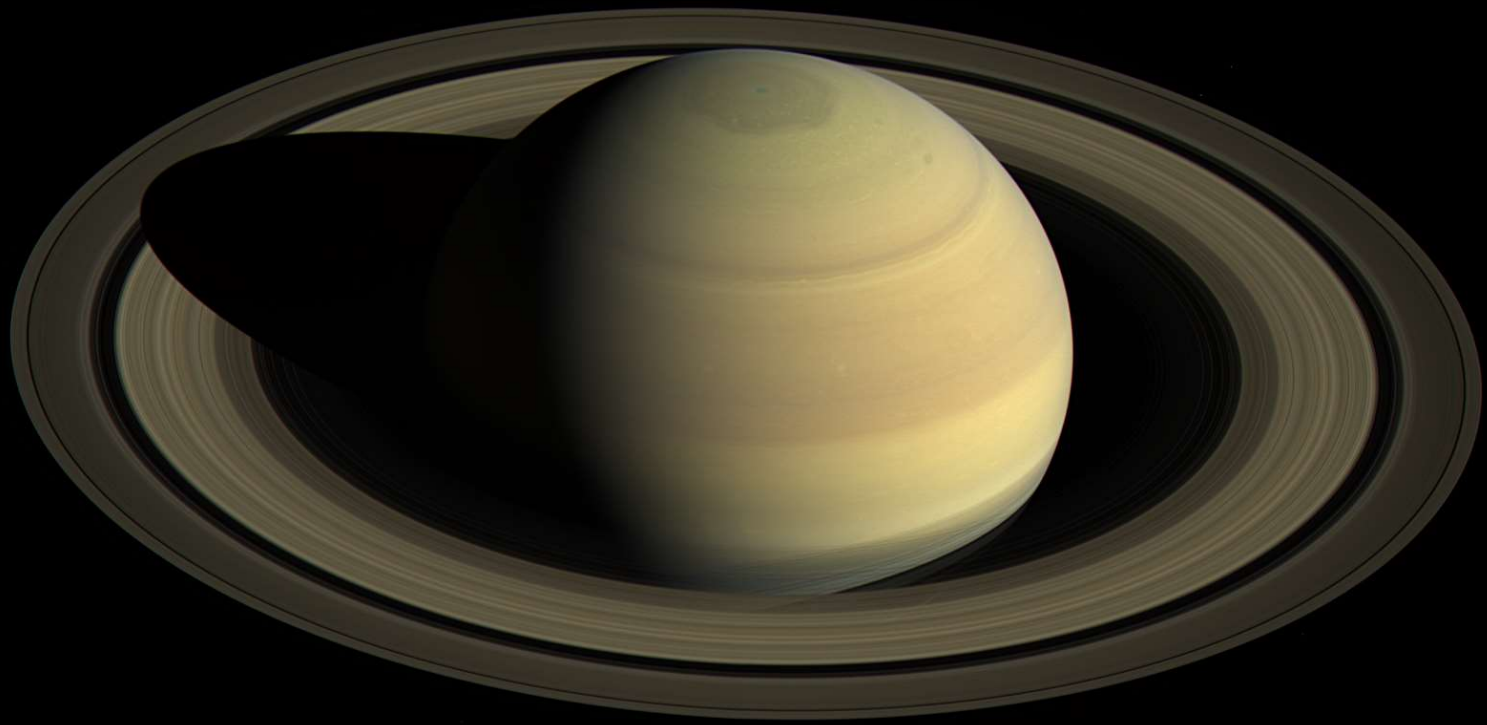
AST 2002
Introduction to Astronomy



iClicker2

Available at the bookstore.

At the beginning of every class will sync with iClicker base

(code will be BC).

Must register on Webcourses using knights email address within first week of class

Participation counts for 5%

Correct answers for 5%

We will use the 1st week to practice taking polls

Material may be based on reading material to be covered that lecture

iClicker2 Instructions

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Question #1

What is the correct order, from smallest to largest?

A: An Asteroid, The Milky Way Galaxy, The Solar System, The Universe
B: The Universe, The Milky Way Galaxy, An Asteroid, The Solar System
C: An Asteroid, The Solar System, The Milky Way Galaxy, The Universe
D: An Asteroid, The Solar System, The Universe, The Milky Way Galaxy

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Question #2

What is the correct order, from smallest to largest?

A: A Jovian Planet, A Terrestrial Planet, One Astronomical Unit (AU), a Light-year
B: A Terrestrial Planet, A Jovian Planet, One Astronomical Unit (AU), a Light-year
C: A Terrestrial Planet, a Light-year, One Astronomical Unit (AU), A Jovian Planet
D: A Jovian Planet, A Terrestrial Planet, a Light-year, One Astronomical Unit (AU)

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C: A Terrestrial Planet, a Light-year, One Astronomical Unit (AU), A Jovian Planet
D: A Jovian Planet, A Terrestrial Planet, a Light-year, One Astronomical Unit (AU)

We Would Like to Understand This Better…
… by the end of Today's lecture, you will

The patterns we observe in the night sky are affected by:

- The rotation of the Earth
- The revolution of the Earth around the Sun
- The axial tilt of the Earth
- The movement of the Moon around the Earth
- The movement of the planets around the Sun

http://www.universalworkshop.com/2016/12/29/celestial-foretaste-of-2017/

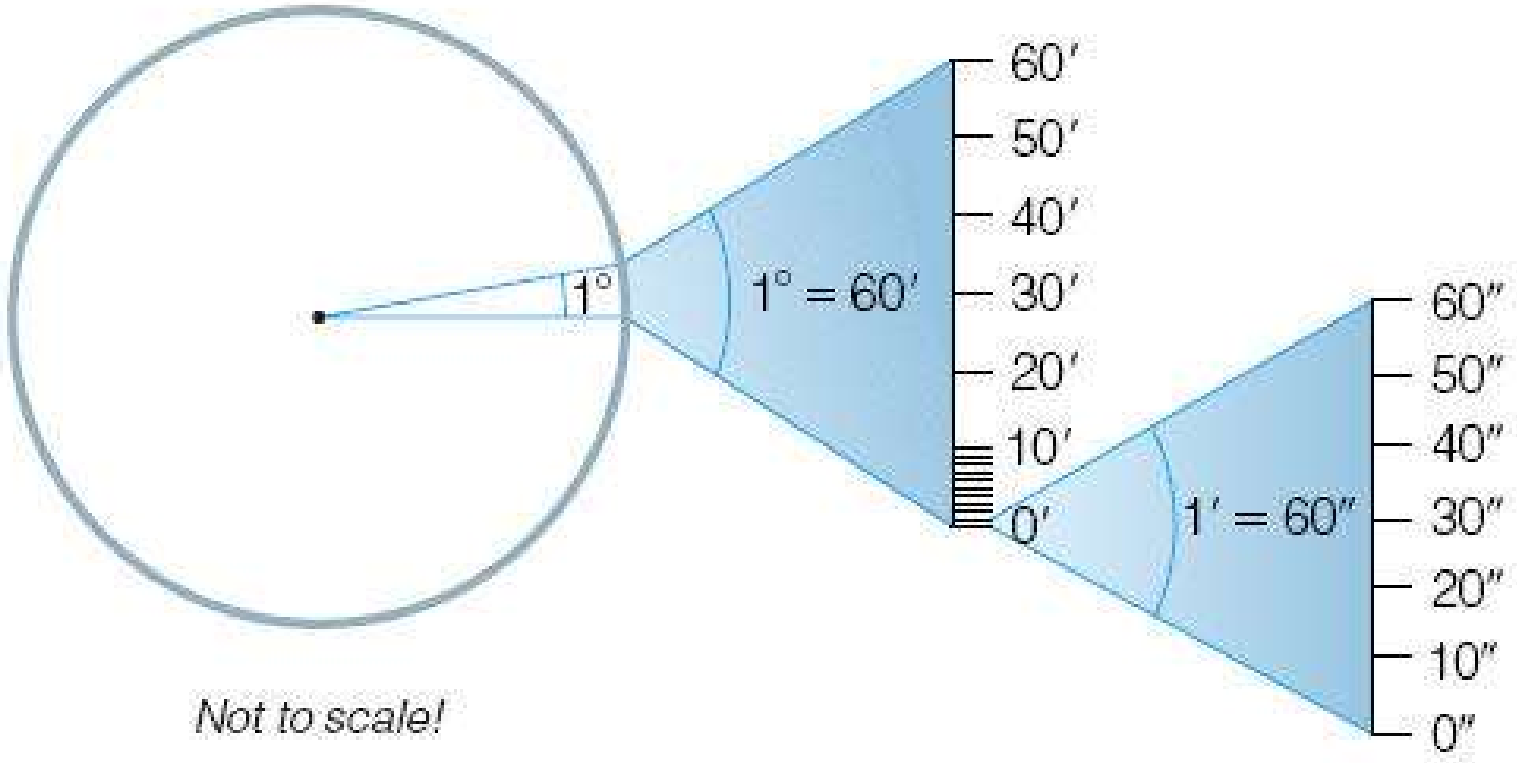
We measure the sky in *angles*

Full circle = 360º (degrees of arc)

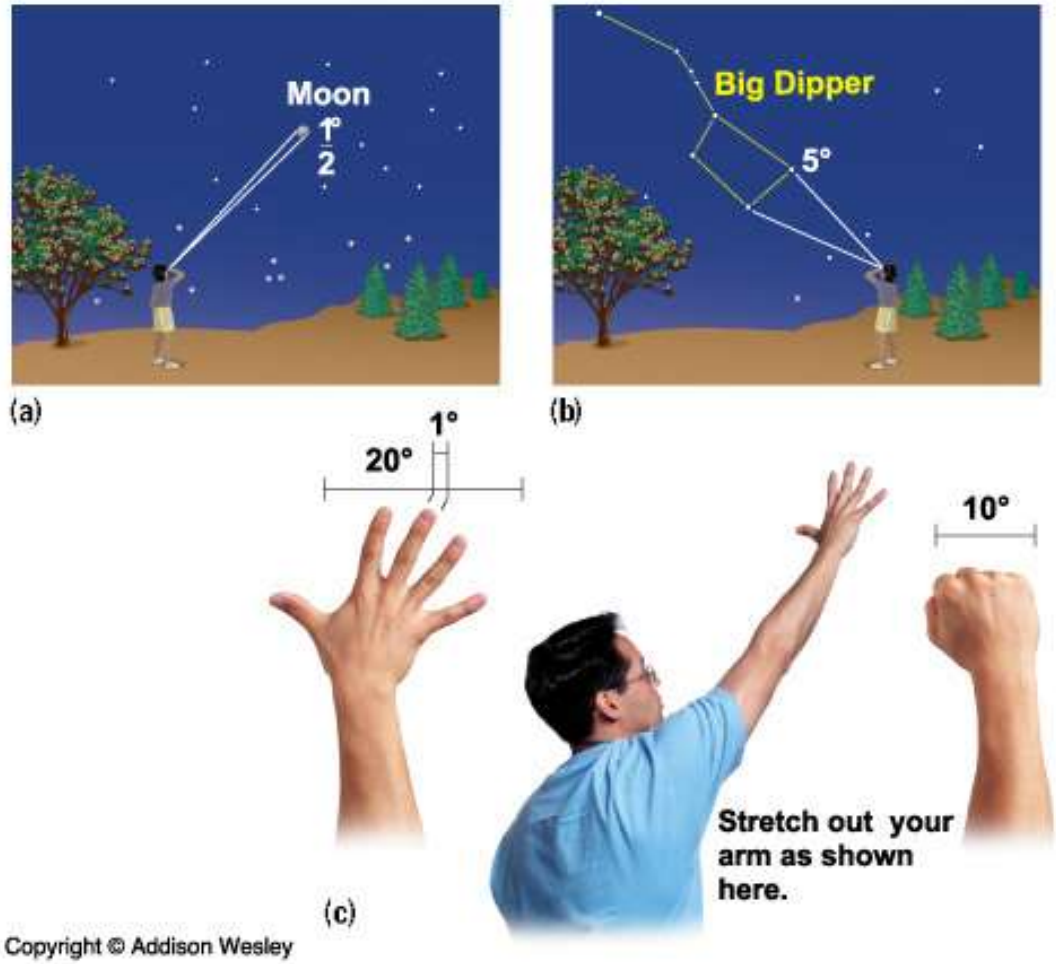
1º = 60’ (arcmin)

1 arcmin = 60” (arcsec)

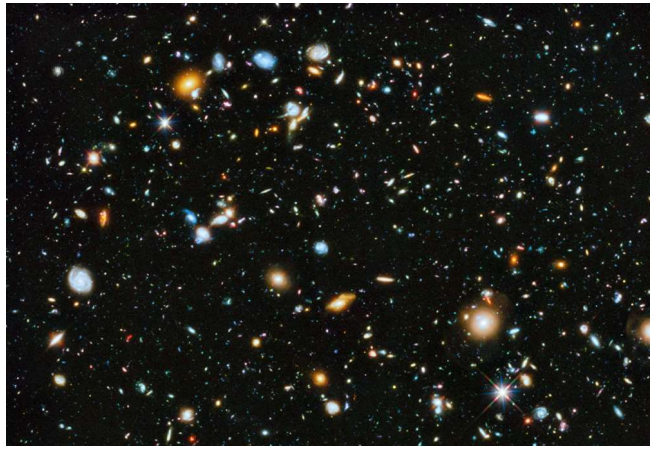
(May also see 360º ~ 24 hours)



How to Approximately Measuring Angles in the Sky



Hubble Ultra-Deep Field

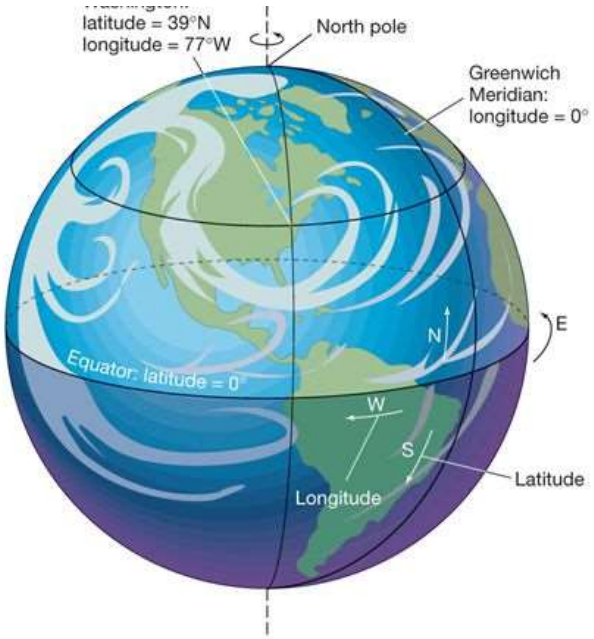


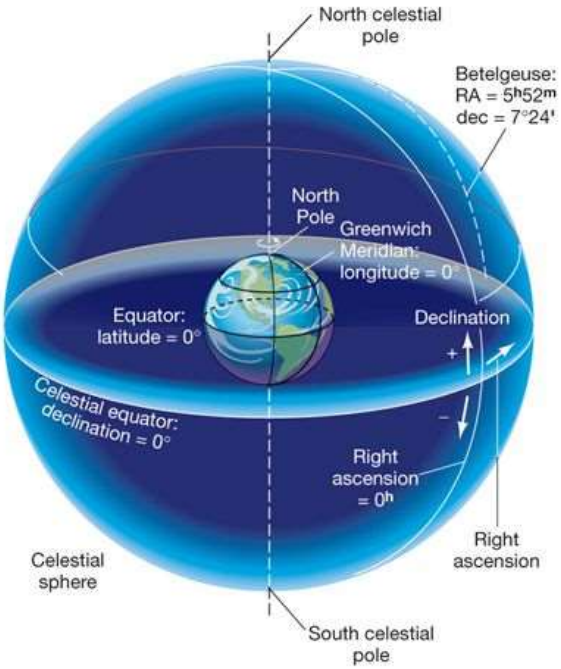
Width or Height = 2.4' arcminutes

roughly one thirteen-millionth of the total area of the sky

Describing Positions on the Celestial Sphere

Declination: **Degrees north or south of celestial equator (*cf.* Latitude)**
Right Ascension: **Measured eastward position from the 0° (given in degrees, or hours and minutes). 0° is defined as the position of the Sun at *Vernal equinox* (*cf.* longitude)**

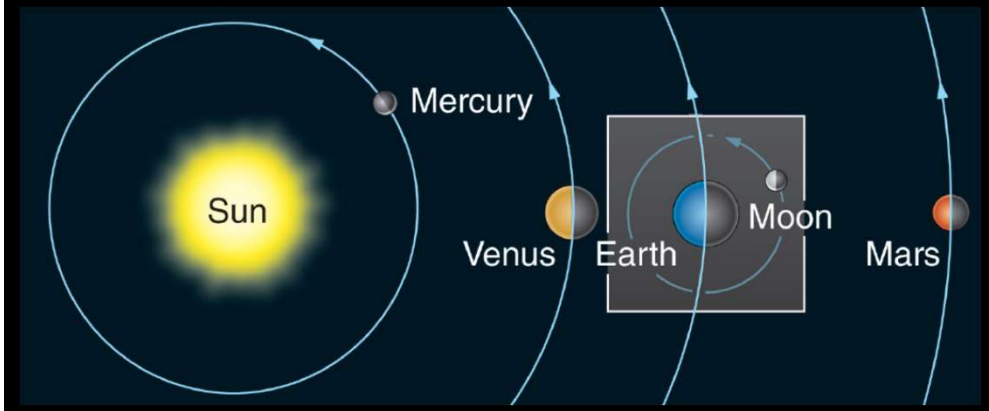


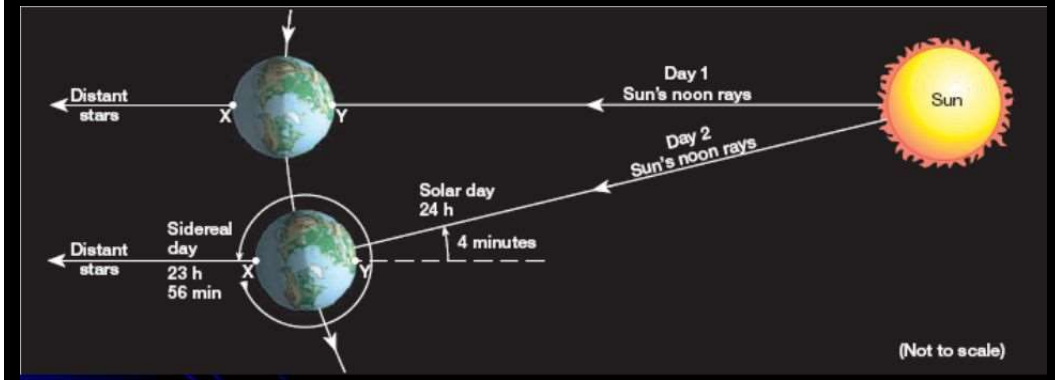


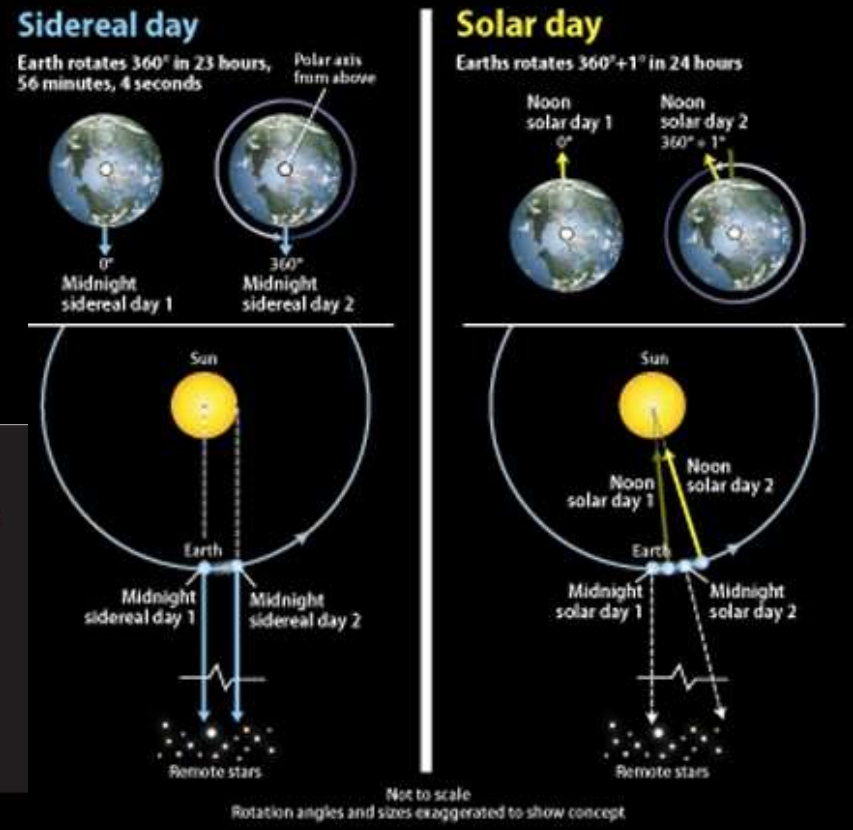
Solar Day *vs.* Sidereal Day *(take II)*

http://www.jgiesen.de/astro/astroJS/siderealClock/
http://aa.usno.navy.mil/data/docs/siderealtime.php

Remember: It takes Earth 365 days to rotate 360°

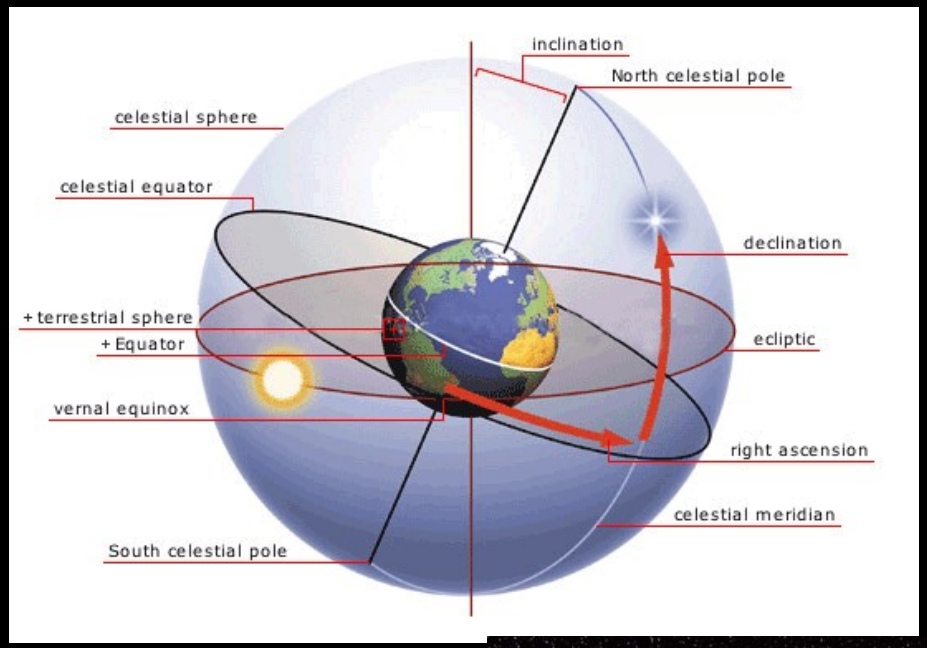




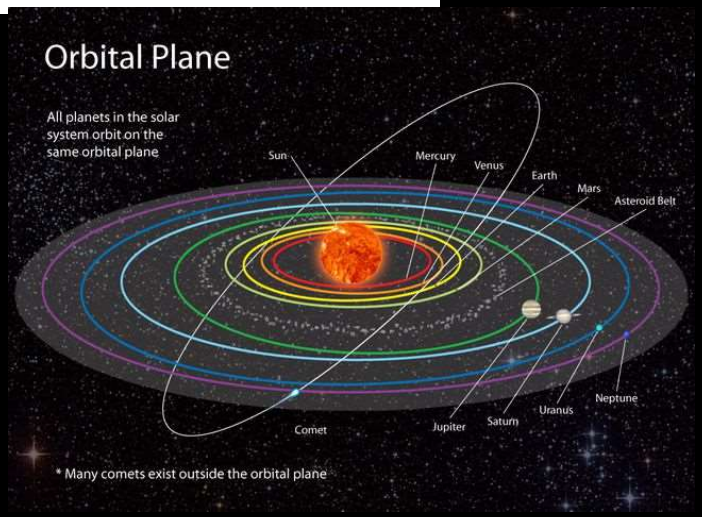


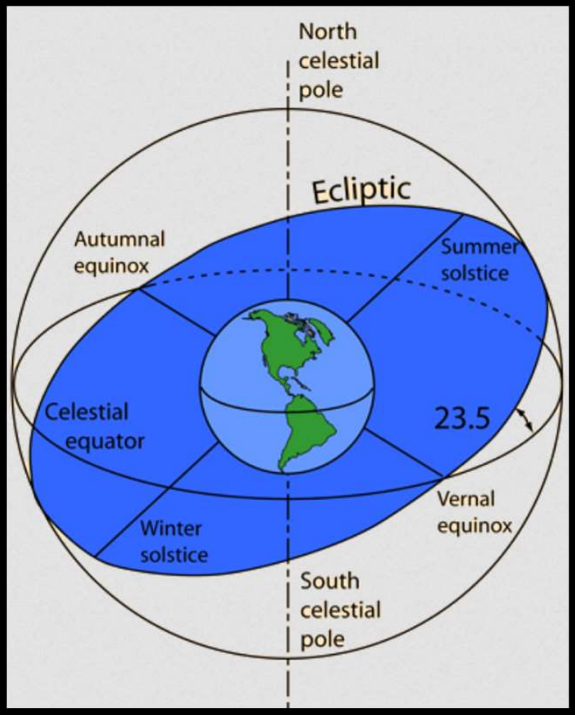
Earth is Tilted 23.5° to the Ecliptic Plane…

The Sun, the Moon, the planets and the constellations of the zodiac all lie in the Ecliptic plane (orbital plane of solar system)



Viewed from Ecliptic Plane:
Earth axis is tilted if viewed in ecliptic plane, celestial equator tilted 23.5°



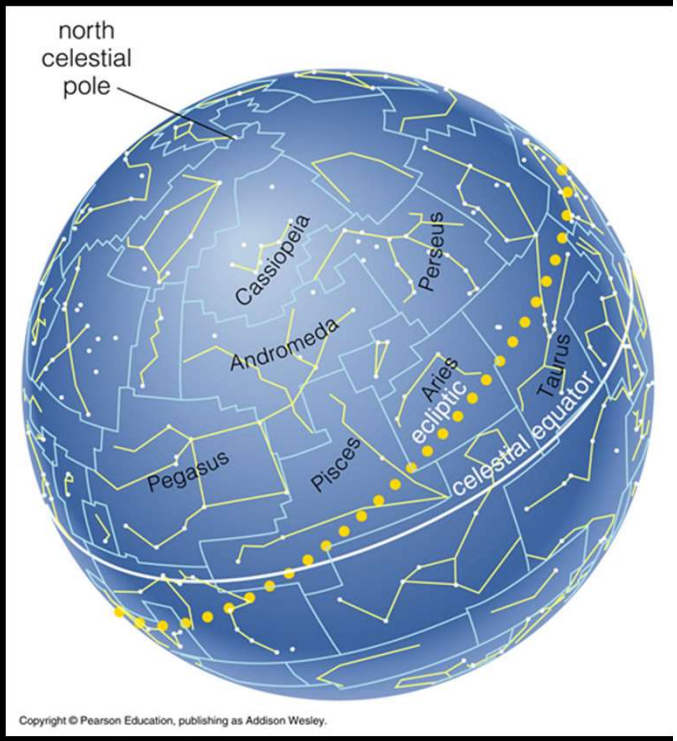


Viewed from Celestial Plane:
If image is aligned with North celestial pole and equator, and Earth is not tilted

Annual Motion

Ecliptic: the apparent path of the Sun, moon, and planets through the sky

Equinox: where the ecliptic Intersects the celestial equator (days and nights ~ equal)



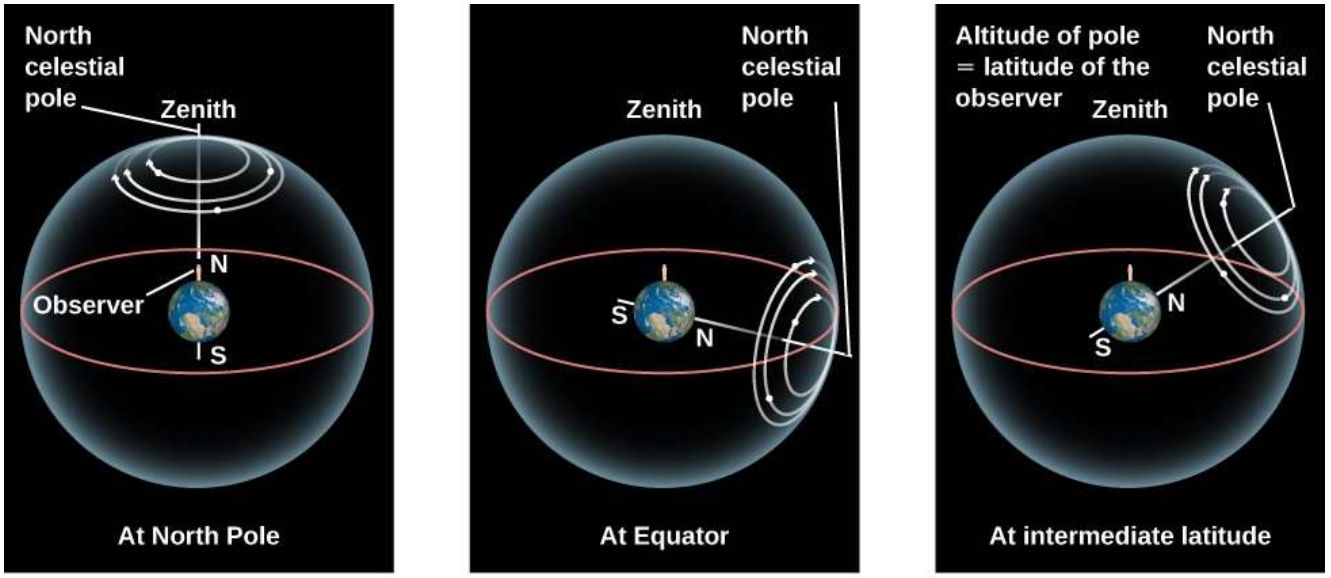
Solstice

where the ecliptic is farthest from the celestial equator
(Sun, stars of particular constellations reach max/min point)

Zodiac

the constellations which lie along the ecliptic

How does the night sky change by location on the Earth?

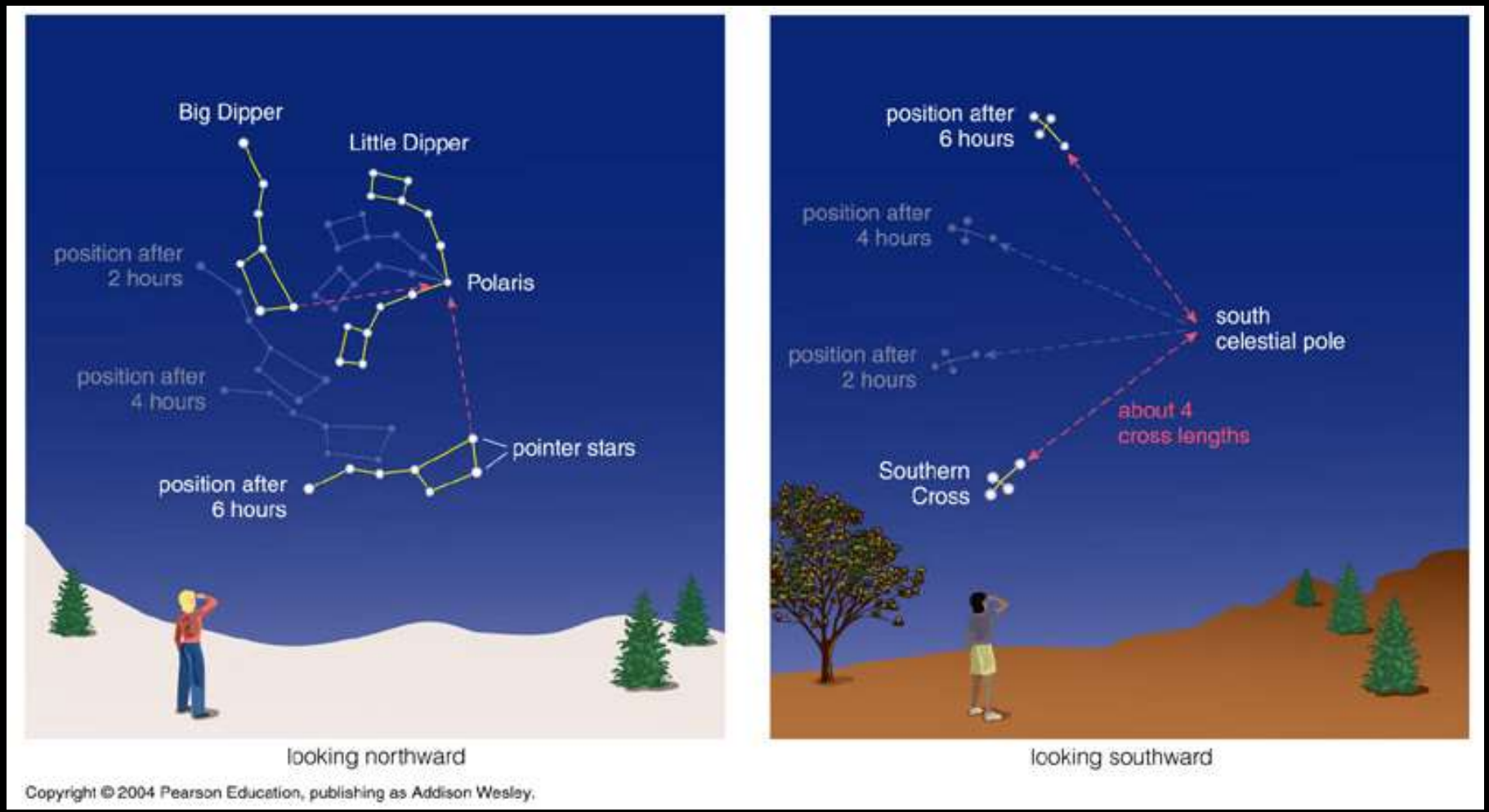


a) At the North Pole:

- we would see only the top half of the celestial sphere.
- The Zenith would point approximately towards Polaris.
- The night sky would be almost the same each night (but for precession)
- All circumpolar stars are visible (no stars ‘rise’ or ‘set’)

North & South Celestial poles are ~Fixed *(precession slowly changes this)*

North and South rotate in opposite directions




created with Advanced Stacker PLUS
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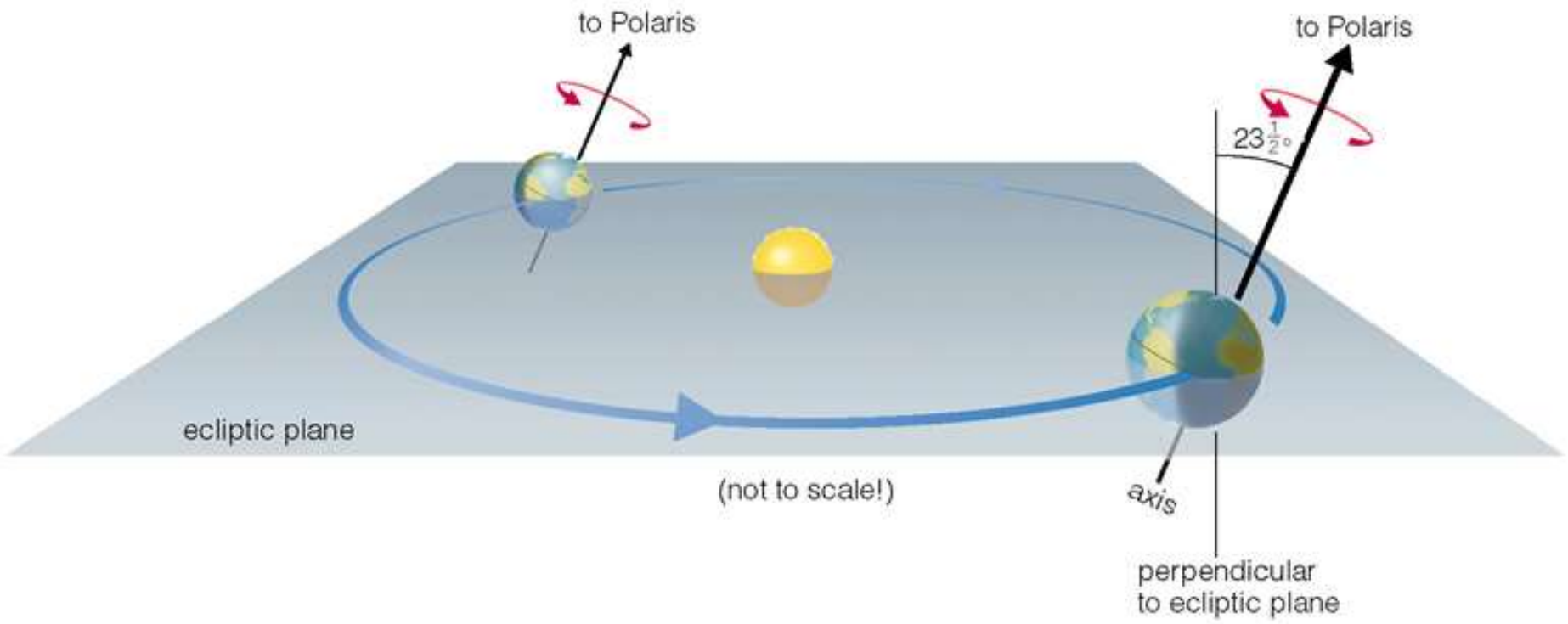
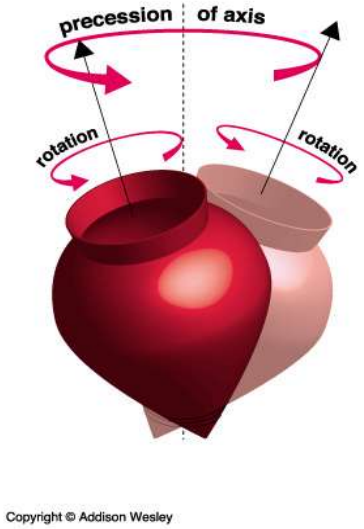
Steven Christenson
StarCircleAcademy.com

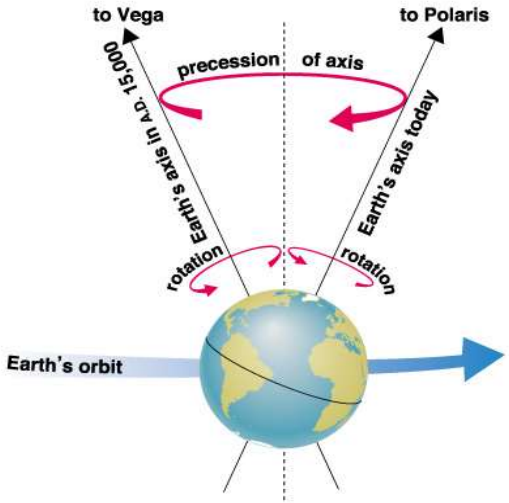
If a Star over a celestial pole is far away enough (Polaris is 434 light years away), the star position is practically constant throughout the day, and even the year

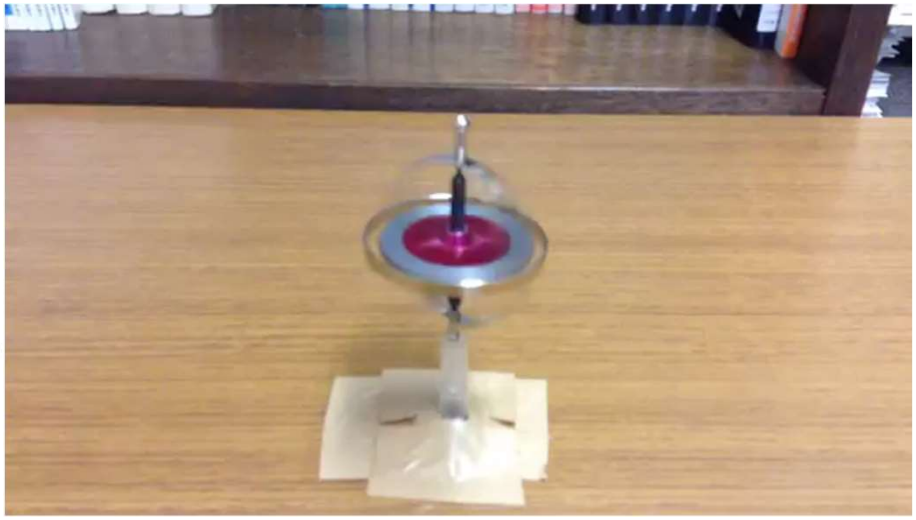


Precession of the Equinoxes

https://www.youtube.com/watch?v=qlVgEoZDjok





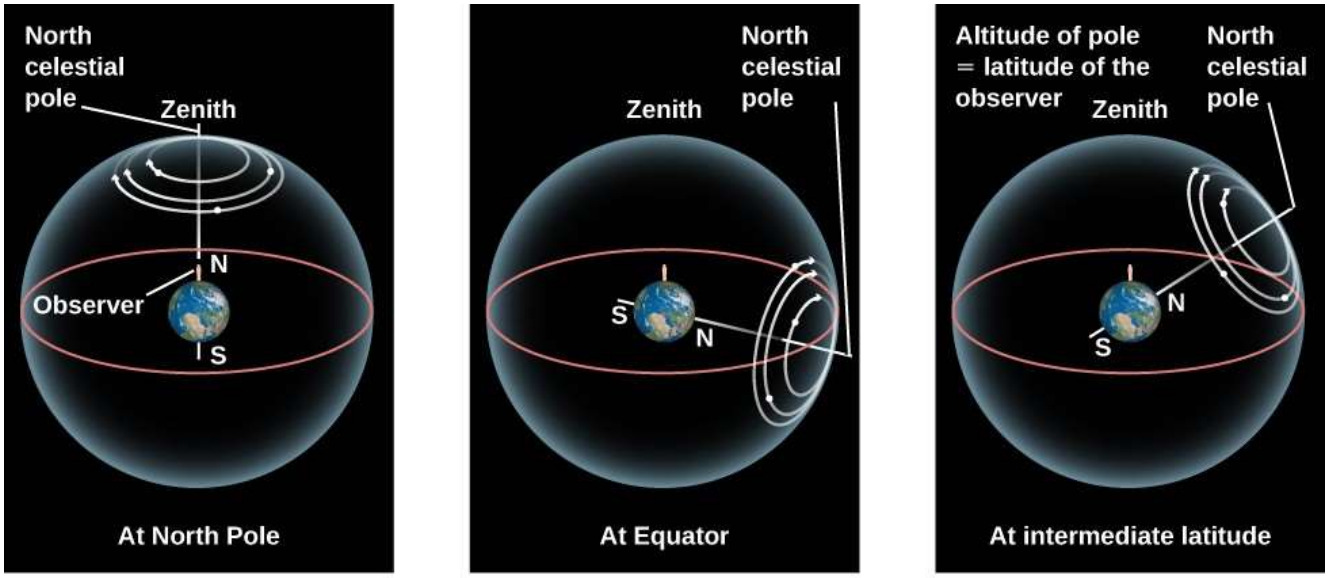


- **The Earth's axis precesses (wobbles) like a top, once about every 26,000 years.**
- **Precession changes the positions in the sky of the celestial poles and the equinoxes.**

⇒ *Polaris* won't always be the north star.

⇒ The spring equinox, seen by ancient Greeks in *Aries*, moves westward and is now in *Pisces*!

How does the night sky change by location on the Earth?



b) At the Equator:

- All celestial poles would like at the horizons to the North and South
- All stars will rise and set
- There would be no circumpolar stars

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Question #3

From what location on Earth would all of the stars on the celestial sphere be visible?

A: The Equator
B: The North Pole
C: The Prime Meridian
D: The South Pole

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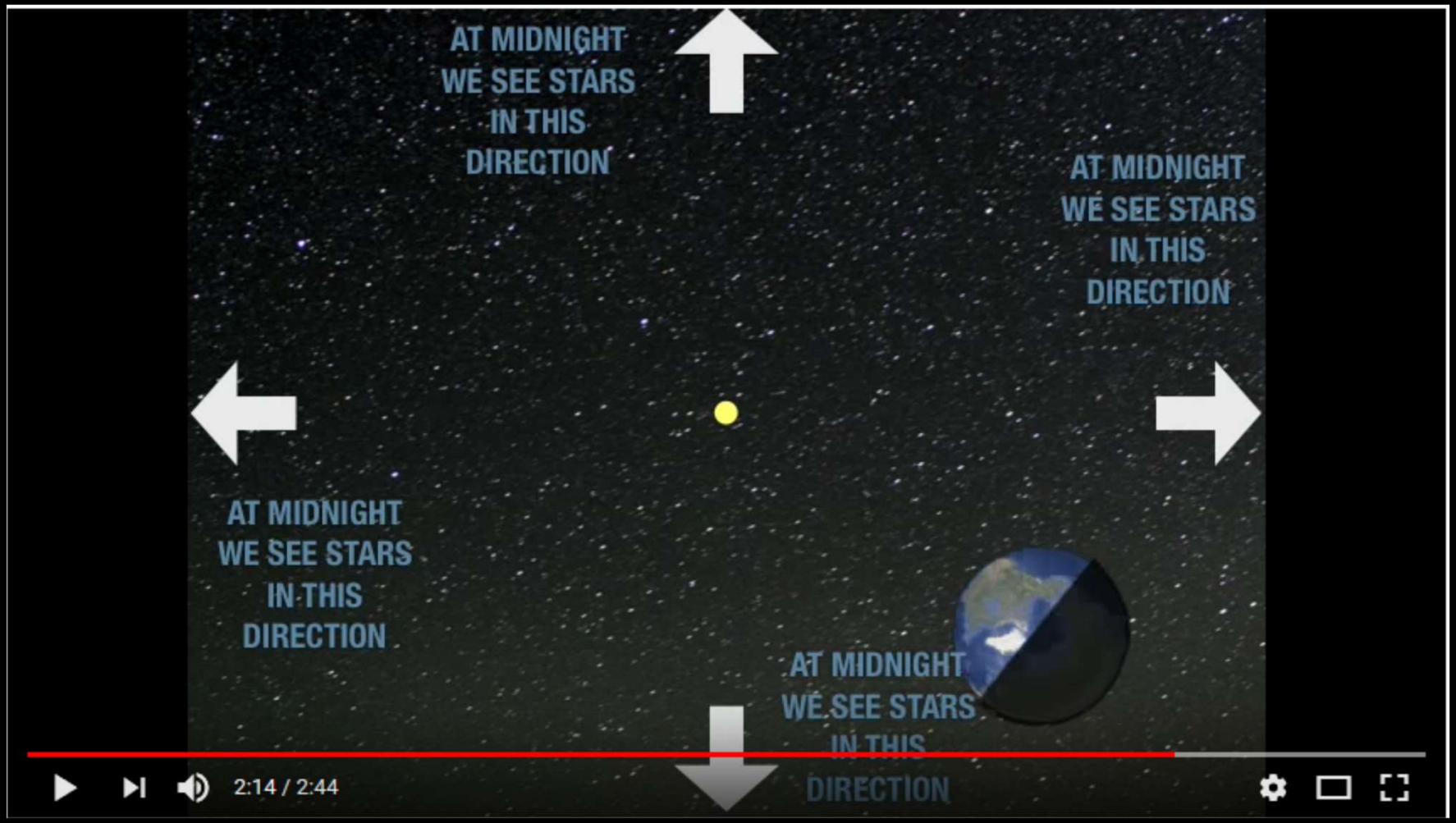
At Different Times of the Year, A Different Night Sky is Visible at the Equator



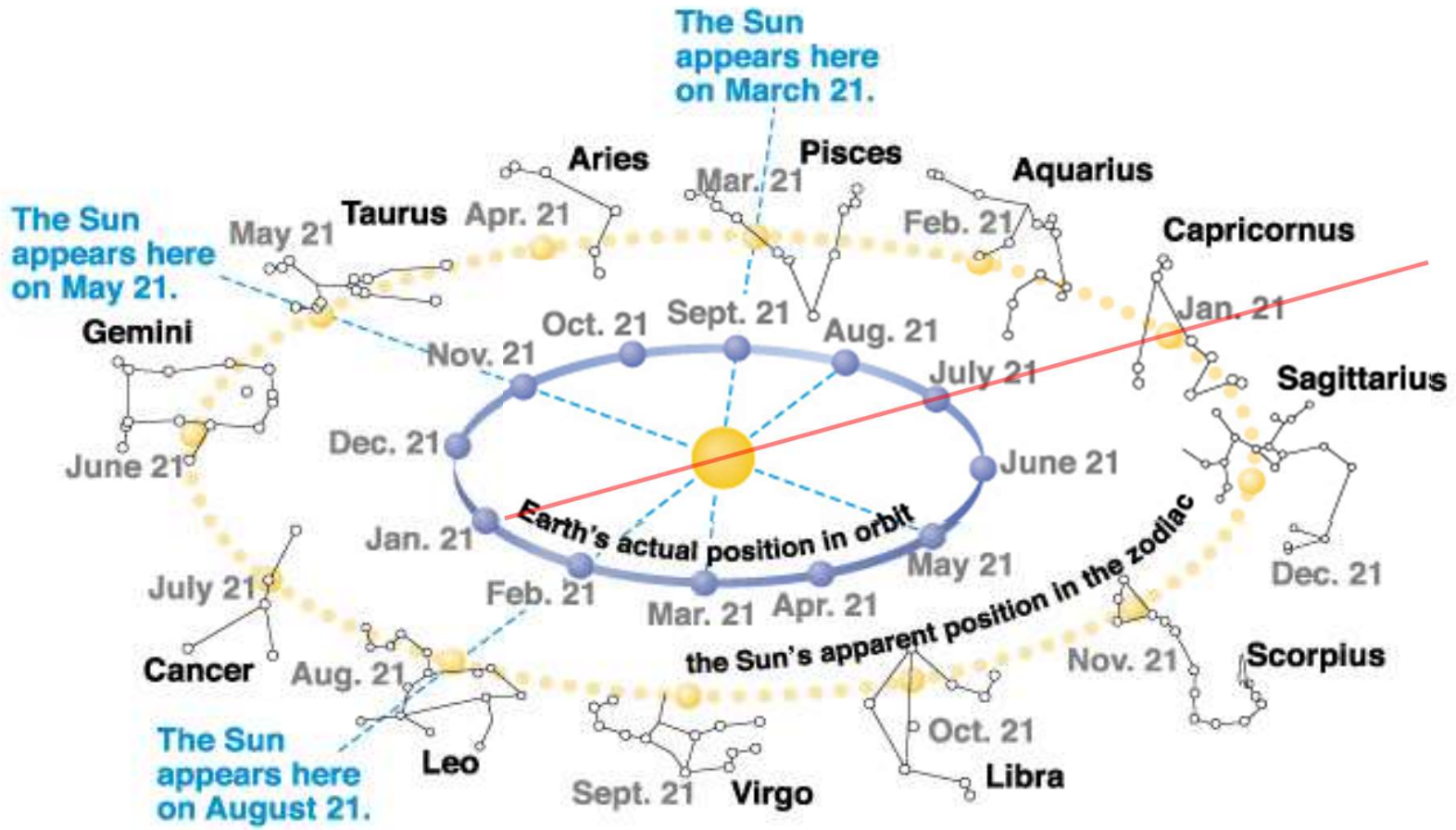
https://www.youtube.com/watch?v=kMjSiJ7V2Xc

The Constellations of the Zodiac

http://astro.unl.edu/classaction/animations/coordsmotion/zodiac.html

https://www.youtube.com/watch?v=7lwJGHg_SQM

The Sun Appears to Move Through the Constellations of the Zodiac



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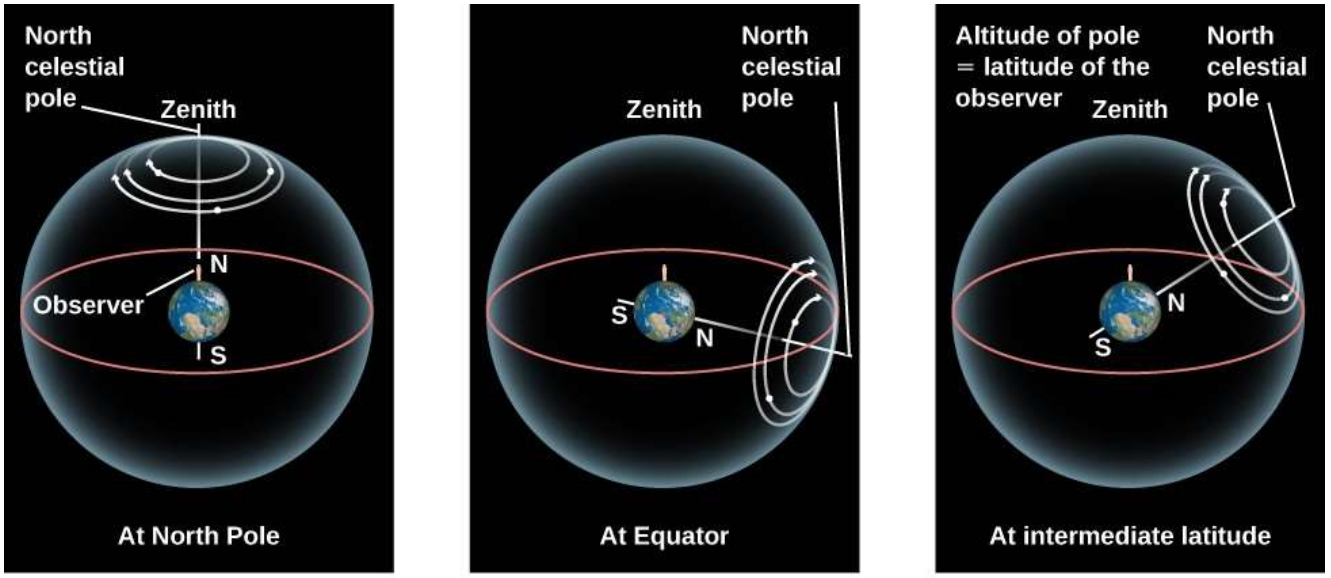
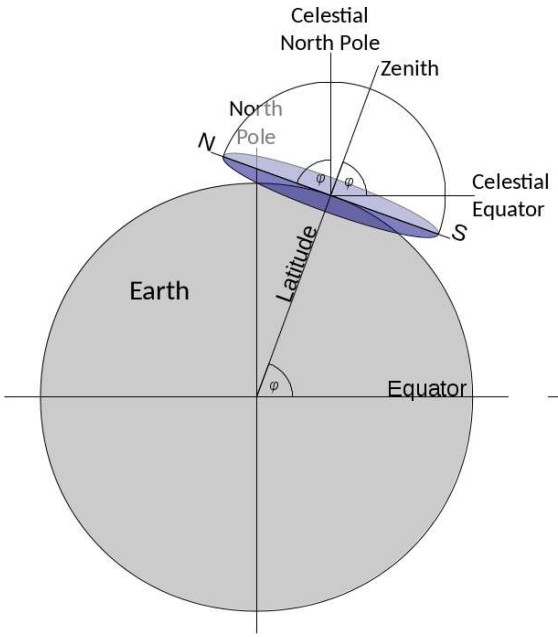
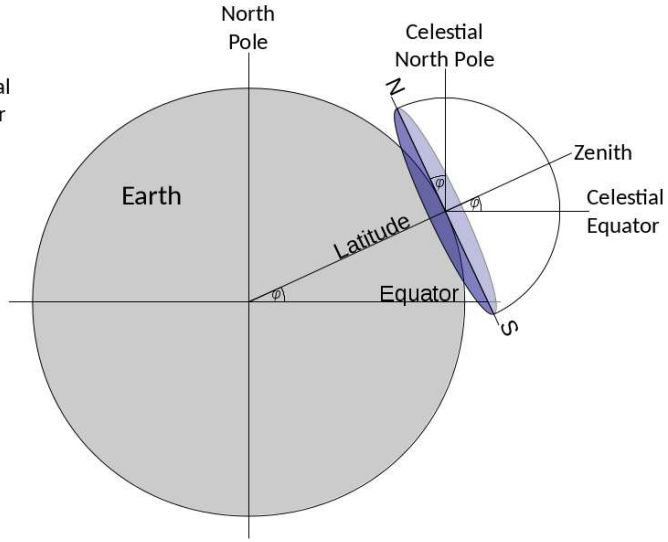


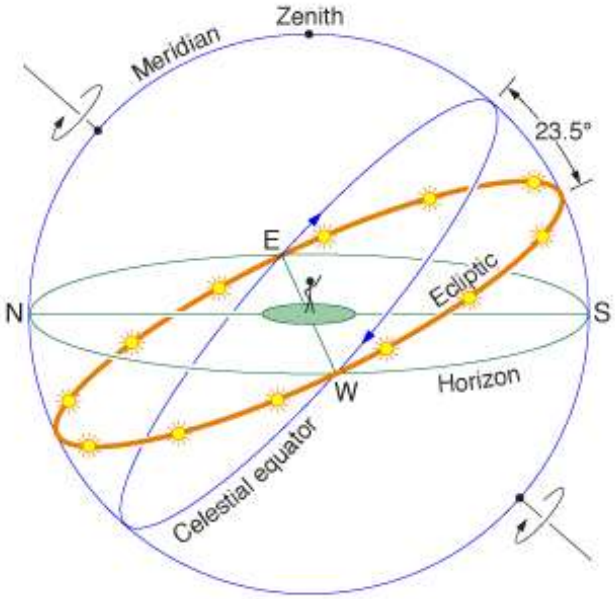
c) At Intermediate Latitude:

- Some stars are circumpolar
- Some stars are never visible

So unless you are in one of the poles, or the equator, your local reference frame is usually *a bit* more complicated







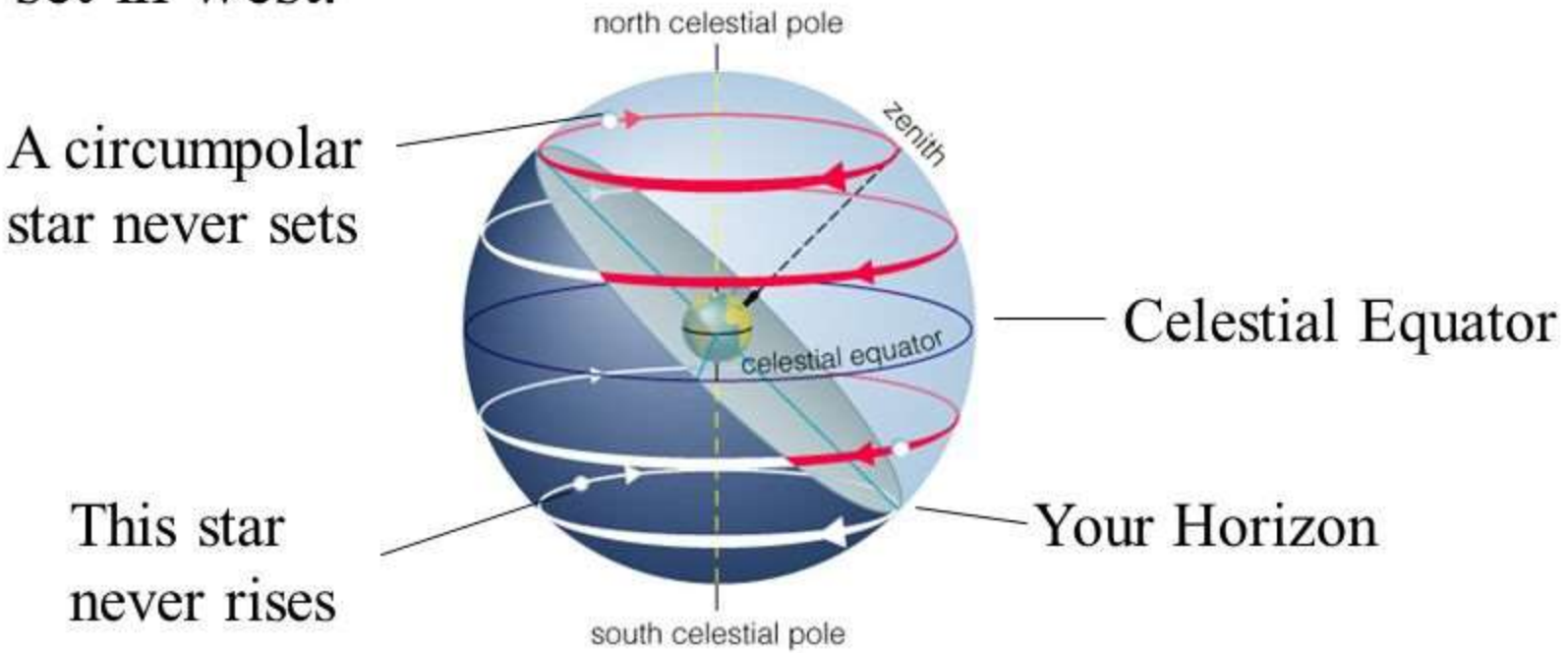
Zenith: lies directly above the observer

Horizon: plane blocked by Earth, lying 90° from the zenith

Meridian: crosses from due North over zenith to due South

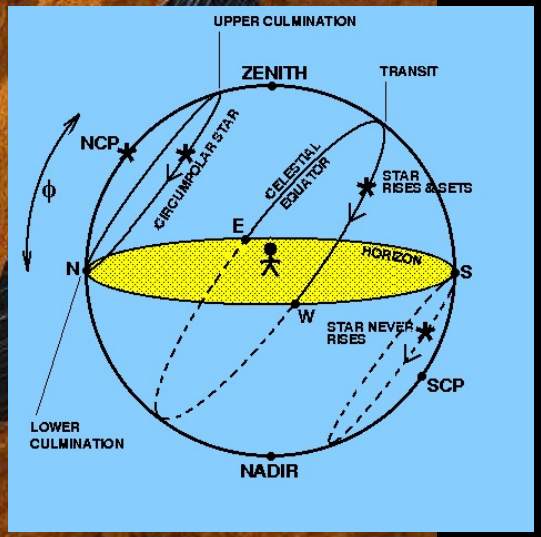
Our view from Earth:

- Stars near the north celestial pole are circumpolar and never set.
- We cannot see stars near the south celestial pole.
- All other stars (and Sun, Moon, planets) rise in east and set in west.



If you are not at the North Pole, The stars will rotate around a point indicative of your latitude

- Zenith at the North pole
- ~ at the Horizon if at the Equator

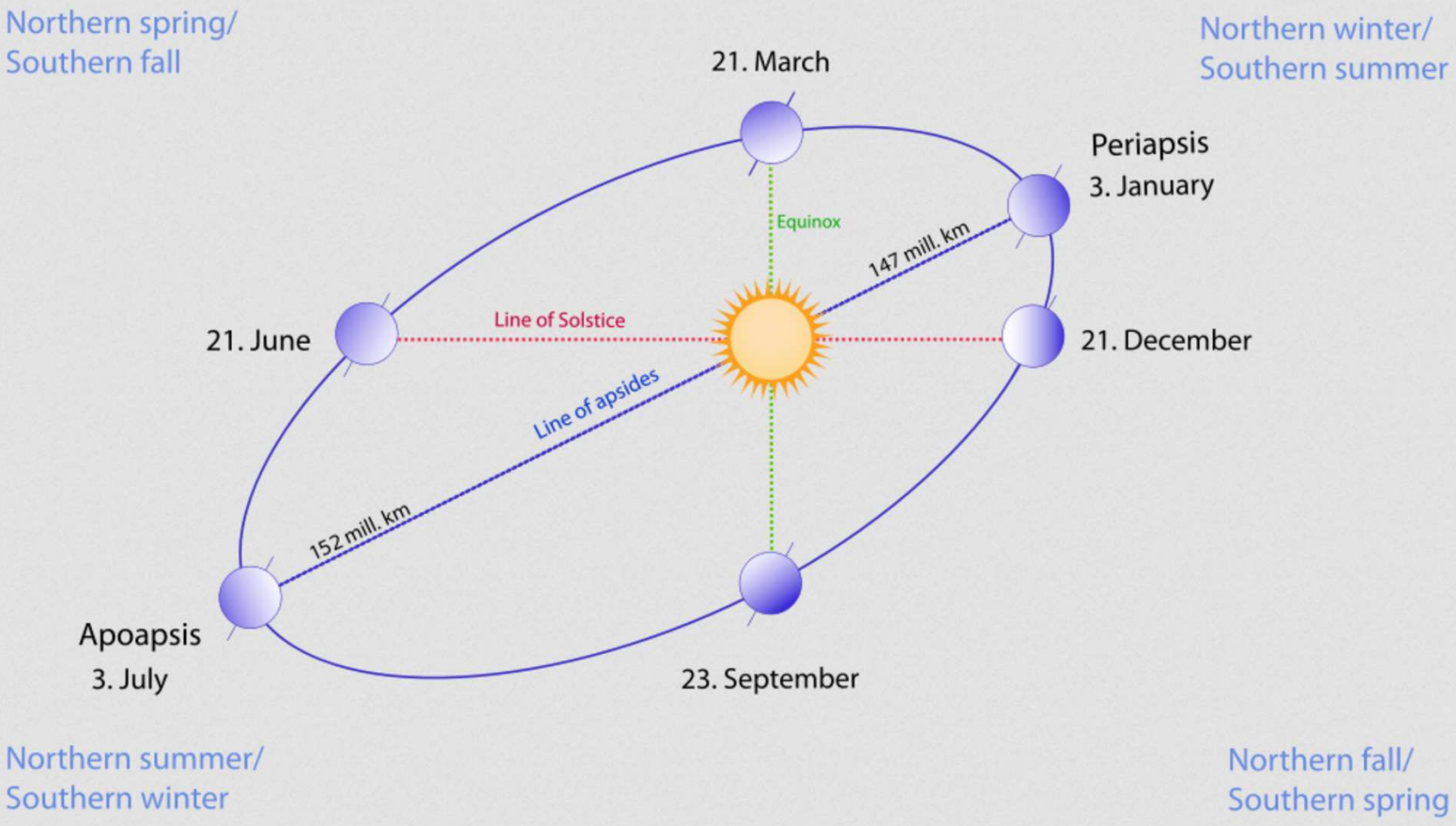


The Seasons are determined based on how close the Earth is to the Sun

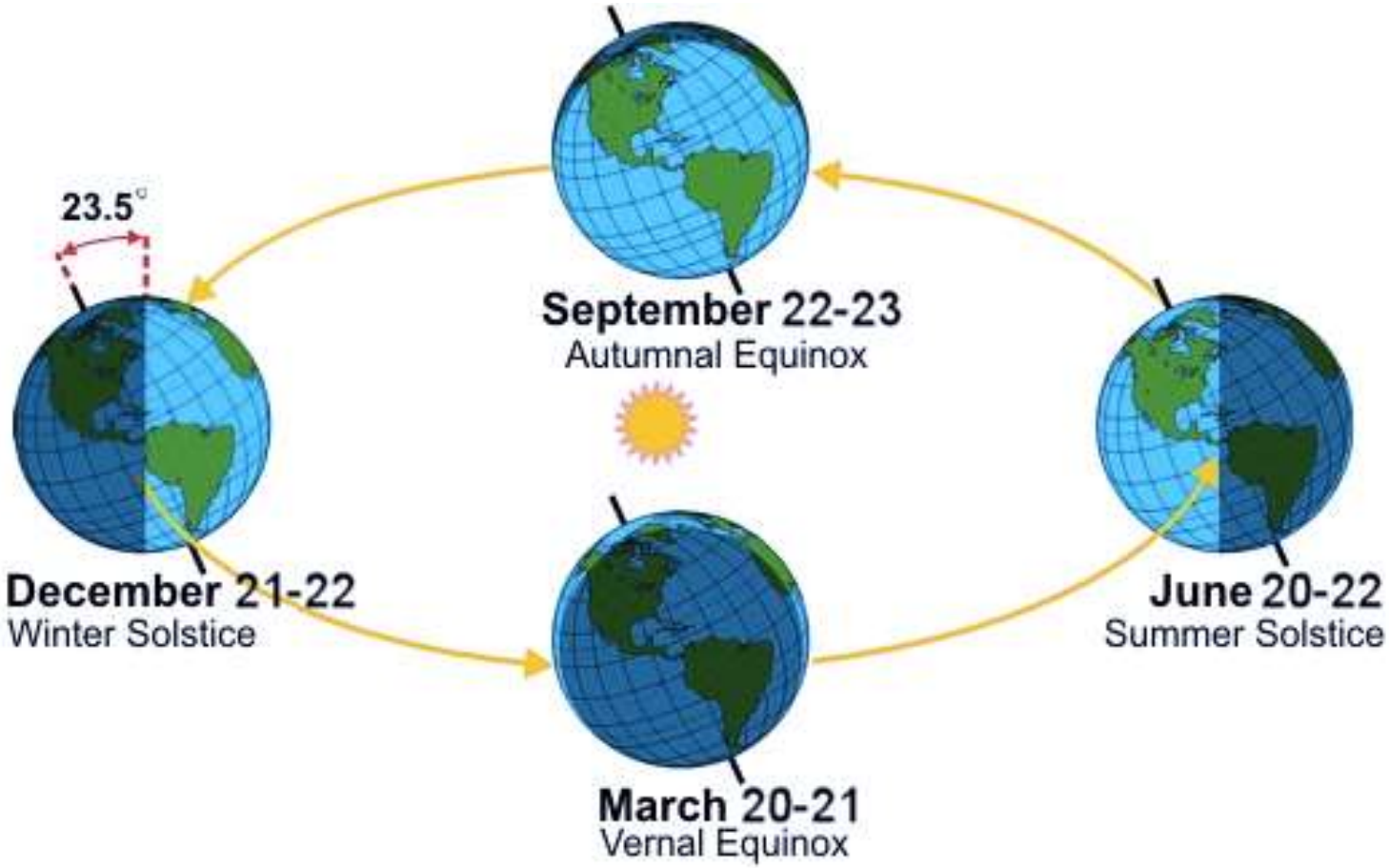
A: True

B: False

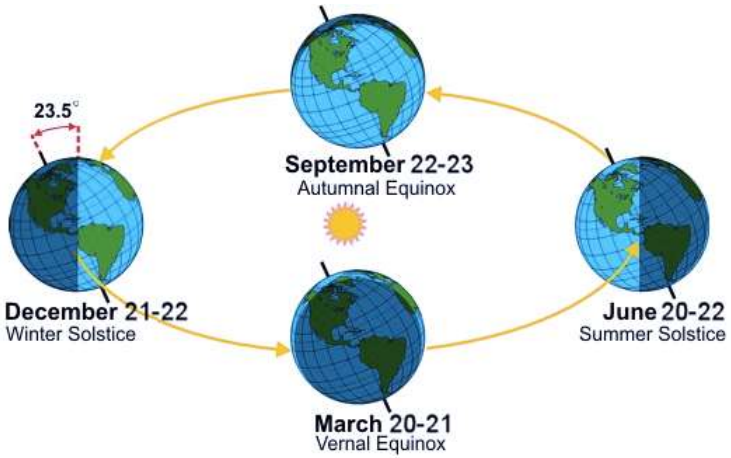
Actually, for Winter in the Northern Hemisphere, the Sun is further away!

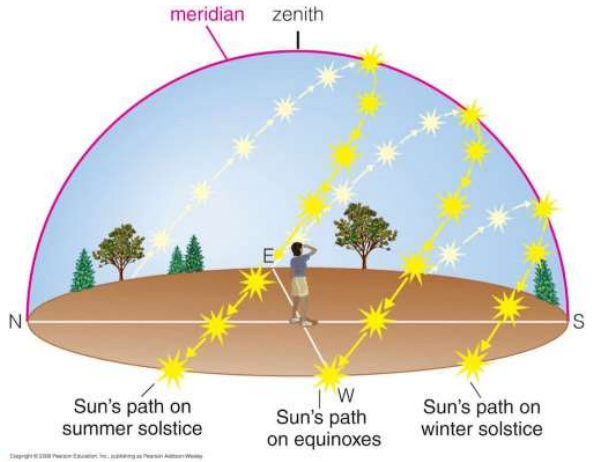


The Seasons are caused by the Tilt of Earth's axis

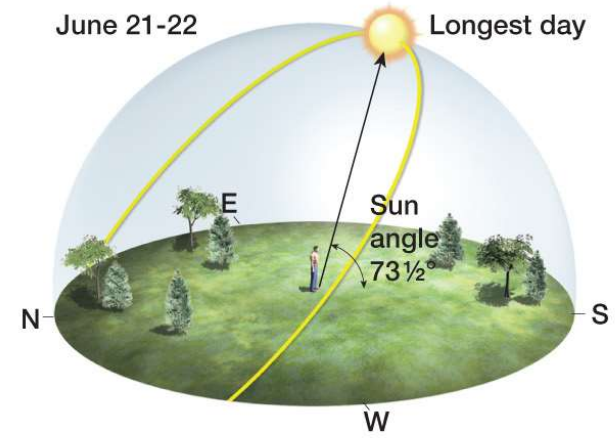


Extremes of Solstices & Equinoxes

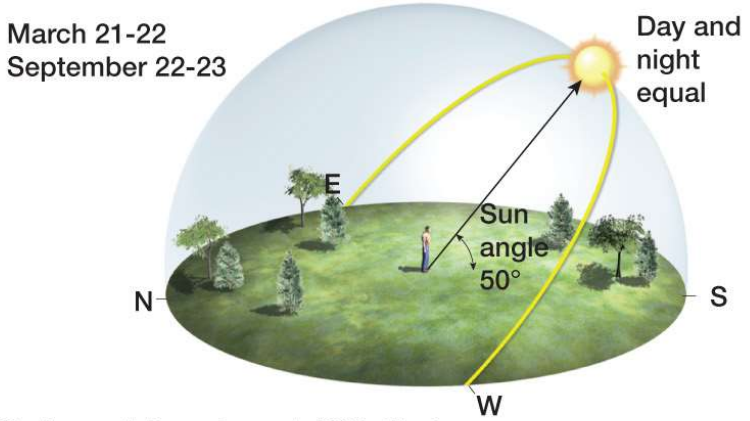




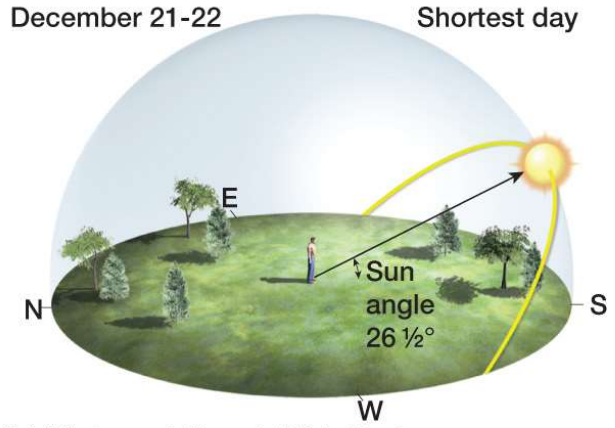
Sun angle changes with Season



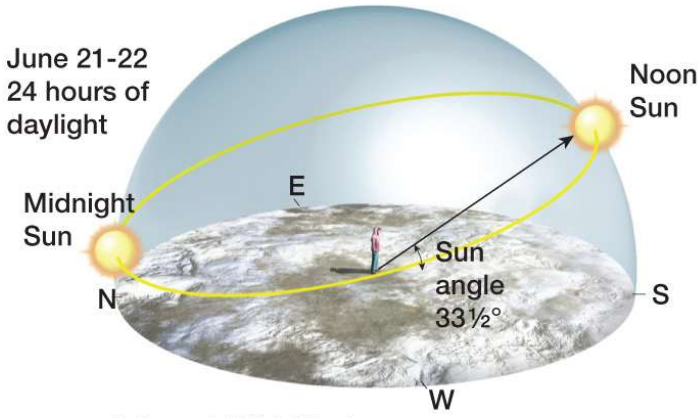
(a) Summer solstice at 40° latitude



(b) Spring or fall equinox at 40° latitude



(c) Winter solstice at 40° latitude



(d) Summer solstice at 80° latitude

The Phases of the Moon

Waning Crescent

Third Quarter

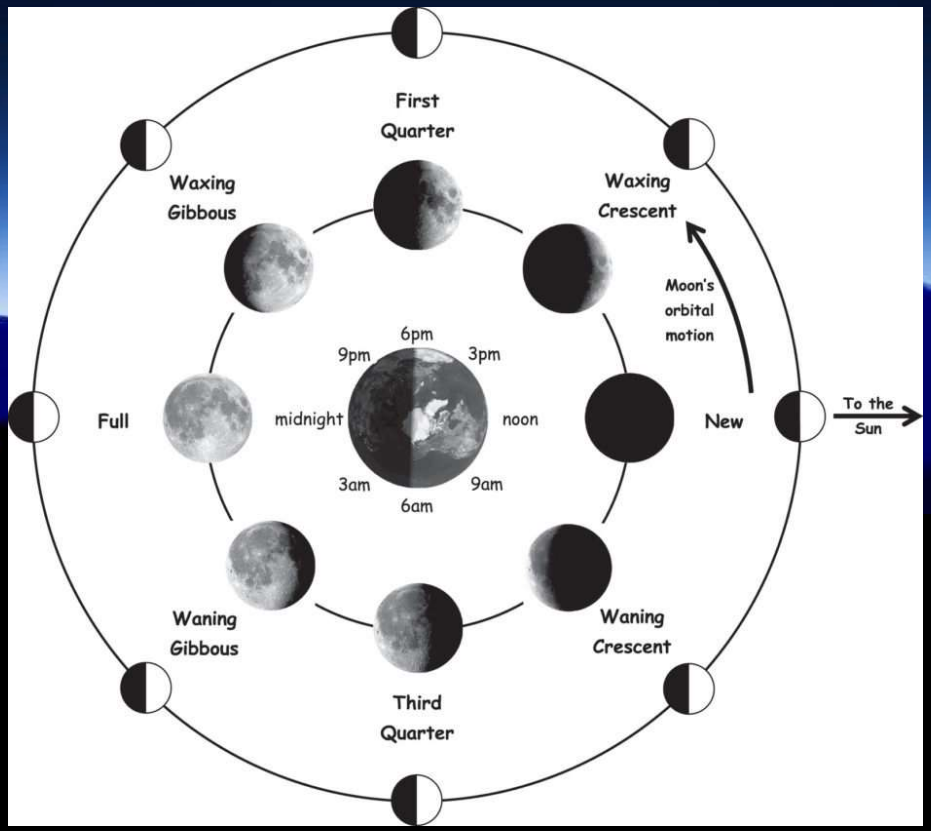
Waning Gibbous

Full

Waxing Gibbous

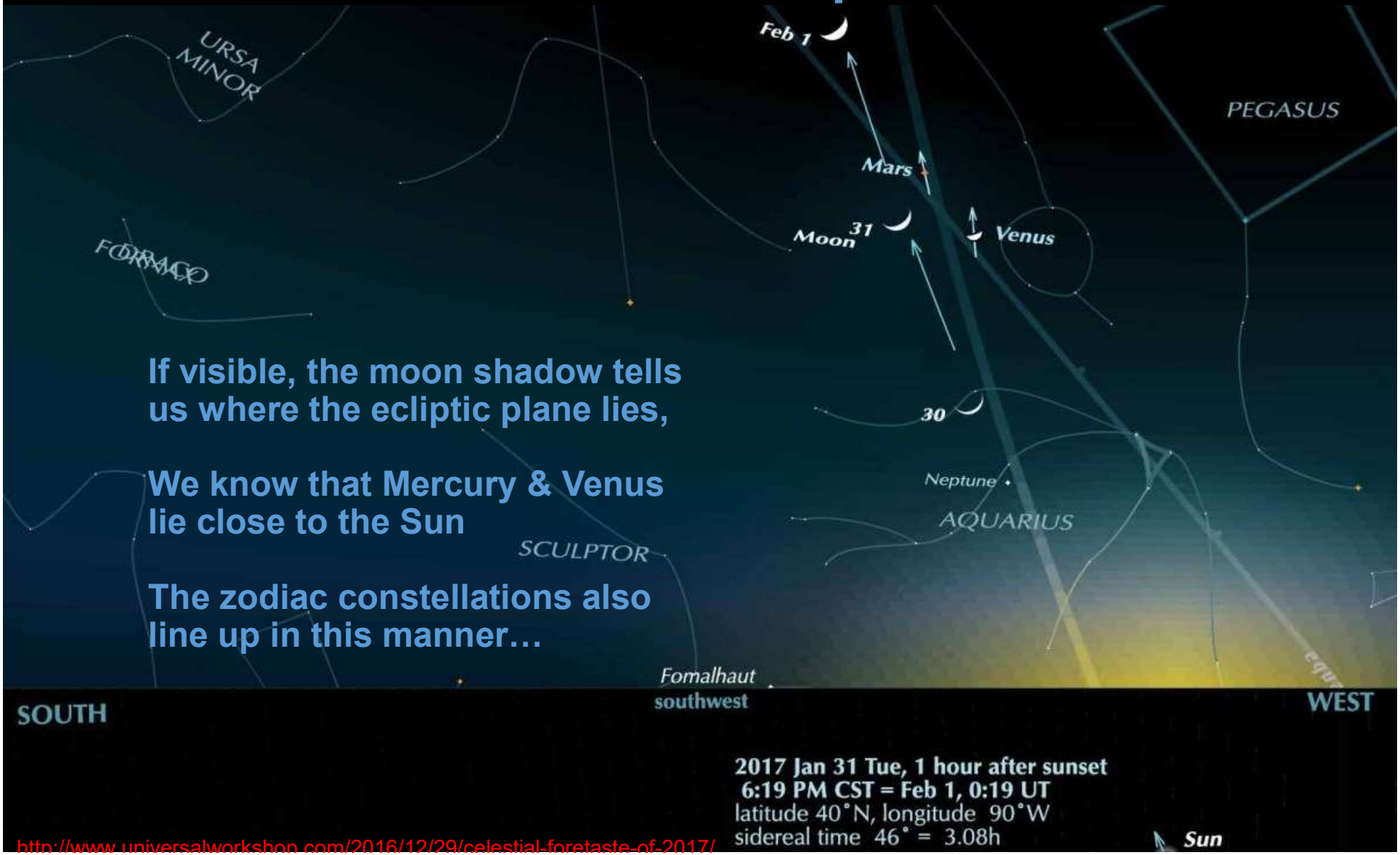
First Quarter

Waxing crescent



The moon orbits the Earth every ~27 days

The Planets, Sun, Moon, Constellations of the Zodiac All Lie in the Ecliptic Plane



If visible, the moon shadow tells us where the ecliptic plane lies,

We know that Mercury & Venus lie close to the Sun

The zodiac constellations also line up in this manner…

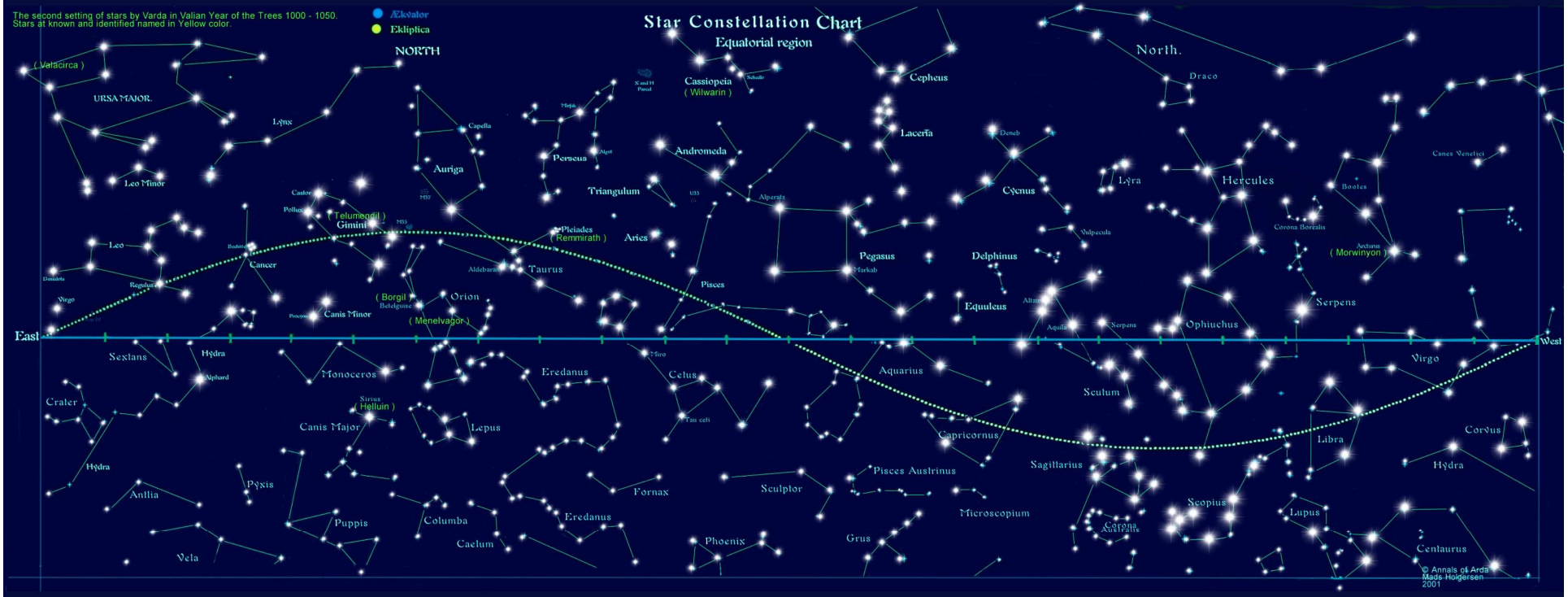
http://www.universalworkshop.com/2016/12/29/celestial-foretaste-of-2017/

The 88 Constellations

Begin at East (Vernal or Spring Equinox)

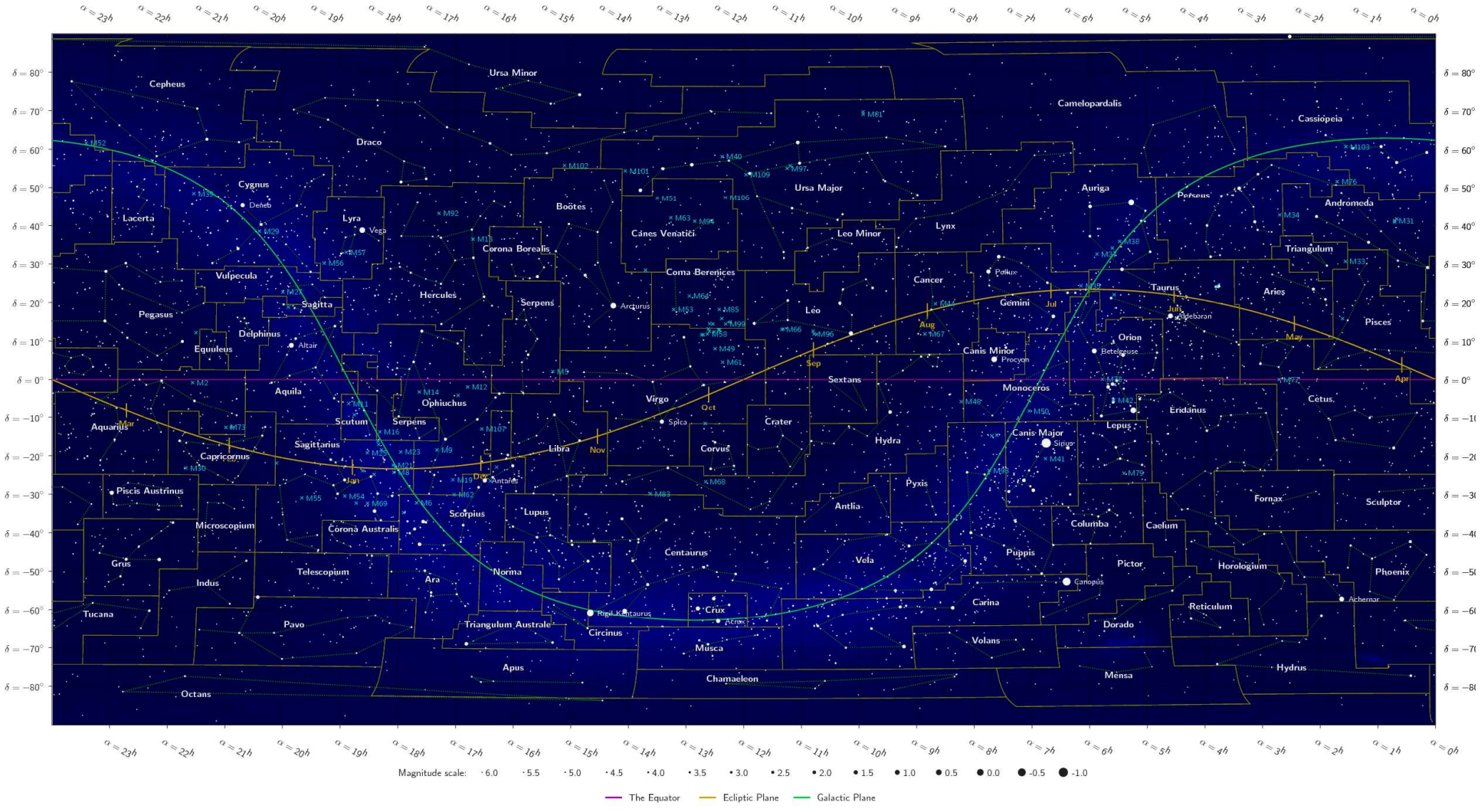
Here, Equator is shown in Blue horizontal line

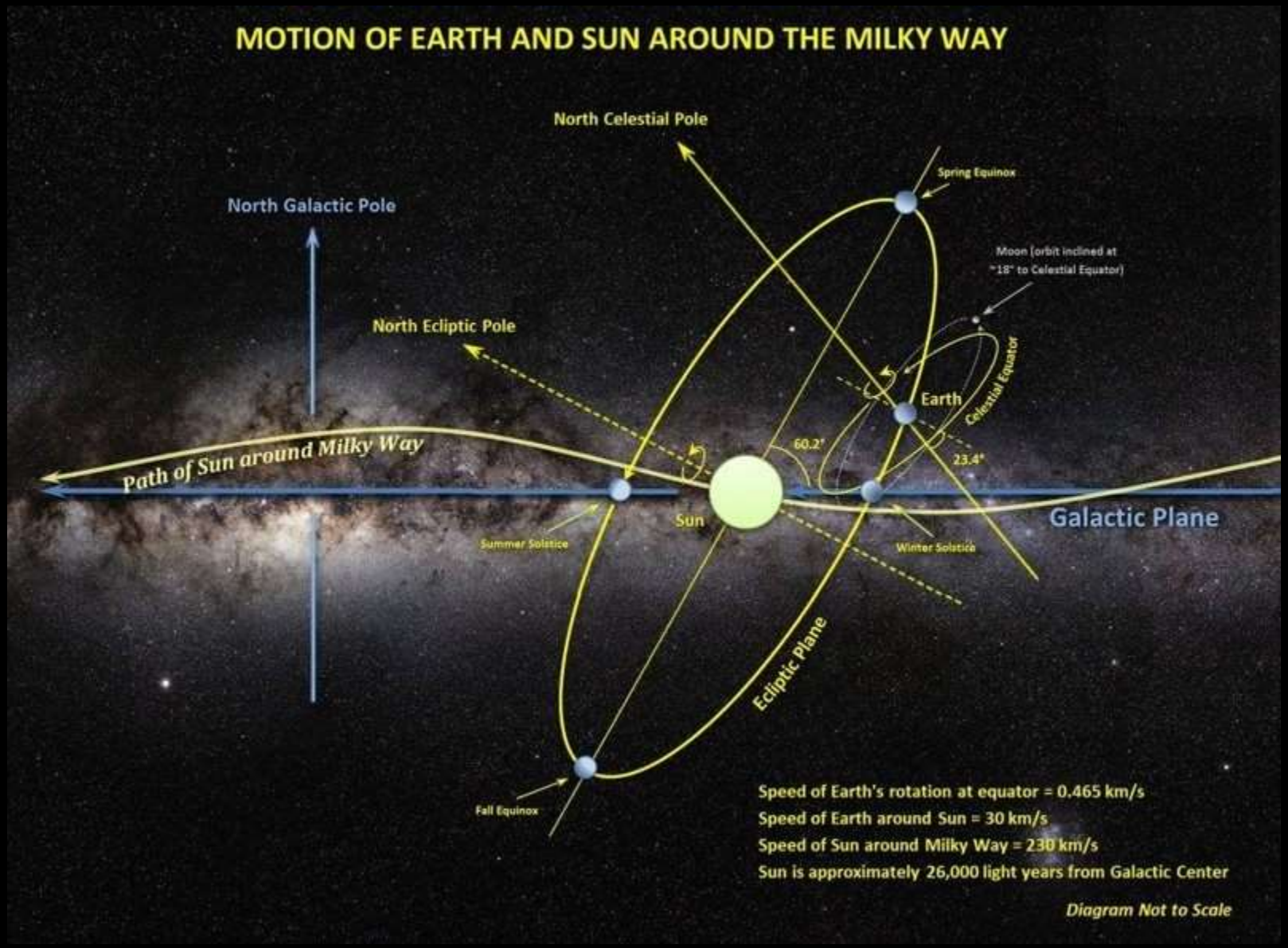
Ecliptic plane as it changes with seasons is green



What About the Galactic Plane?

https://in-the-sky.org/data/constellations_map_equ11012.png




MOTION OF EARTH AND SUN AROUND THE MILKY WAY
North Celestial Pole
Spring Equinox
North Galactic Pole
Moon (orbit inclined at ~18° to Celestial Equator)
North Ecliptic Pole
Celestial Equator
Earth
60.2°
23.4°
Path of Sun around Milky Way
Sun
Galactic Plane
Summer Solstice
Winter Solstice
Ecliptic Plane
Fall Equinox
Speed of Earth's rotation at equator = 0.465 km/s
Speed of Earth around Sun = 30 km/s
Speed of Sun around Milky Way = 230 km/s
Sun is approximately 26,000 light years from Galactic Center
Diagram Not to Scale

End of Todays Lecture