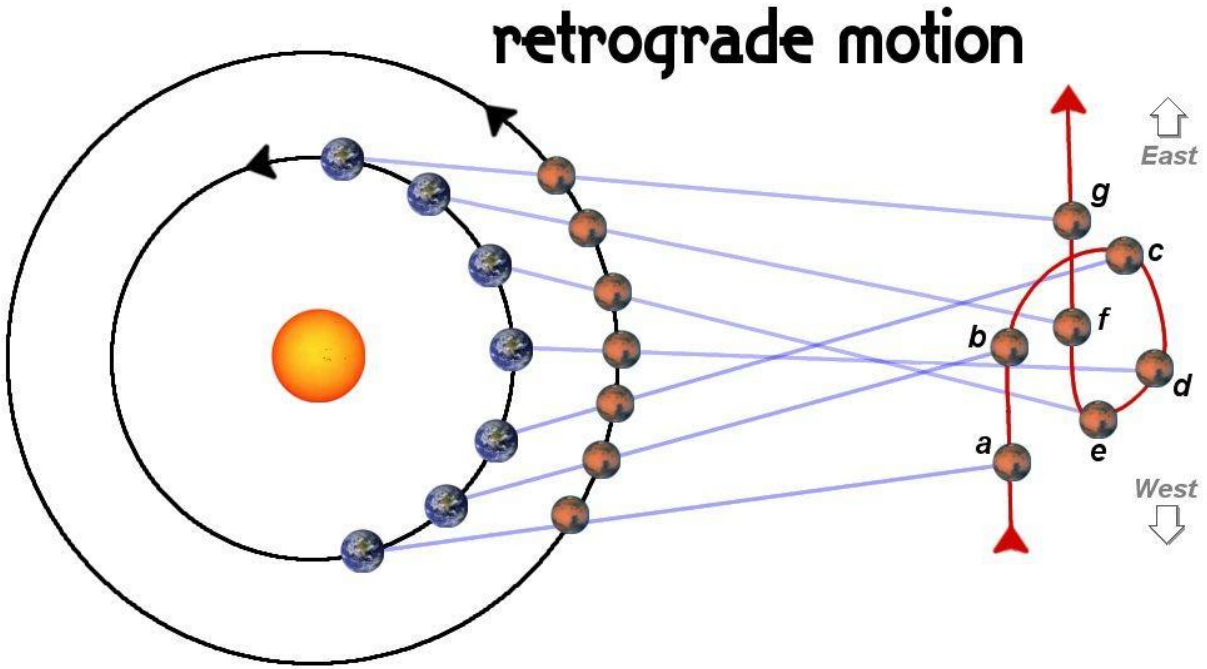
Steadily-held, good quality binoculars or a small telescope will show Jupiter as a small white disk, nearby we can see its four brightest natural satellites.



At midnight we face directly away from the Sun, so our part of Earth is facing toward the outer solar system.

(Planet positions plotted for February 8, 2021 from Solar System Live at www.fourmilab.ch.)

Retrograde Motion



- Apparent **retrograde motion** occurs when a planet appears to **move backward** (westward) for a short period before resuming normal eastward motion.
- This happens because Earth **overtakes** an outer planet in its orbit (or an inner planet overtakes Earth in the case of Mercury and Venus).

- All planets orbit the Sun in the same direction (prograde motion) but at different speeds.

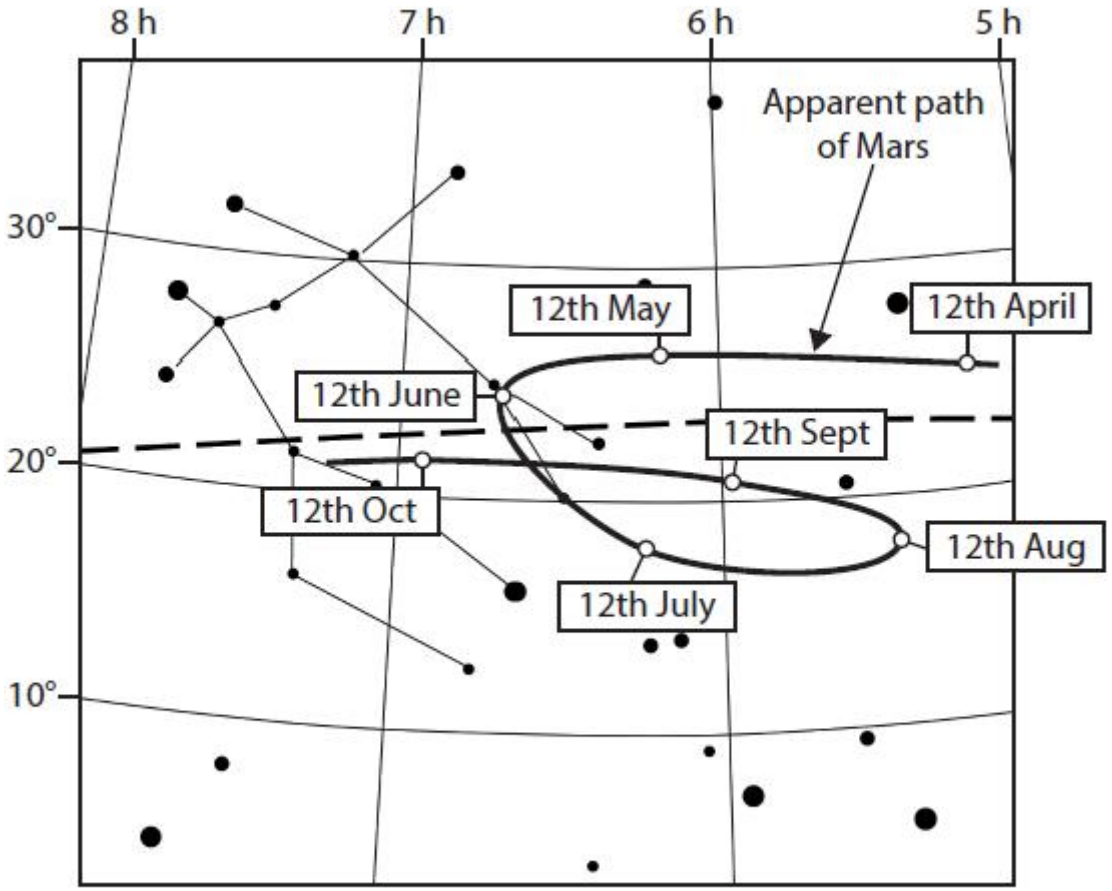
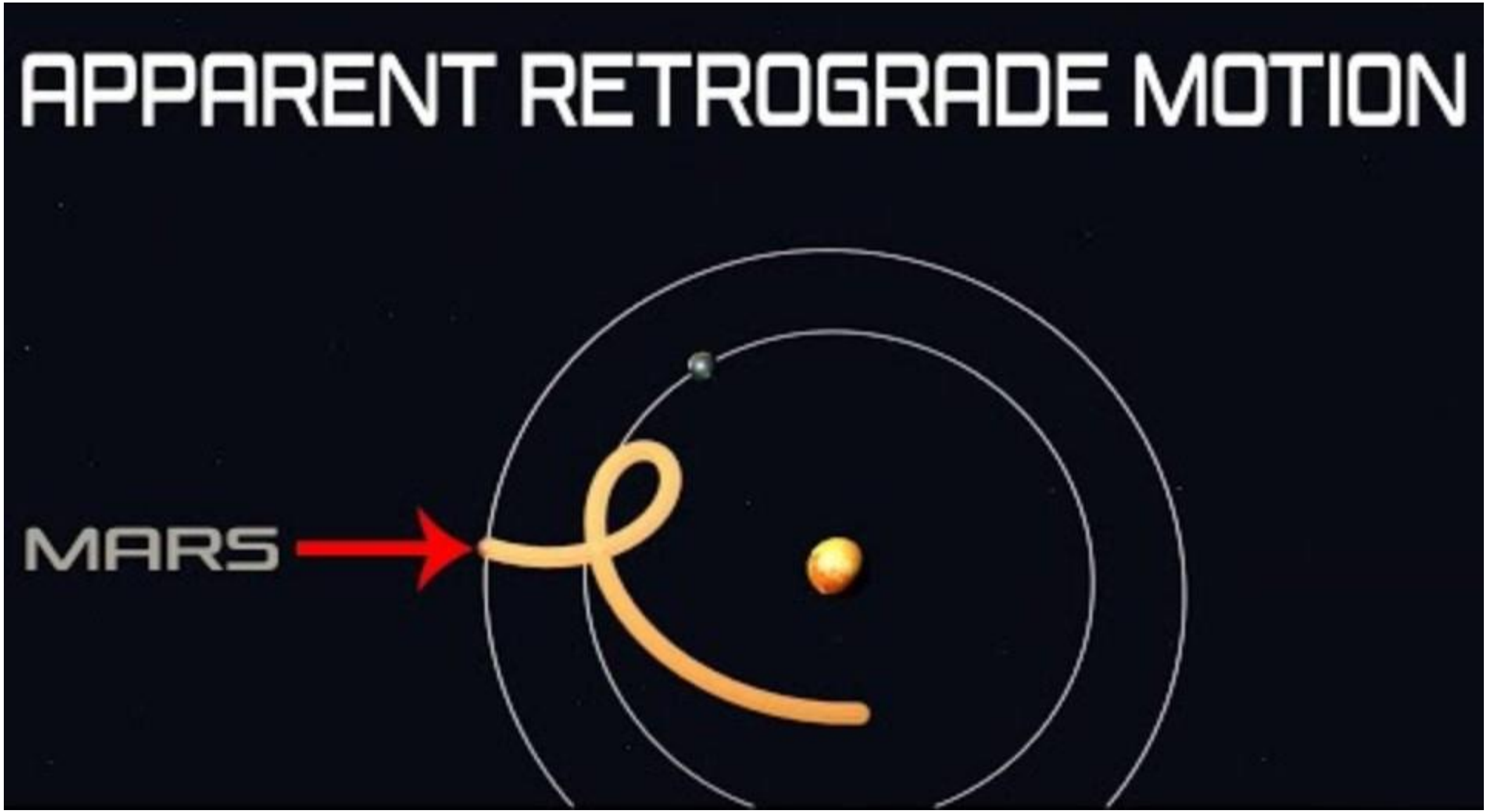


Figure 2

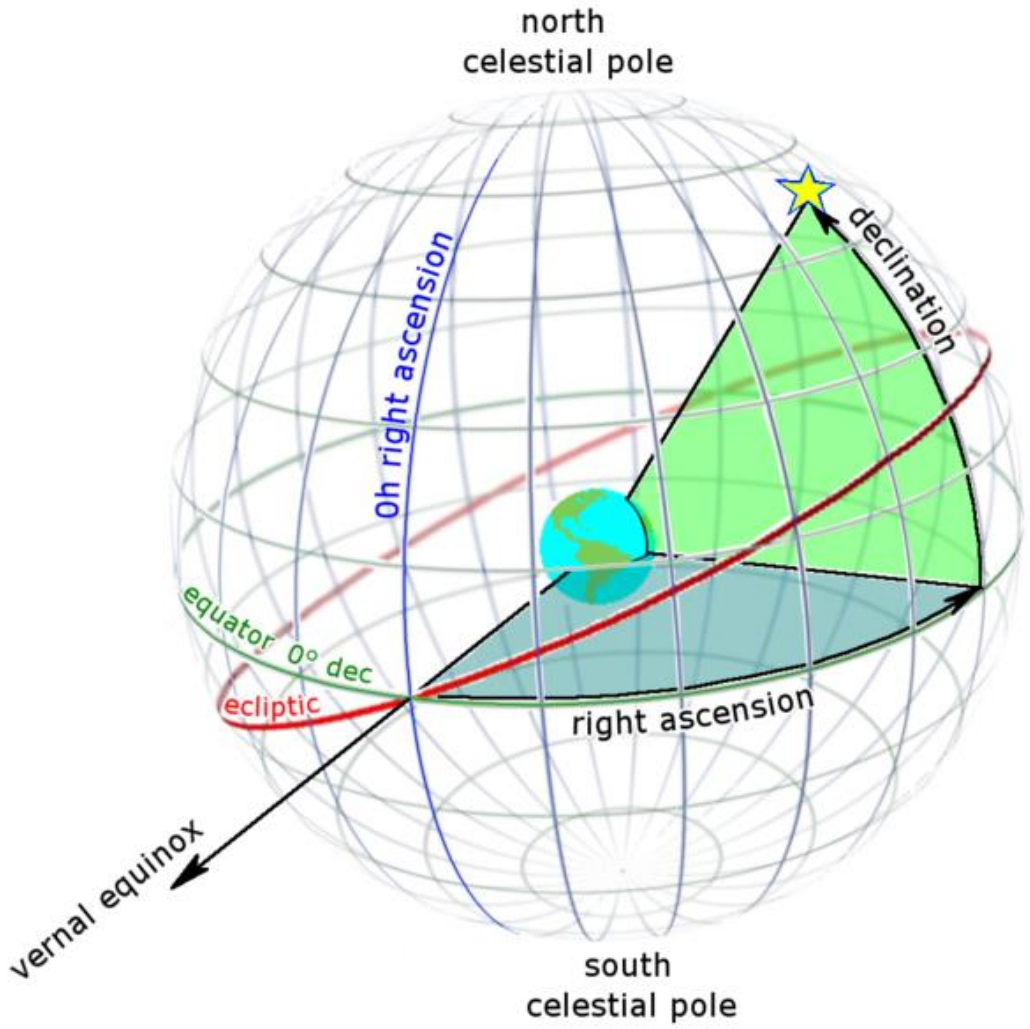

APPARENT RETROGRADE MOTION
MARS

Celestial Coordinates

The celestial equivalent of latitude is called **declination** (angle measured above and below the 0 º line which is the celestial equator at 23.5 º to the ecliptic).

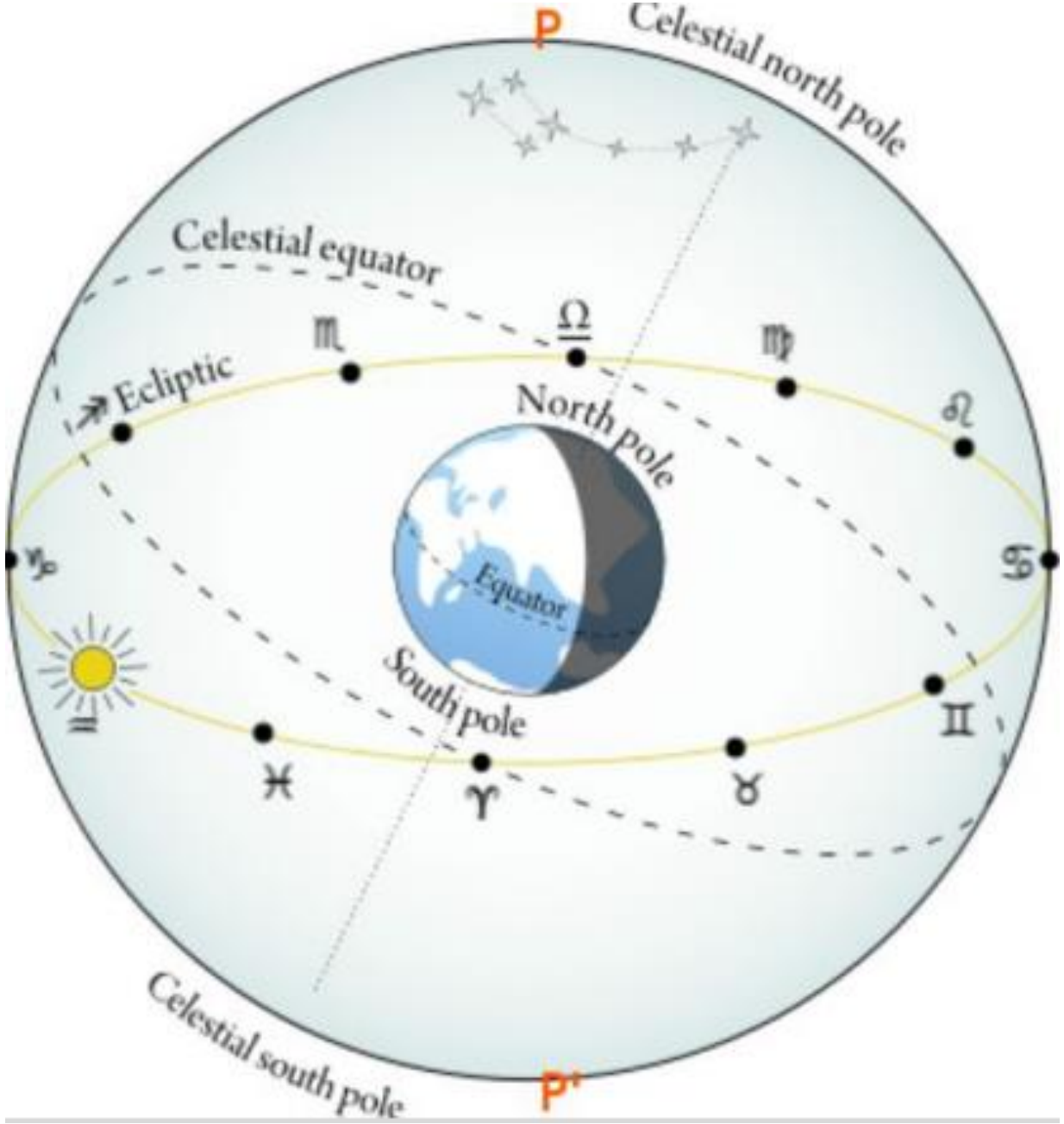
Right ascension is an astronomical coordinate that specifies an object's position on the celestial sphere, equivalent to longitude on Earth. It is expressed in units of time, where 24 hours represents a full 360° circle

•Our 'meridian' line is the '**The First Point of Aries**'; the point at which the Sun crosses the **celestial equator moving from south to north** along the ecliptic (at the vernal Equinox)



Locating Galaxies

ANDROMEDA

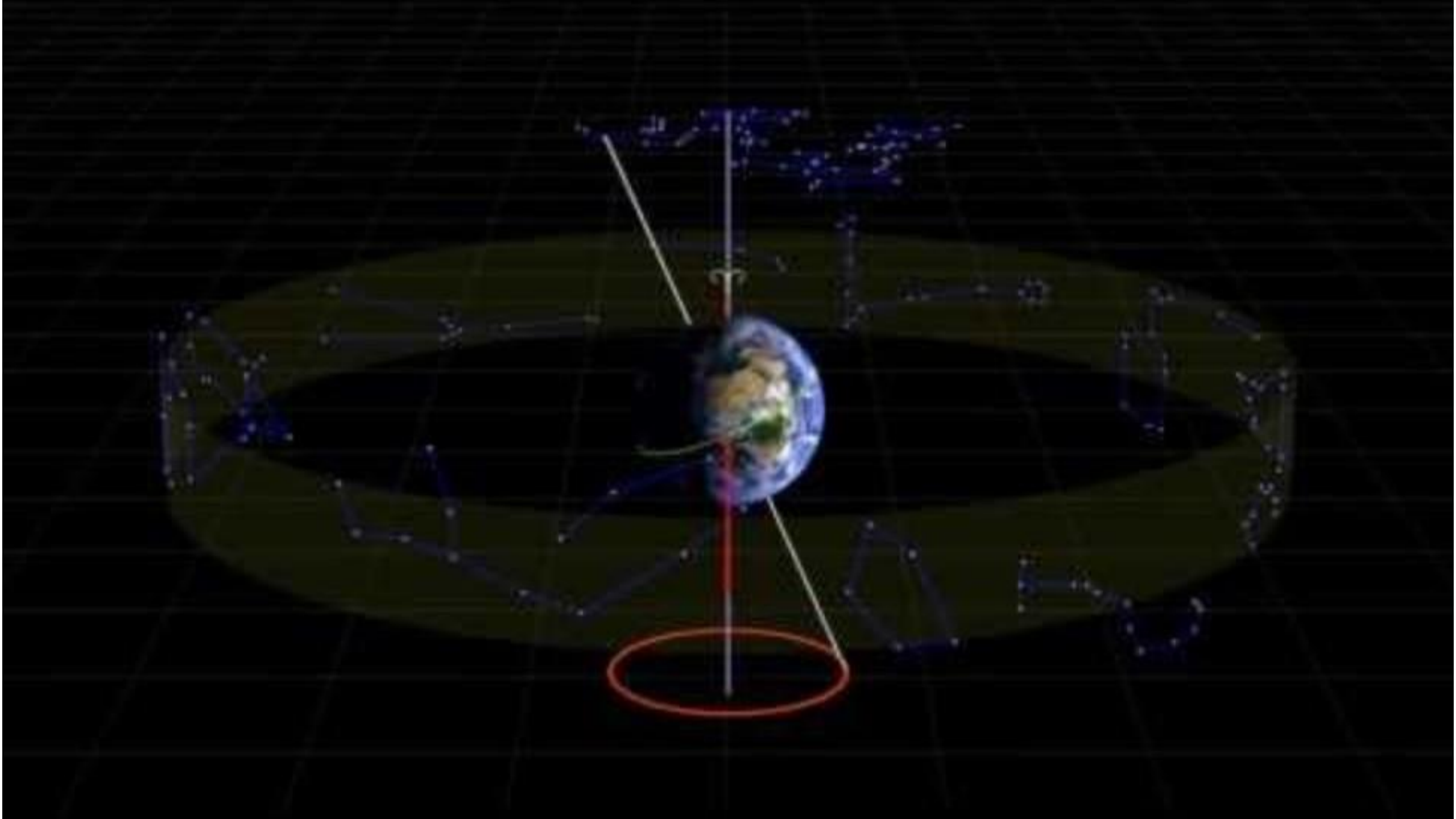


Points of reference

The '**First Point of Aries**' because was defined in 150 B.C. when Ptolemy first mapped the constellations, Aries lay in that position.

However, although still named the 'First Point of Aries', due to precession, the vernal equinox now lays in the constellation Pisces.The First Point of Aries is usually represented by the 'ram's horn' symbol.

The **First Point of Libra** on the celestial sphere is **diametrically opposite** the first point of Aries. It is the same as the autumnal equinox. It has right ascension 12h and declination zero. (Because of precession, it no longer lies in Libra but in neighbouring Virgo)



Space rocks

Meteoroid

While it is floating around in Space, a space rock is called a **meteoroid.**

Meteor

When a meteoroid enters the Earth's atmosphere, friction heats it up and it begins to burn. The trail of light left behind by a burning meteoroid is called a **meteor.**

Meteorite

If a meteoroid doesn't completely burn up as it travels through the Earth's atmosphere and makes it to the ground, it's called a **meteorite.**

Meteor Showers