

# MAT221V / Introduction to Astronomy

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AP/Mathematics

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Textbook

Astronomy

By

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# Unit 1

## Content

1. Celestial Coordinates
2. Diurnal Motion

# Introduction

- Astronomy

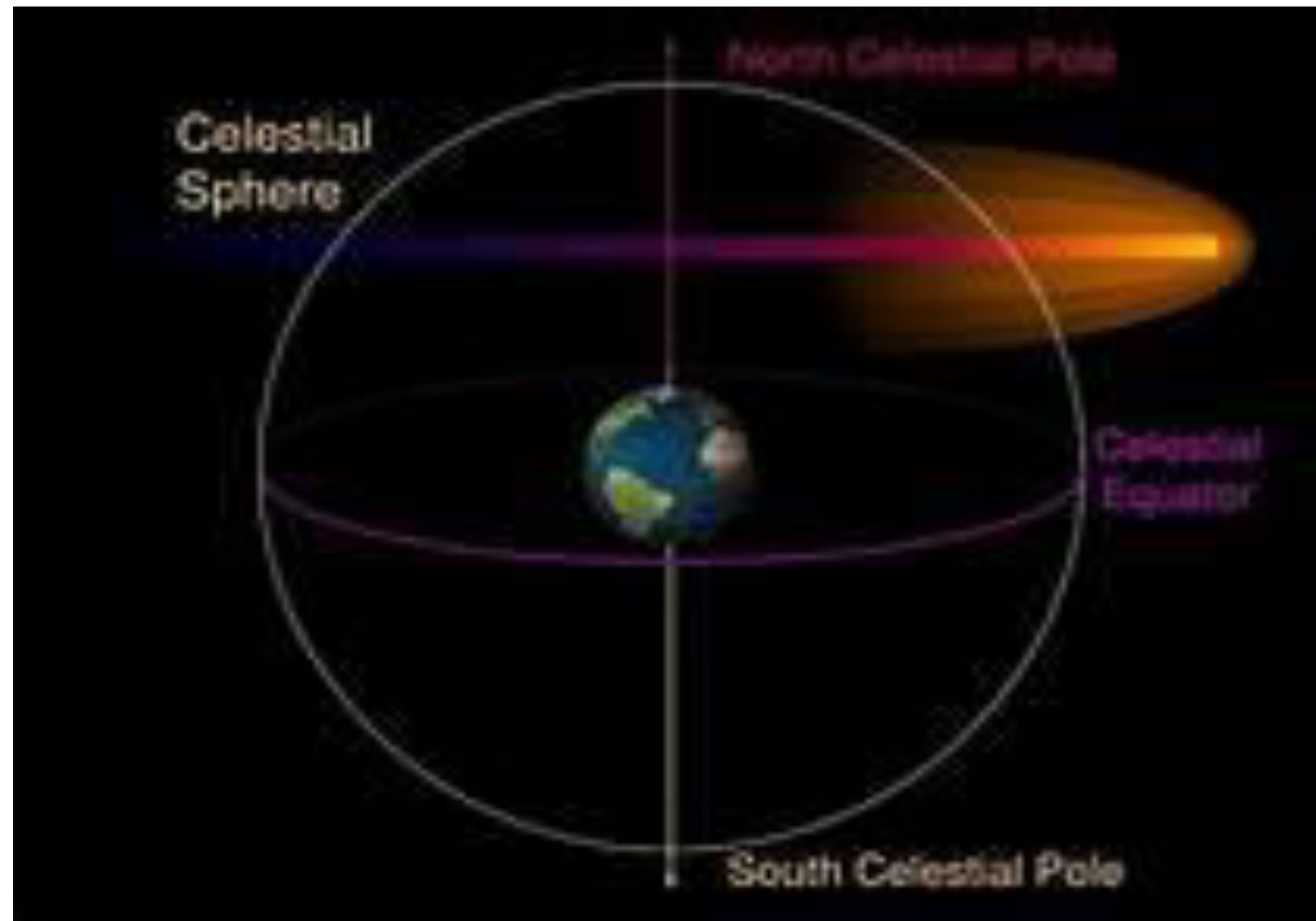
Astronomy is the science dealing with the celestial bodies like sun, the moon, the planets and the stars.

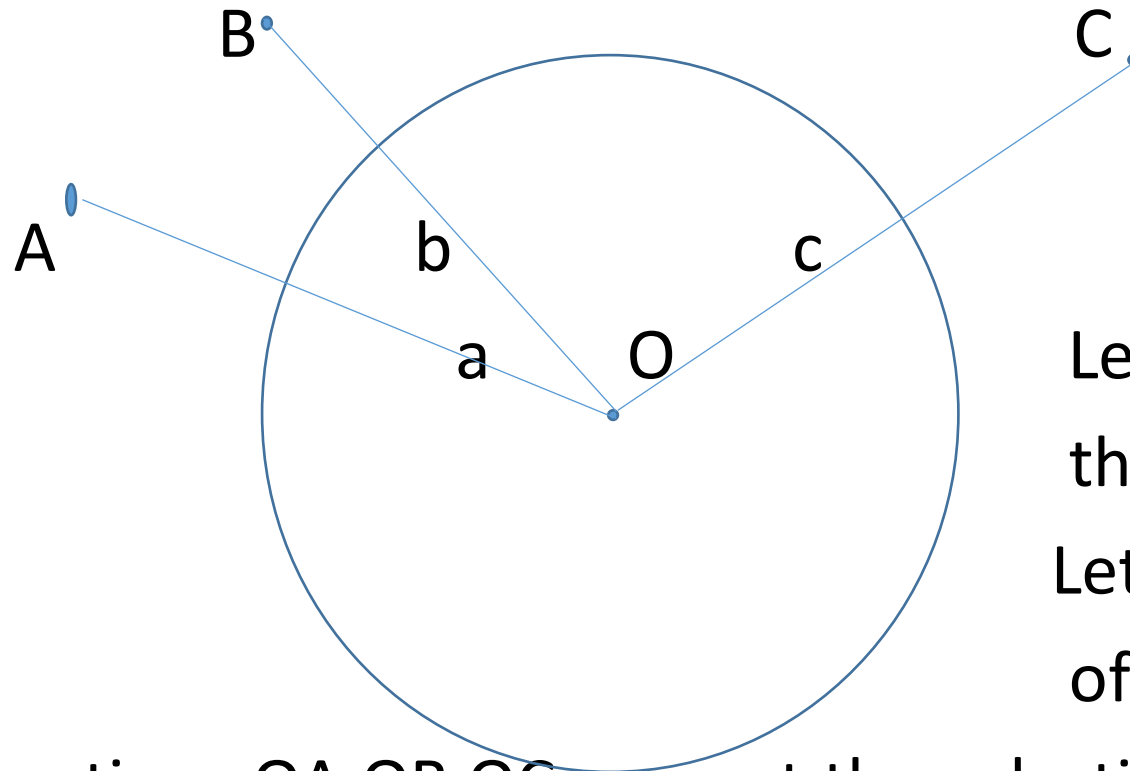
- Celestial Sphere

The imaginary sphere surrounding the observer on which we may suppose that all celestial bodies are fixed is called **celestial sphere**

The observer's position is taken as the **centre** of the celestial sphere whose **radius** is infinite.

# Celestial Sphere





Let  $O$  be the position of the observer (earth).  
Let  $A, B, C$  be the positions of the celestial bodies.

Let the directions  $OA, OB, OC, \dots$  meet the celestial sphere at  $a, b, c, \dots$

Sidereal day

The earth rotates about its axis from west to east in 23 hrs. 56 min and 4 sec. of apparent solar time

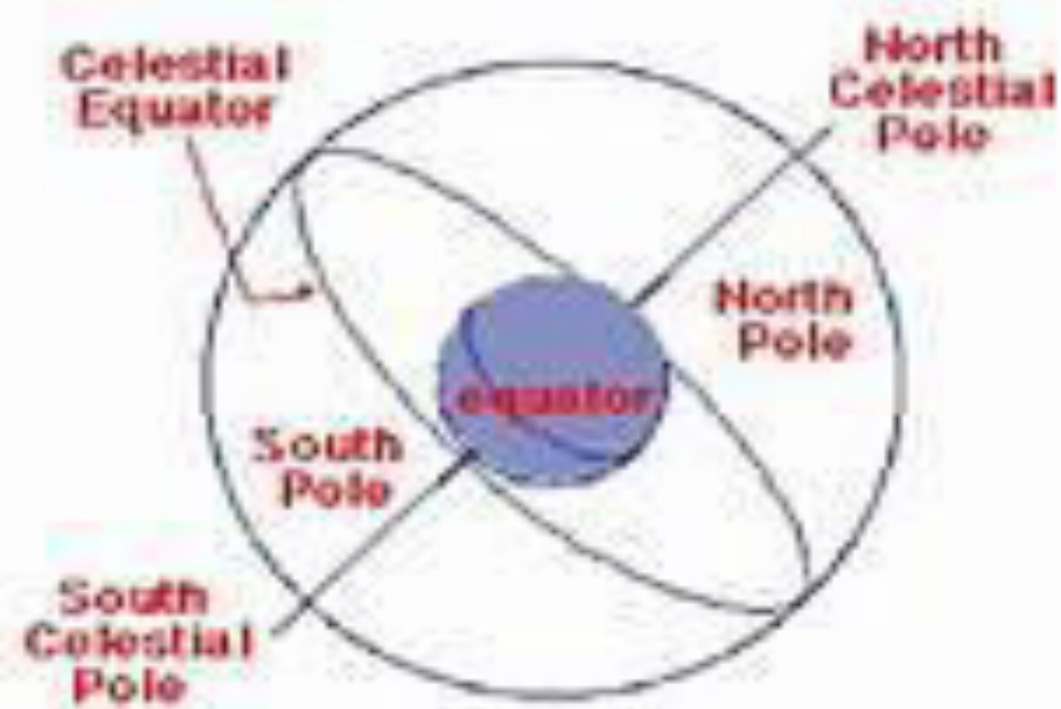
# Diurnal Motion

- Due to the rotation of the earth from west to east, the observer is carried eastward constantly
- But the observer is not aware of this motion in space so all the celestial bodies appears to rotate from east to west.
- This apparent daily rotation of the celestial sphere is called the **diurnal rotation**.

# Celestial axis, poles, equator

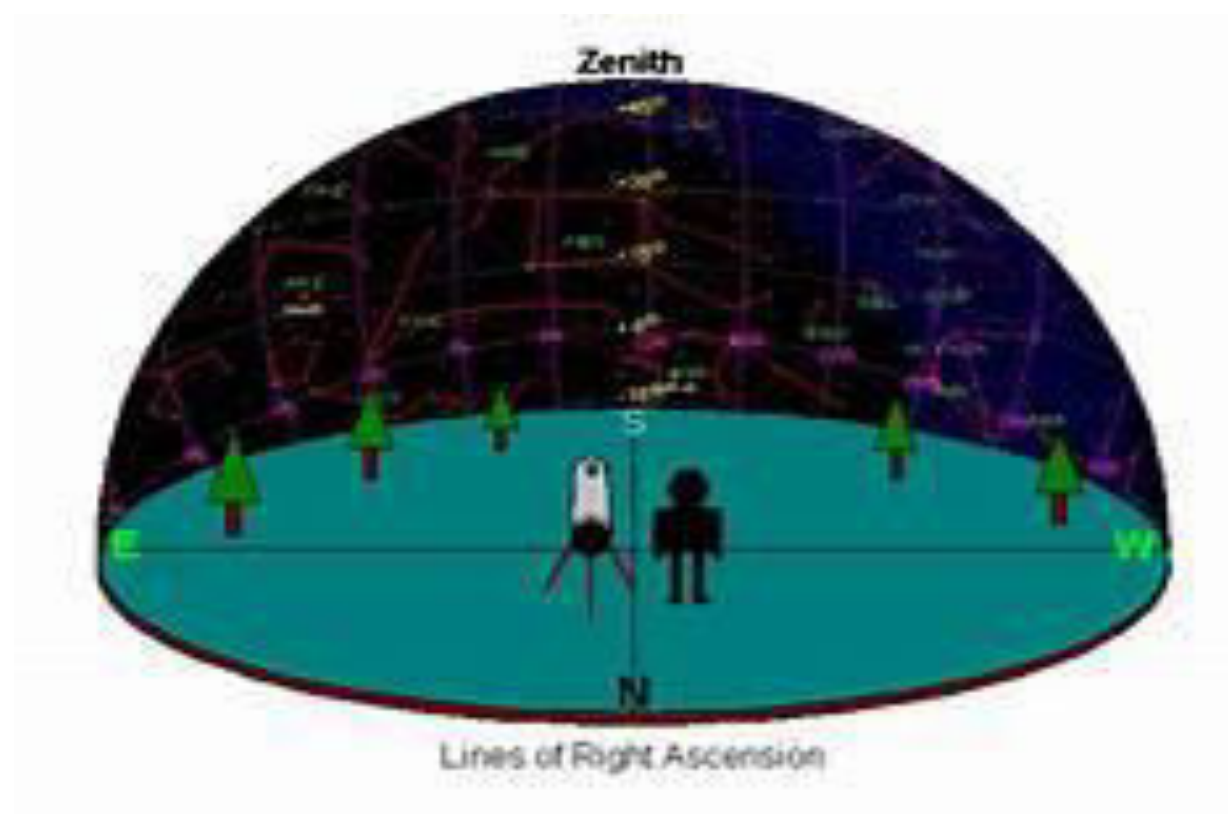
- The rotation of the celestial sphere is about an axis which is parallel to the axis of the rotation of the earth is called **celestial axis**.
- The points where the axis meets the celestial sphere are called the **celestial poles**. The celestial poles are classified into north celestial pole and south celestial pole.
- The great circle of the celestial sphere perpendicular to the celestial axis is called the **celestial equator**.

## Celestial sphere



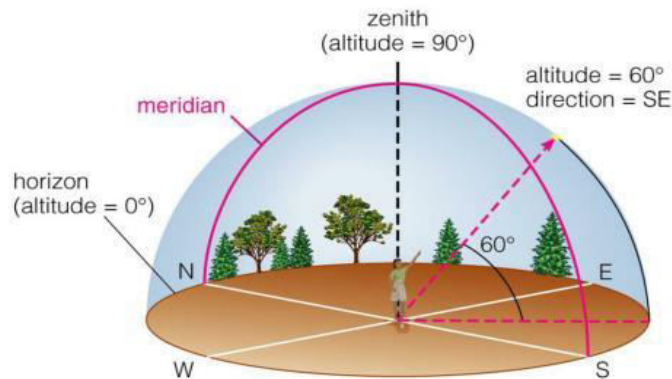
# Celestial Horizon, Zenith and Nadir

- The tangent plane at the position of the observer to the surface of the earth produced in all directions meets the celestial sphere along a great circle. This great circle is called **celestial horizon**.
- The direction of a plumbline at the position of the observer produced both ways meet the celestial sphere in two points Z and N . The point Z above the observer is called the **Zenith** and the point N which is beneath him is called the **Nadir**. Zenith and Nadir are the poles of the celestial horizon.



# Celestial Meridian

## Descriptions of Celestial Sphere



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The sky appear like a dome overhead.

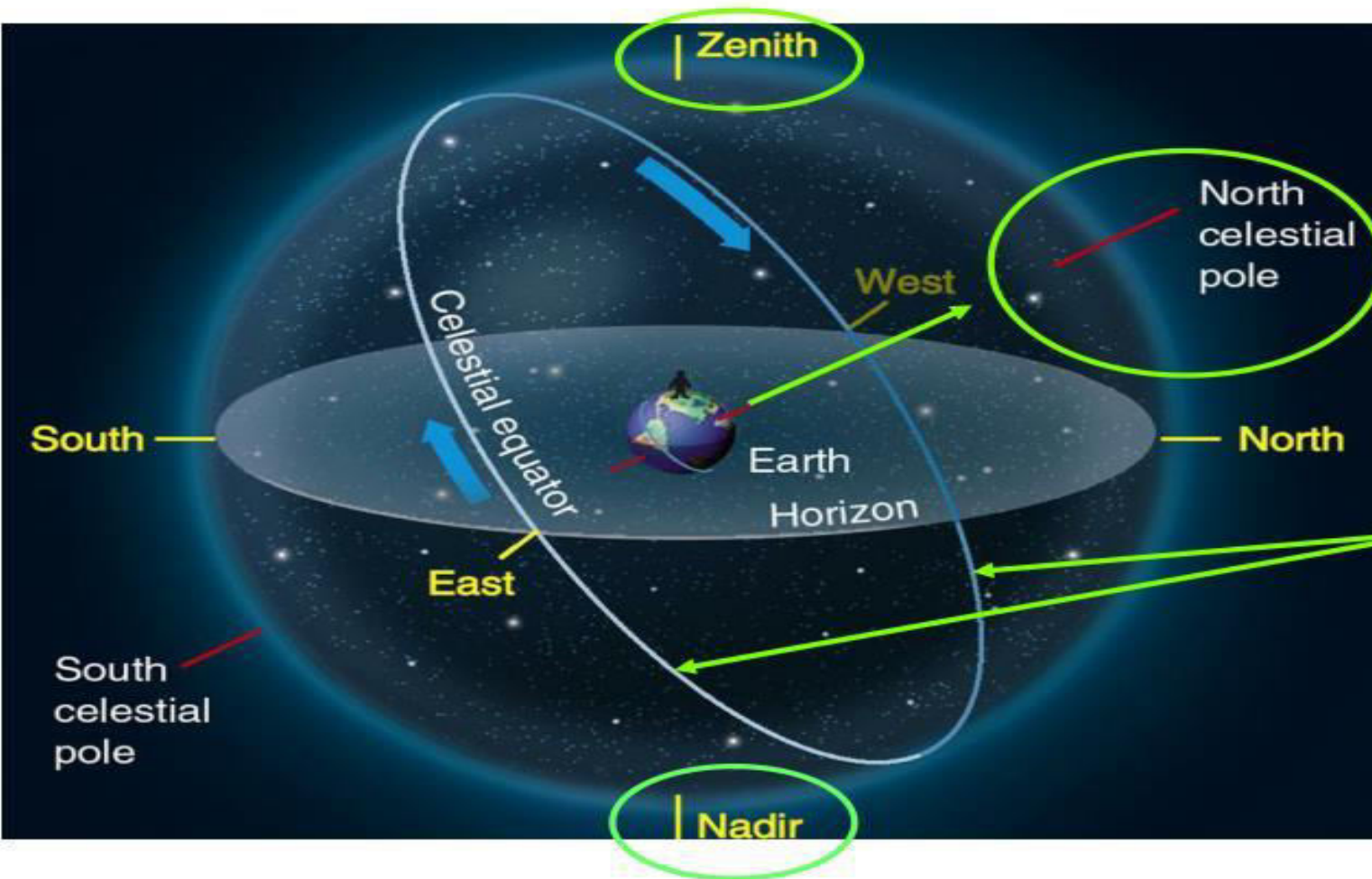
- Zenith-directly overhead
- Meridian – imaginary line running north & south through the zenith
- Horizon – where the sky appears to intersect the ground.
- Altitude – height of a star above horizon (degrees).

• The great circle through the celestial poles, Zenith and Nadir is called Celestial Meridian

# Cardinal points

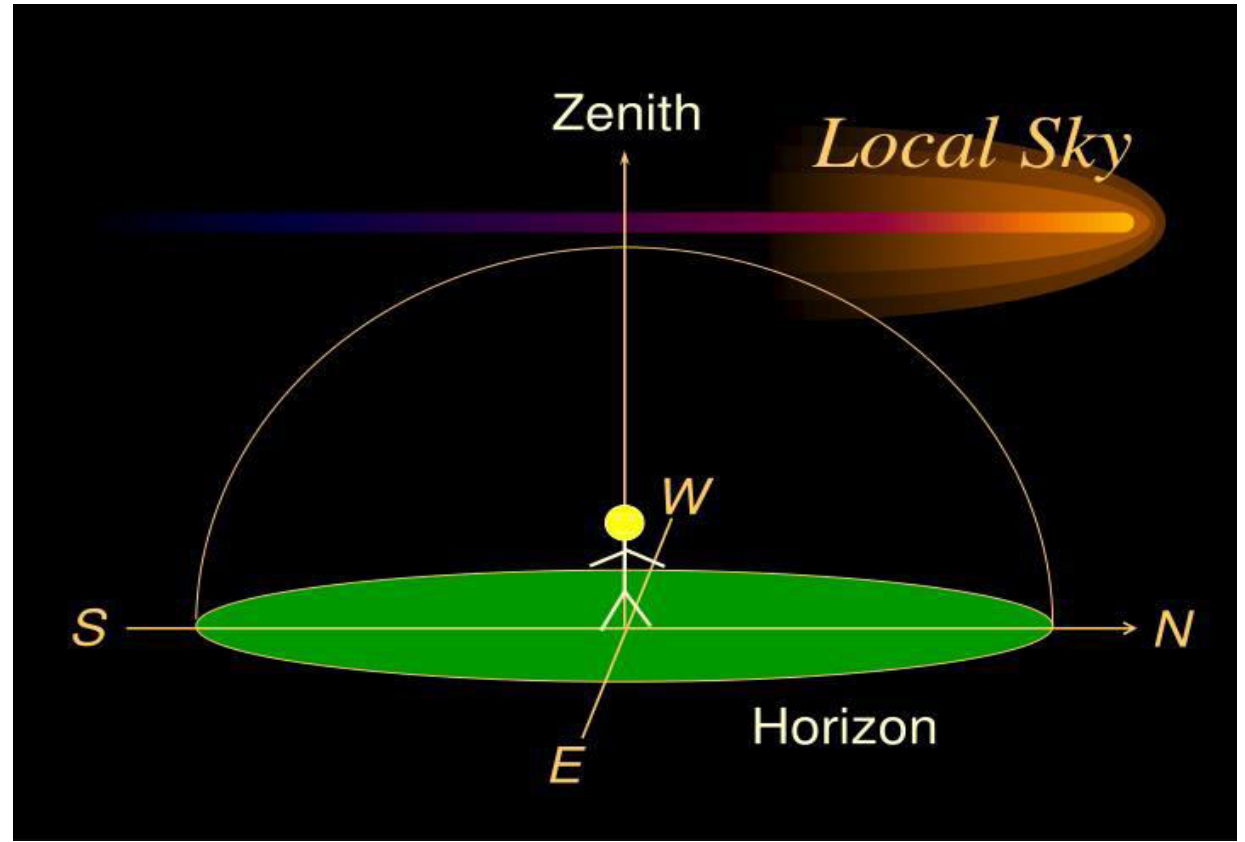
- The celestial equator and the horizon meet at two points E and W called the east and west points.
- The meridian meets the horizon at two points n and s. The point n near the north pole is called the north point and the point s near the south pole is called the south point.
- All these four points are together called the cardinal points.

# The Celestial Sphere — A model of the sky



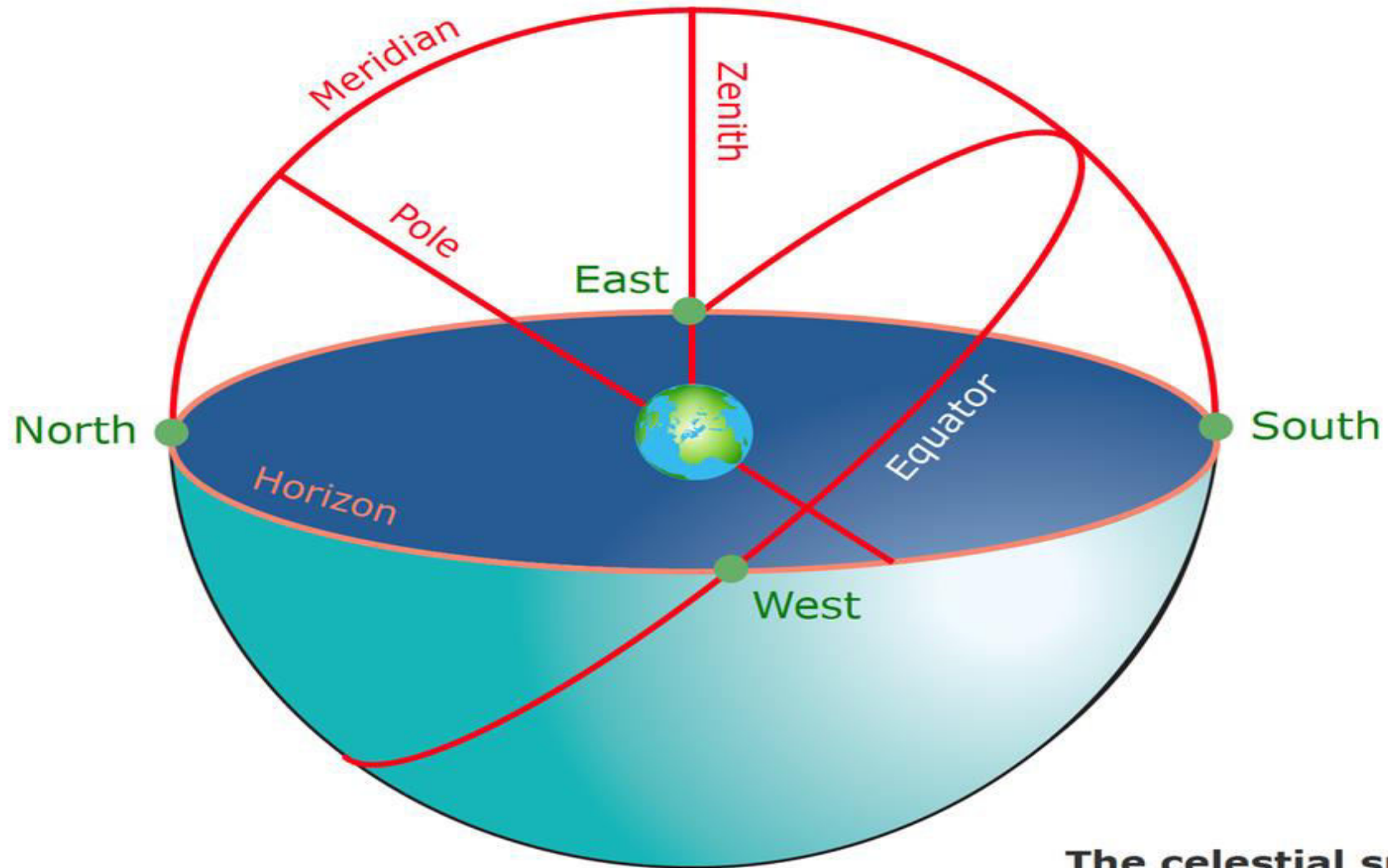
- **Zenith:** Point on the celestial sphere directly overhead
- **Nadir:** Point on the celestial sphere directly underneath (never visible!)
- **Celestial equator:** projection of Earth's equator onto the c.s.
- **North celestial pole:** projection of Earth's north pole onto the c.s.

- The north-south line is in the meridian plane and east-west direction is perpendicular to north-south line.



# Hemispheres

- The celestial equator divides the celestial sphere into two hemispheres. The hemisphere containing the north pole is called northern hemisphere and the other the southern hemisphere.
- The meridian divides the celestial sphere into two hemispheres. The hemisphere containing the east point is called eastern hemisphere and the other the western hemisphere.
- The horizon divides the celestial sphere into two hemispheres. The observer on the surface of the earth cannot see the objects in the hemisphere below the horizon , is called invisible hemisphere and the above the horizon is called visible hemisphere.

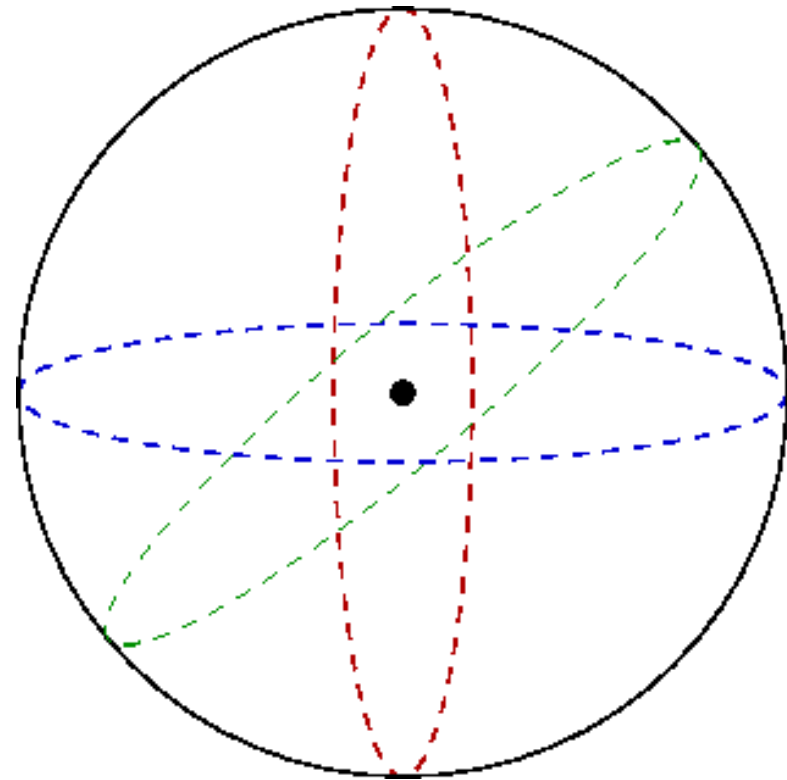
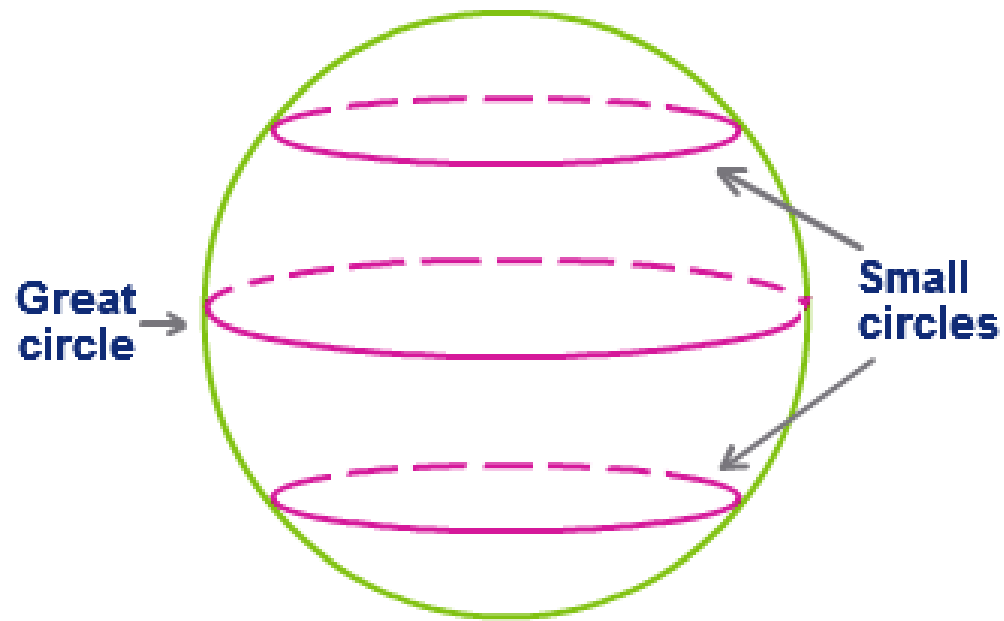


**The celestial sphere**

# Great circles, Secondaries

- The section of a sphere by a plane through its centre is called a **great circle**.
- Any great circle passing through the poles of a circle is called a **secondary** to the given circle.
- A circle and its secondaries are at right angles.

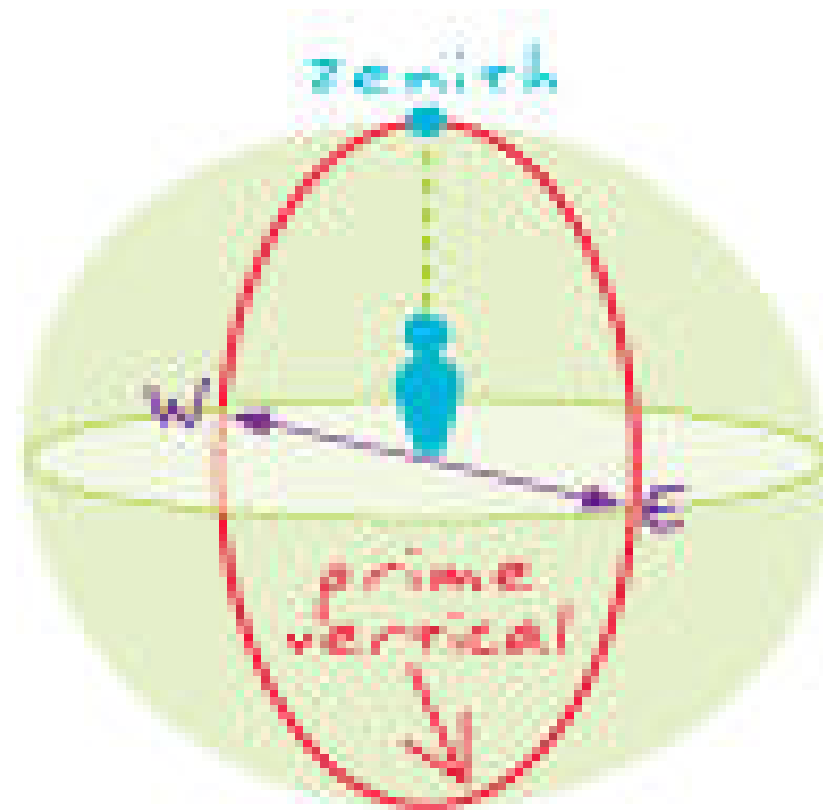
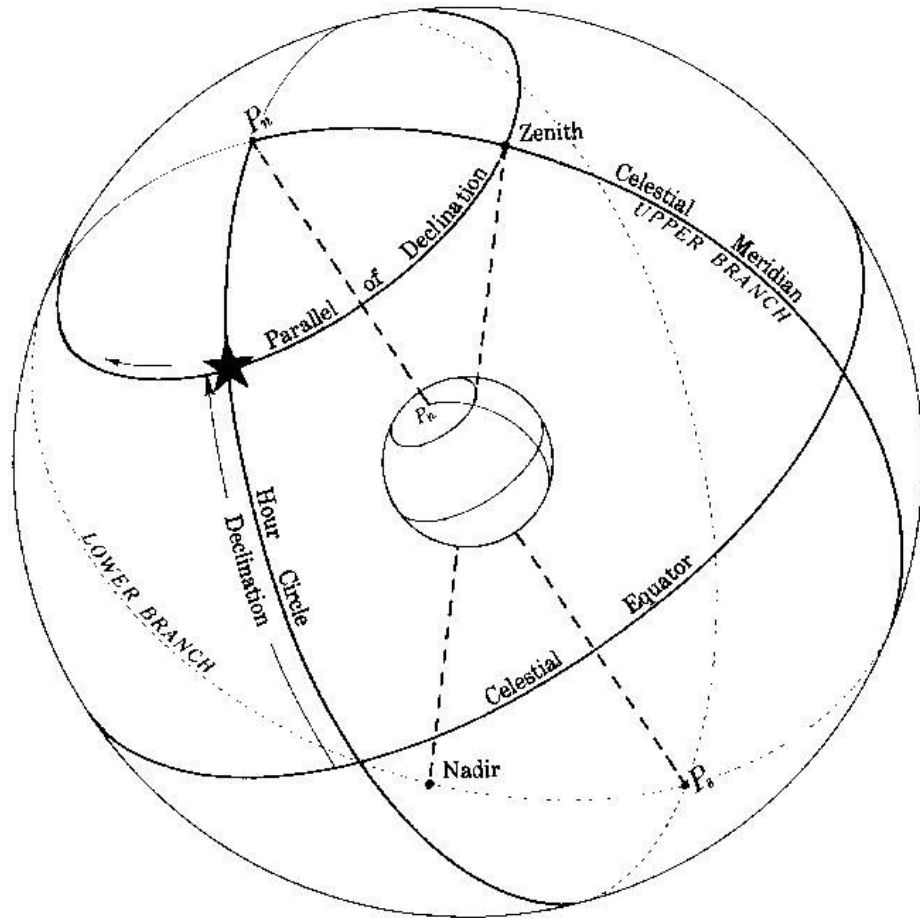
# Great circles, Secondaries



# Declination Circles, Verticals

- The secondaries to the equator are called declination circles.
- The secondaries to the horizon are called vertical circles or verticals.
- The verticals which passes through the east and west points is called the prime verticals.
- The meridian is also a vertical

# Declination Circles, Verticals





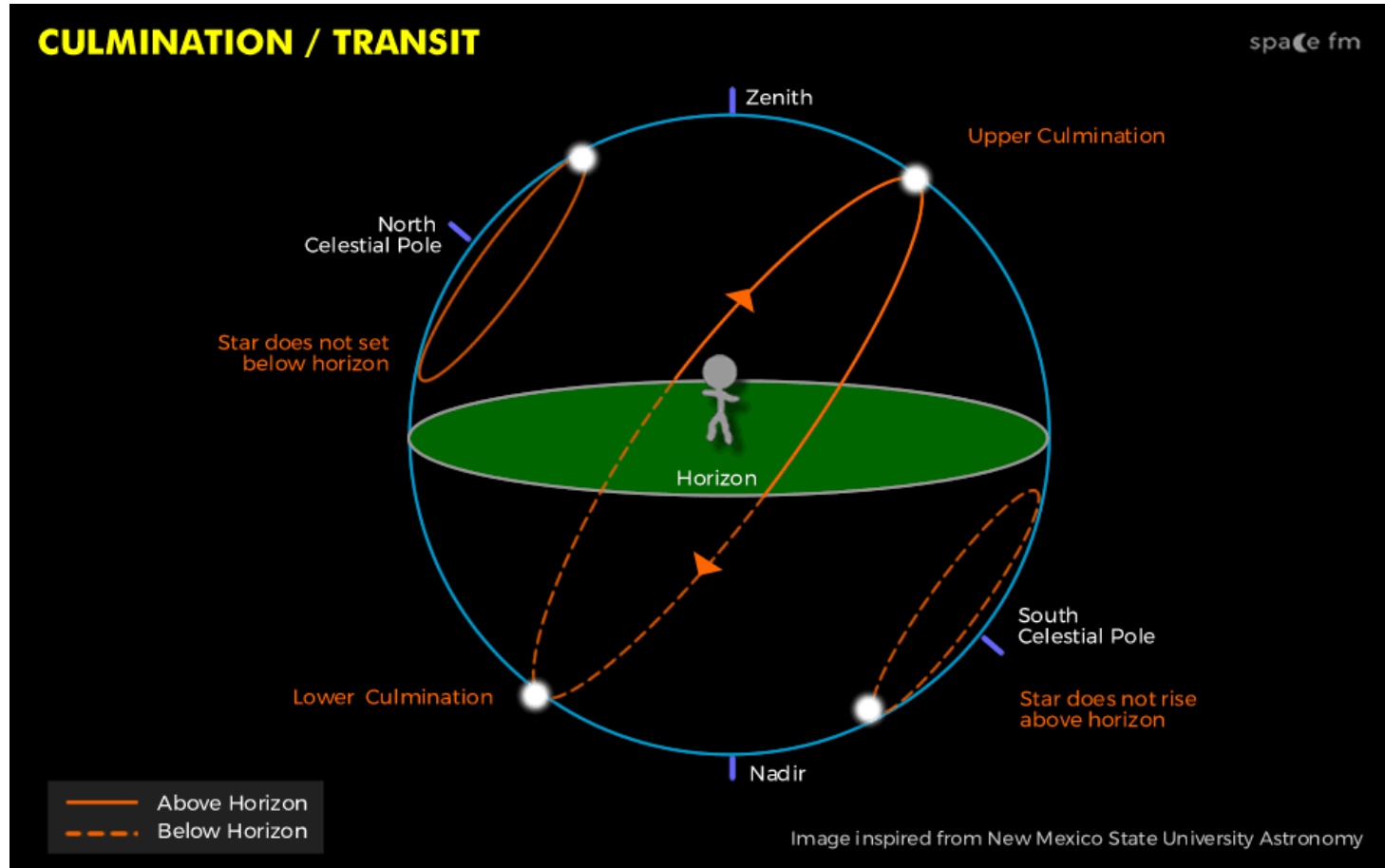
# Rising and setting

- In the course of the diurnal motion the position of a celestial body on the horizon where it enters the visible hemisphere from the invisible hemisphere is called its position of rising.
- The position on the horizon where it enters the invisible hemisphere from the visible hemisphere is called its position of setting.
- Between rising and setting the body is completely visible whereas the body is invisible between the positions of setting and rising.

# Transit or culmination

- Every celestial body crosses the meridian twice during a diurnal motion. At these instant the body is said to transit or culminate.
- The position near the zenith is called upper transit and that which is farther from the zenith is called lower transit.
- The interval between two successive transits of the same kind (upper or lower) is clearly a sidereal day.

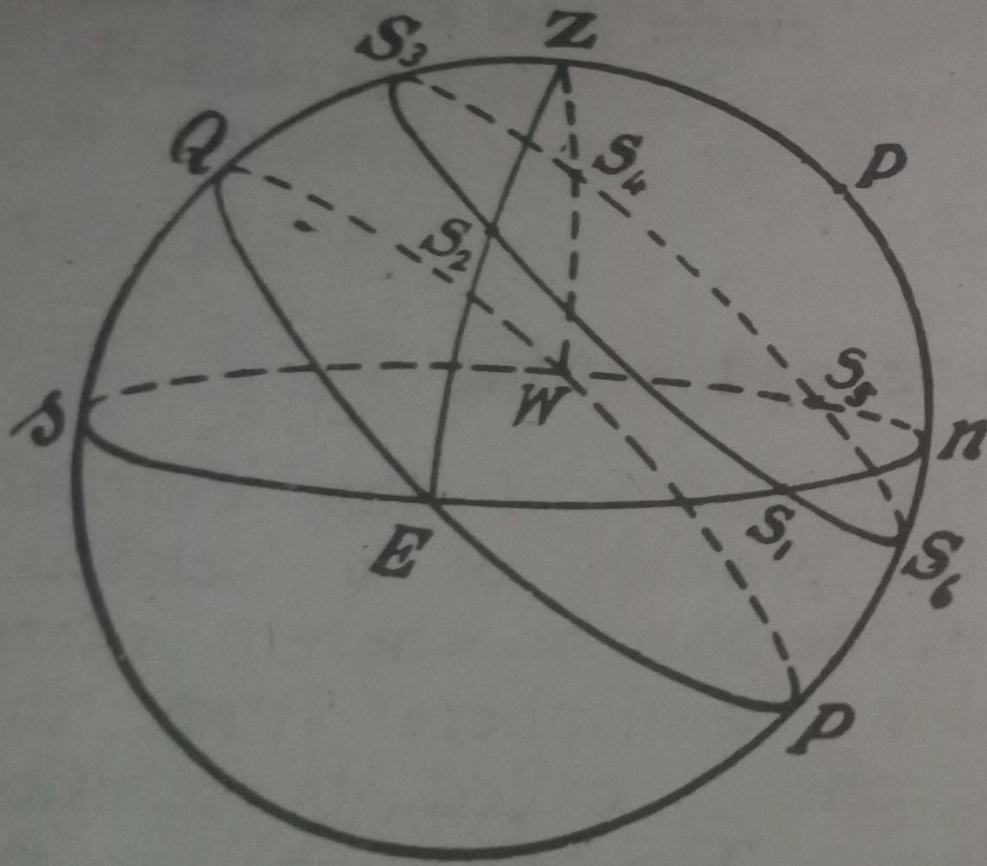
# Transit or culmination



# Due east, due west and due south and north

- The position of a celestial body on the prime vertical in the eastern side is called due east.
- If a celestial body is on the prime vertical in the western side it is said to be due west.
- At the position of upper transit if a star be on the southern side of the zenith it is said to be due south.
- If the upper transit is north of zenith the star is said to be due north.

Other hand if the upper transit is not  
the star is said to be *due north*.



In the figure,

- S<sub>1</sub>—Position of rising
- S<sub>2</sub>—Due east
- S<sub>3</sub>—Upper transit
- S<sub>4</sub>—Due west
- S<sub>5</sub>—Position of setting
- S<sub>6</sub>—Lower transit

Shot on OPPO F5  
By Mathu  
Fig. 24

# Annual motion of the Sun

- All celestial bodies take part in diurnal motion simultaneously.
- Certain bodies like the sun , moon ,planets etc. have their own independent (apparent or actual) motions in space.
- The sun moves along a great circle of the celestial sphere eastward describing about one degree per day relative to stars completing one round in one year.
- This annual motion of the sun is only apparent and is due to the earth annual revolution around sun.

# Ecliptic, Obliquity

- The path of the apparent annual motion of the sun is called the **ecliptic**
- The plane of the ecliptic is inclined to the plane of the equator at an angle of about  $23^{\circ} 27'$ .
- This angle is called the **obliquity** of the ecliptic and is denoted by  $\omega$ .

# First point of Aries and First point of Libra

- The point at which the sun crosses the equator while entering the northern hemisphere from the southern hemisphere in its annual motion is called **first point of Aries  $\gamma$** .
- The point at which the sun crosses the equator while entering the southern hemisphere from the northern hemisphere in its annual motion is called **first point of Libra  $\varphi$** .

# Equinoxes

- The first point of Aries and the first point of Libra are together called the **equinoctial points**
- The sun comes to the first point of Aries on March 21 , which marks the beginning of the Spring season and this position is called the **vernal equinox**
- The sun comes to the first point of Libra on September 23 , which marks the beginning of the Autumn season and this position is called the **autumnal equinox**

# Solstices

- The sun crosses the mid way between  $\gamma$  and  $\varphi$  on the ecliptic on June 21<sup>st</sup>. This marks the beginning of the summer season. This position of the sun is called **summer solstice**
- The sun crosses the mid way between  $\varphi$  and  $\gamma$  on the ecliptic on December 22<sup>nd</sup>. This marks the beginning of the winter season. This position of the sun is called **winter solstice**

# Colures

- The declination circle passing through the equinoctial points is called the **equinoctial colure**
- The declination circle passing through the solstitial points is called the **solstitial colure**
- The celestial equator and the ecliptic are fixed great circles
- The horizon, meridian and zenith are different for different places of observation

Thank You