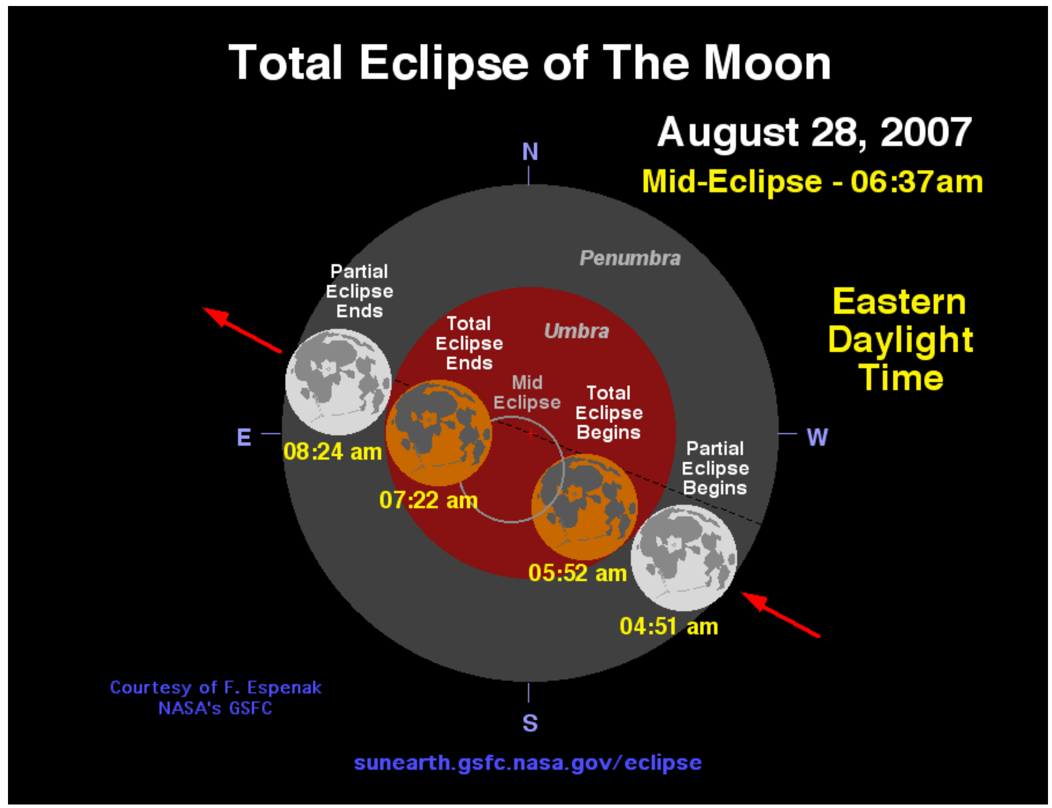
“Now there is one outstandingly important fact regarding Spaceship Earth,

and that is that no instruction book came with it”

- R. Buckminster Fuller

First Bonus Assignment

- Bring me a picture of the Moon during the eclipse tomorrow morning!
  - You must take the picture yourself
  - Can be during partial or total eclipse (extra points for both!)
  - Submit with a brief description of your experience (one paragraph)
- Window of opportunity: 5:30 am – 6:30 am
  - Moon sets at 7:13 am
- Due by Friday, August 31st



What We Will Learn Today

- In how many ways are you moving right now?
- How have patterns in our sky impacted our history?
- What can we learn from them?
- How did astronomy help us define day, month, and year?

How Many Ways Are You Moving?

At least *eight* ways!

Don’t believe me? Well let’s see…

Motion # 1: The Earth Rotates

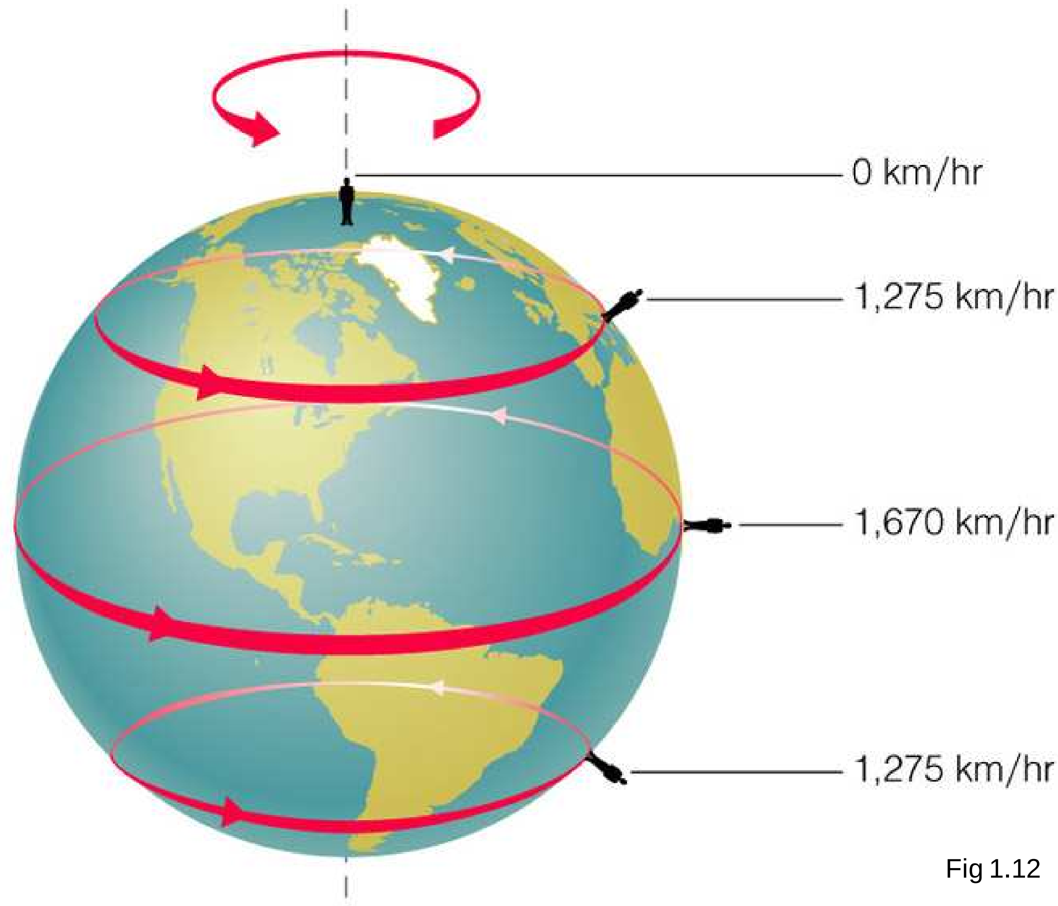
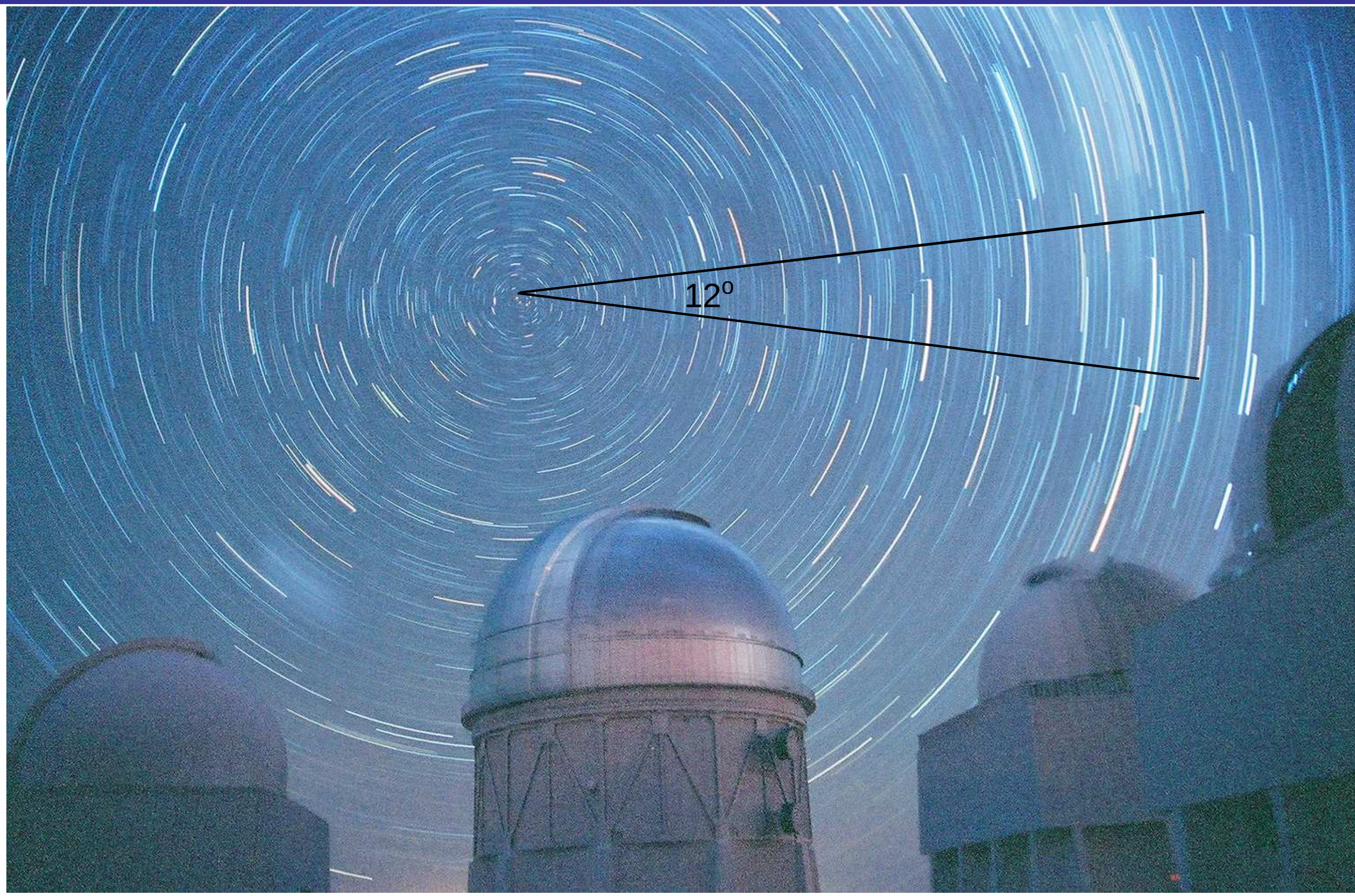


Fig 1.12

- The reason for our days & nights!
- About ½ km per second at the equator
  - A thousand miles per hour!

Mystery Picture



- Approximately when (time of day) was this picture taken?
- What do we see here?
- How long was the exposure? $12^o/360^o*24 = 0.8$ hours = 48 minutes

Motion # 2: The Earth Revolves

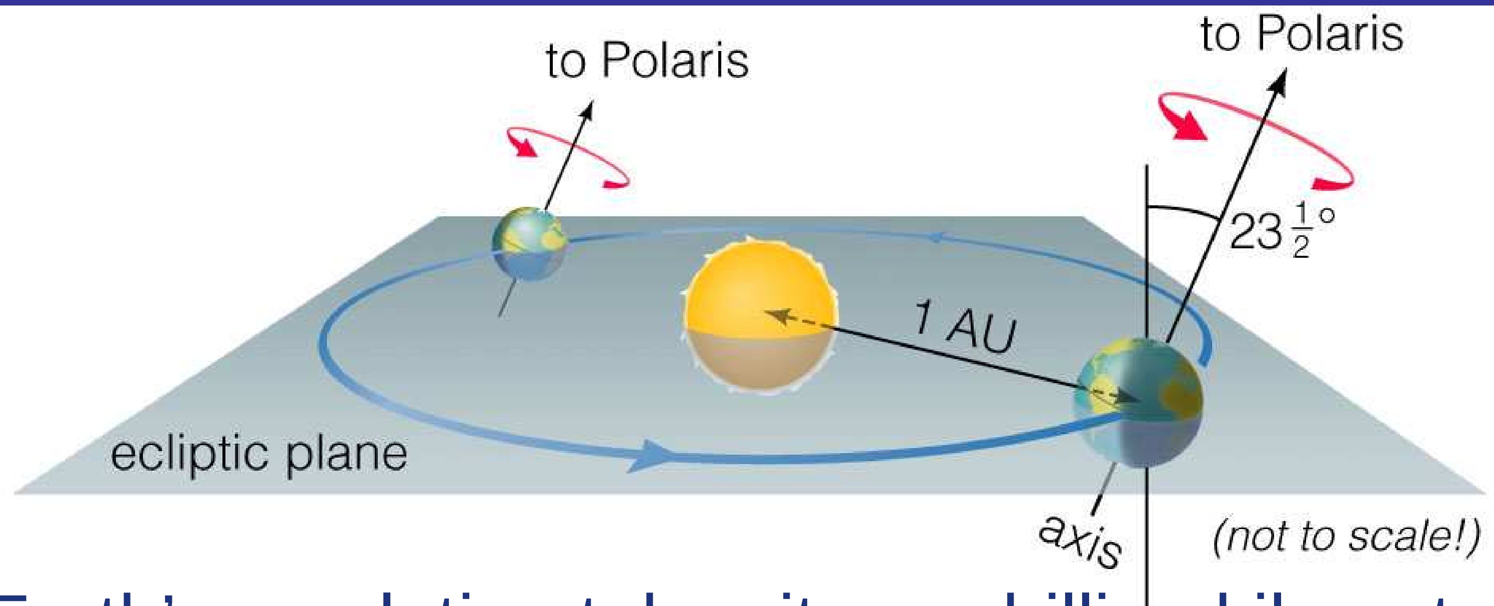


Fig 1.13

- Earth's revolution takes it on a billion kilometer journey around the Sun
- Completes one orbit per year at a speed of over 65,000 miles per hour!
- The orbital plane is called the *ecliptic*
- Earth's rotational axis is tilled 23.5^{o} with respect to this plane

Motion # 3: Sun Moves Thru Galaxy

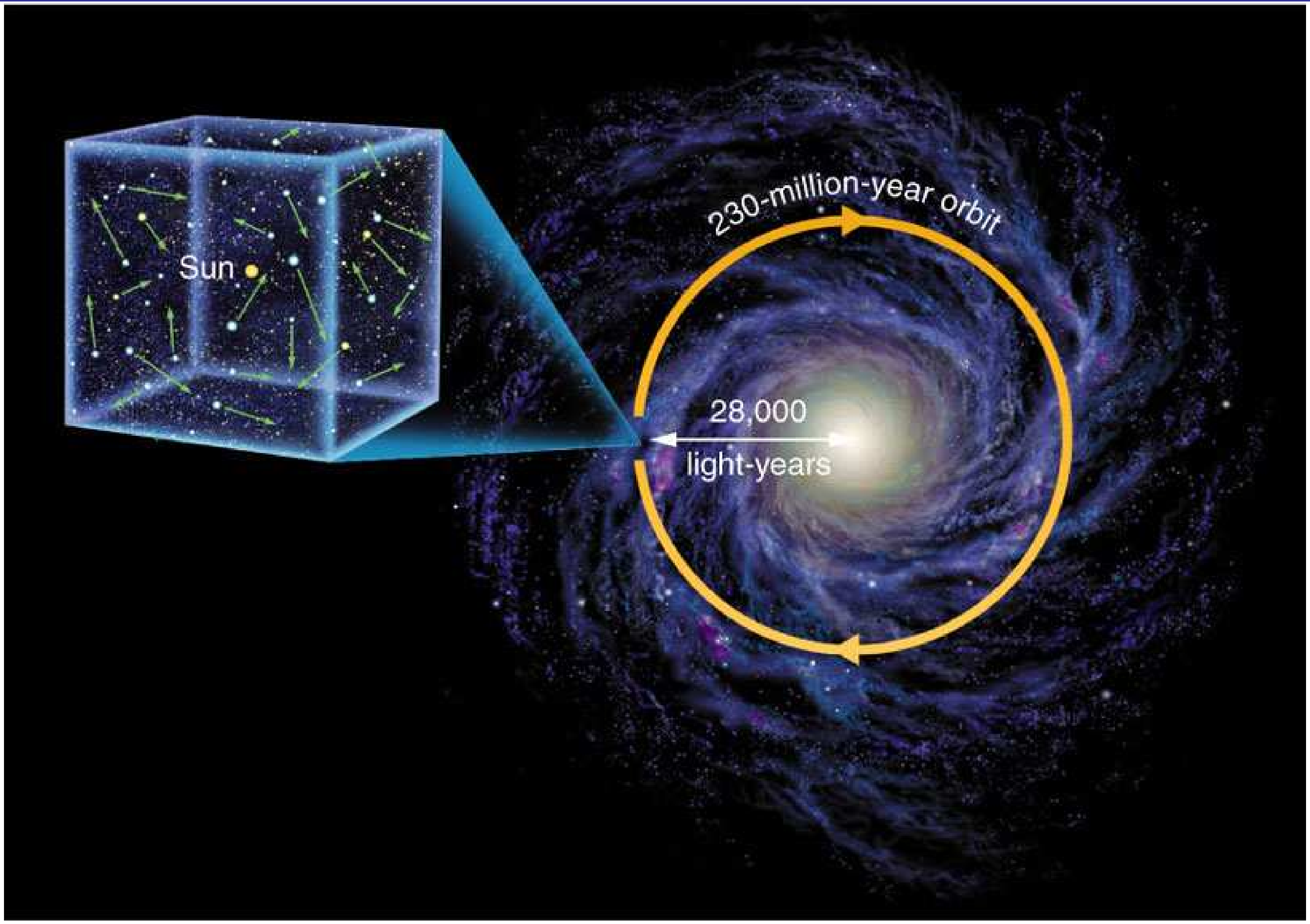


Fig 1.14

- Sun's random motion in local neighborhood
  - 44,000 mph!
- Sun's revolution around Galactic center
  - 500,000 mph!

Motion # 4: The Galaxy's Motion

- Local motion
  - We are approaching the Andromeda galaxy at 190,000 mph
- Expansion of the Universe
  - Farther you look, faster it's moving away

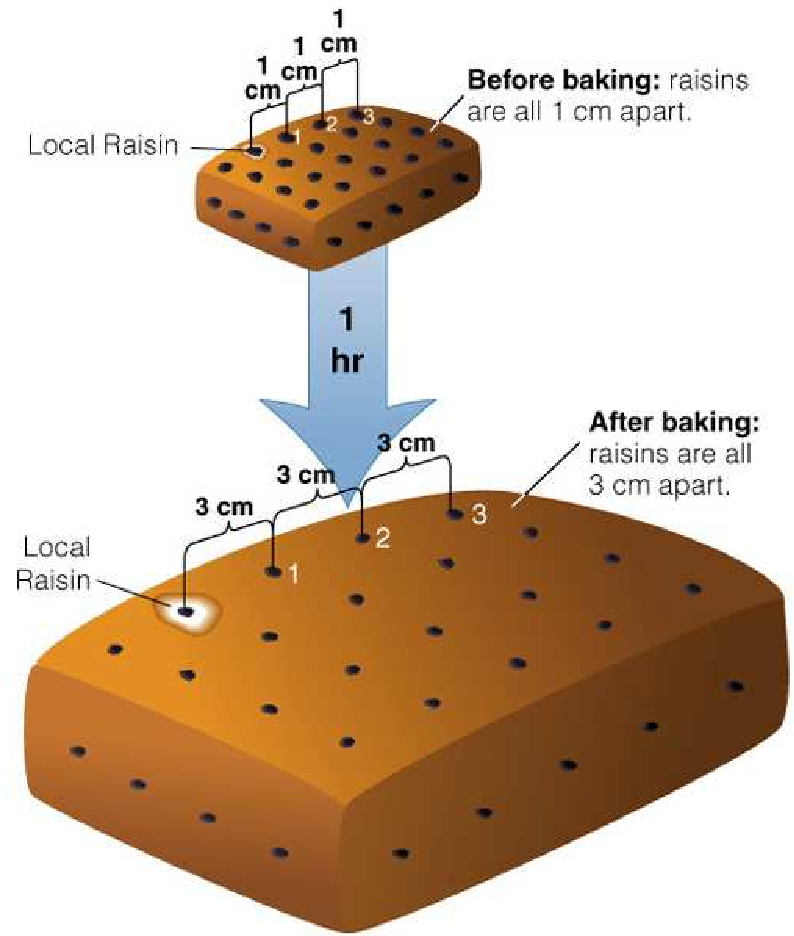


Fig 1.16

Motion # 5: Precession of the Axis

- Similar to a spinning top
- Occurs due to tugs on Earth's equatorial bulge from Sun and Moon
- 26,000 year period
- Polaris will not always be the pole star!

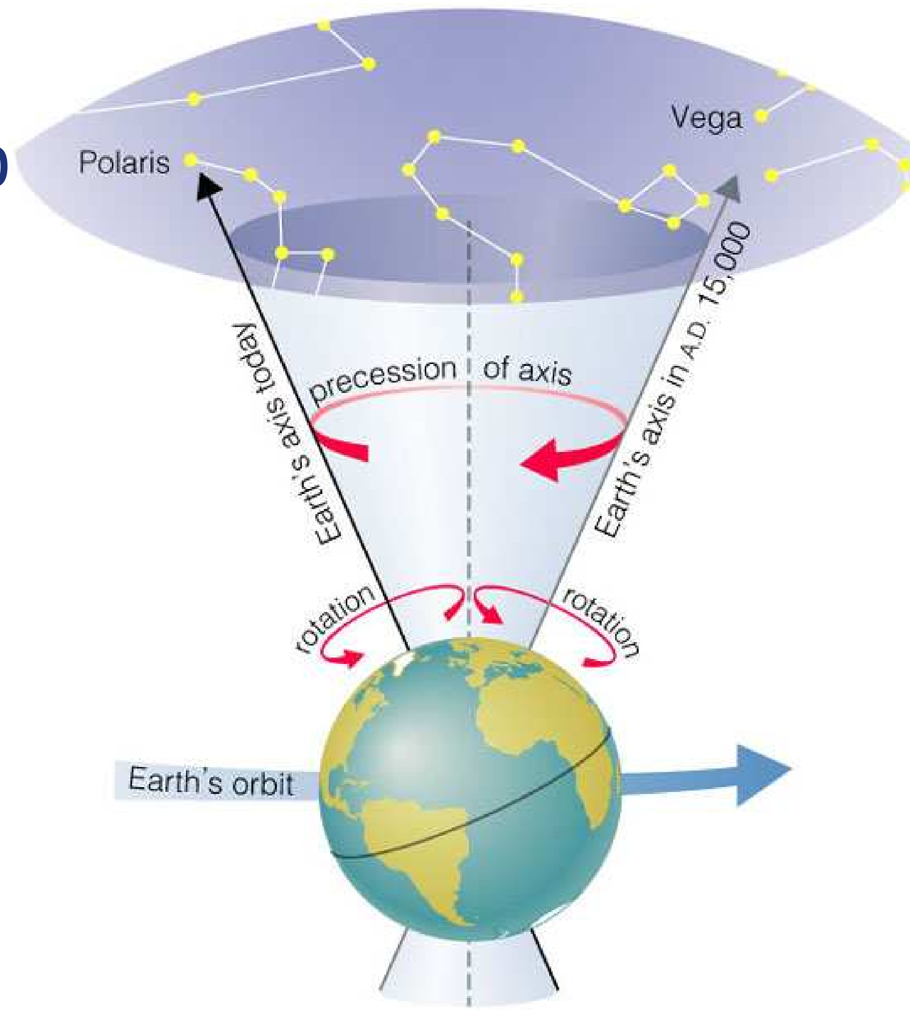


Fig 2.20 b

Other Slower Motions

6. Earth-Moon center of mass
7. Perturbation of Earth's orbit due to other planets (primarily Jupiter)
8. Plate tectonics
   - Few cm per year
   - Atlantic grows
   - Pacific shrinks
   - Himalayas taller

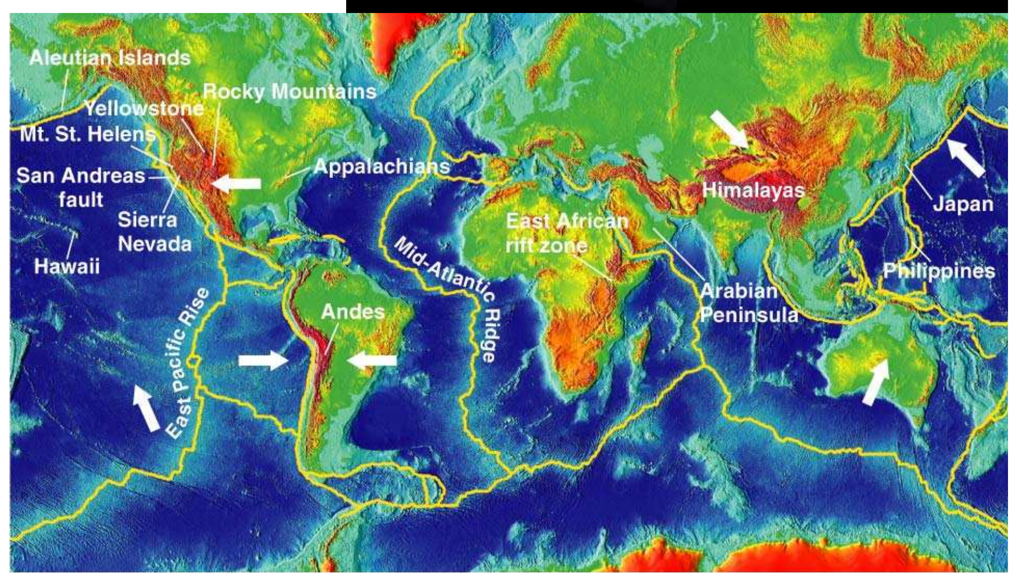


Fig 9.35

The Night Sky: Constellations

- Patterns seen in the sky
- 88 constellations
  - See Appendix I
- 12 Zodiacs
  - Lie along the ecliptic
- Stars in a constellation need not be close together
  - Remember, there is a third dimension!

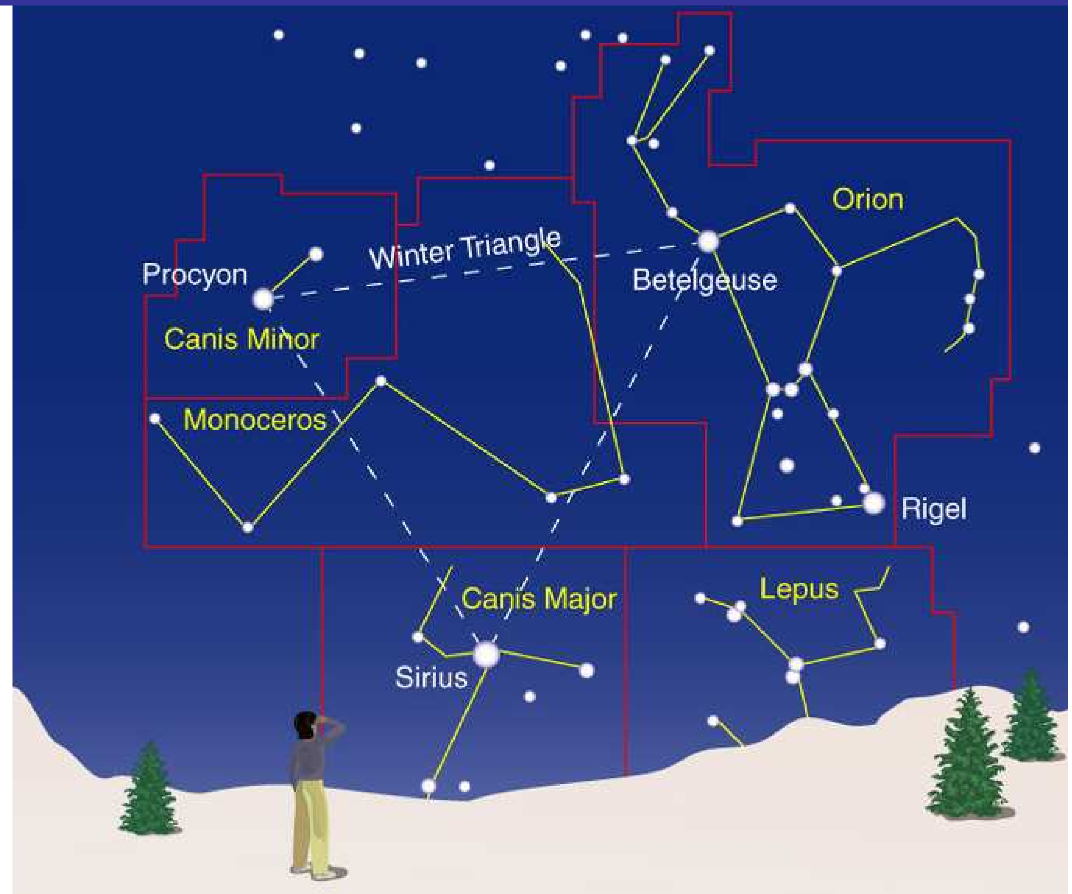


Fig 2.2

Betelgeuse = Alpha Orionis

Brightest star in constellation Orion

Rigel = Beta Orionis

2^{nd} brightest star in Orion

The Zodiac

- Constellations that lie along the ecliptic
- Mnemonic
  – Ram-Ble Twins Crab Li-Ver(ish);
  – Scaly Scorpions Are Good Water-Fish

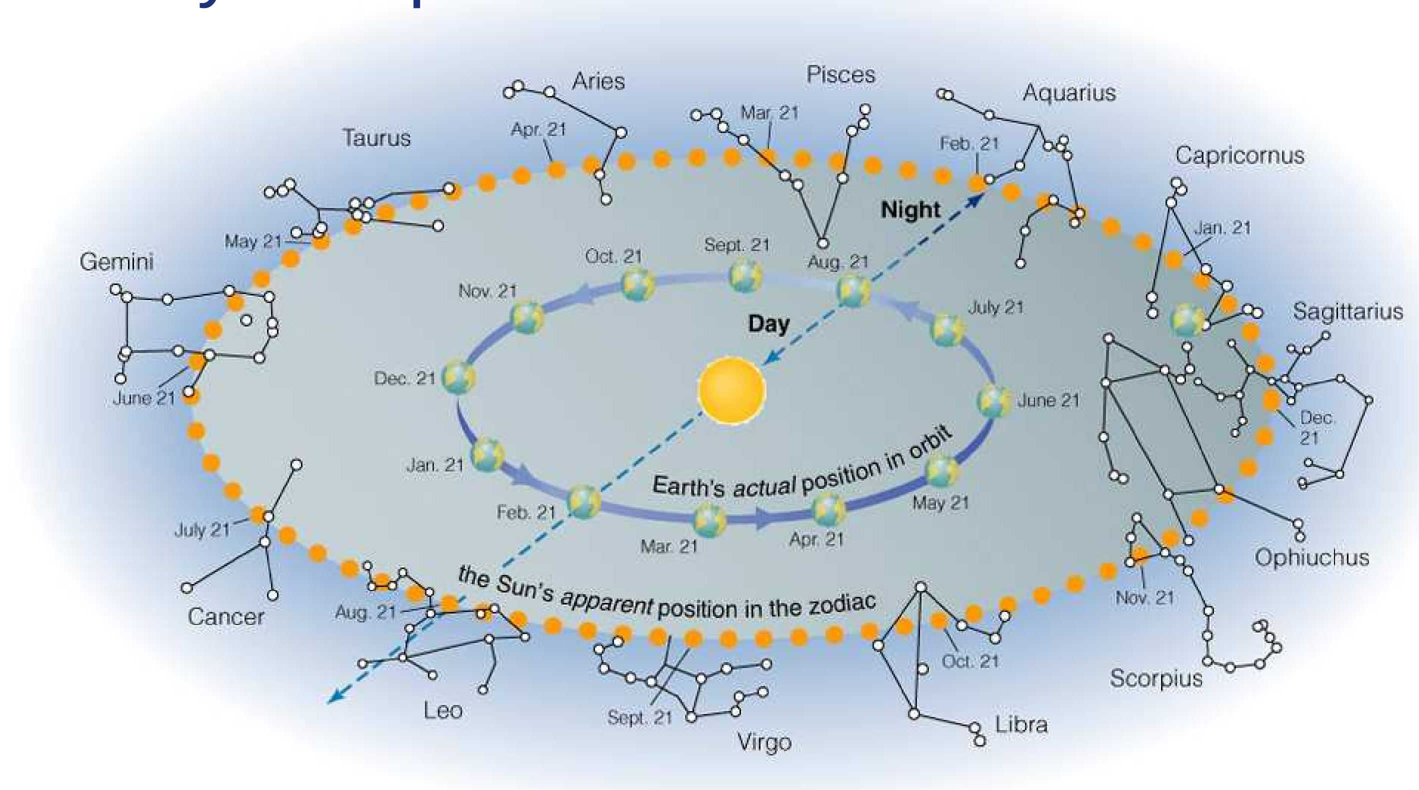


Fig 2.14

The Celestial Sphere

- Geocentric view of the universe
  - Corresponds to our perspective from Earth

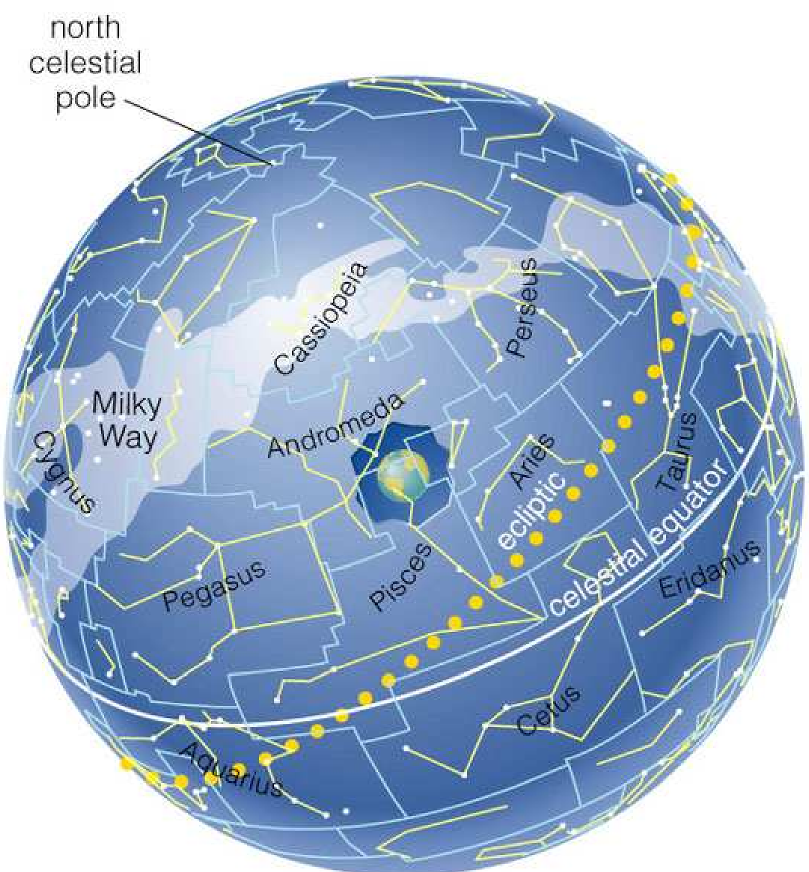


Fig 2.4

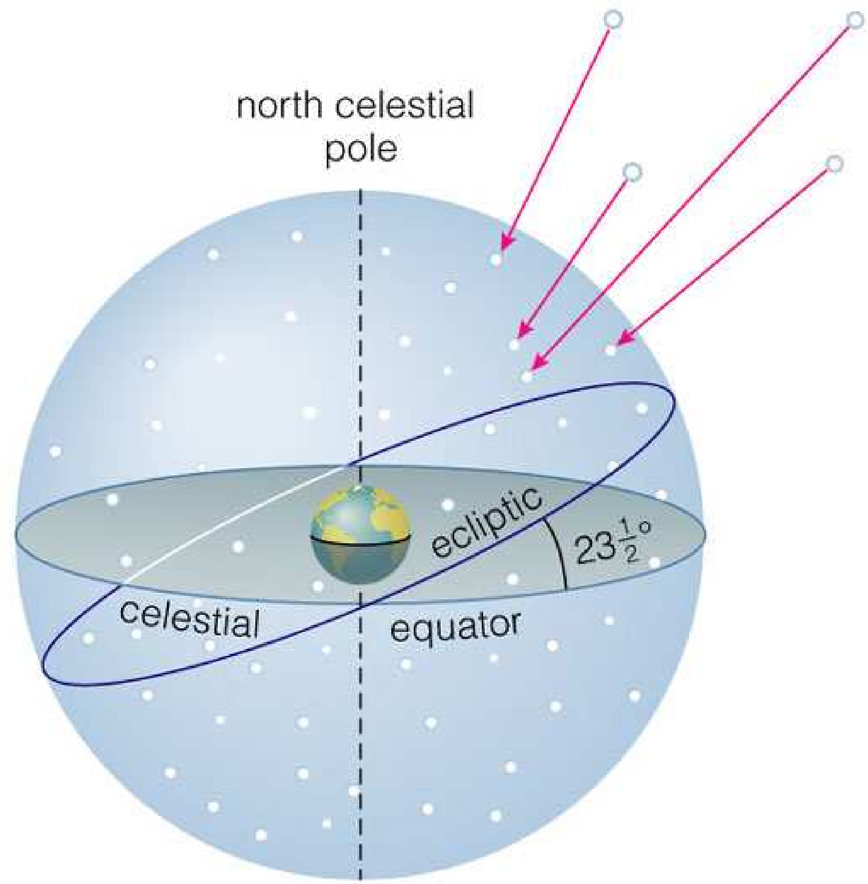
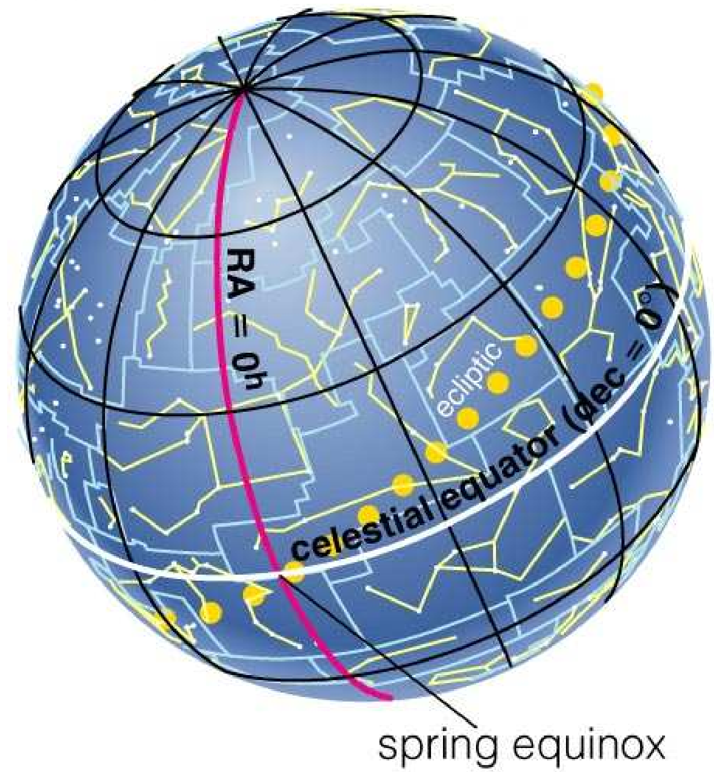


Fig 2.3

Celestial Coordinates

- Right Ascension
  - Like longitudes on Earth
  - RA = 0 Position of Sun at Spring Equinox
  - Specified in hours, minutes, seconds
- Declination
  - Like latitudes on Earth
  - Specified in degrees, minutes, seconds
  - 0^o at Celestial Equator,
  - $+90^o$ at Celestial North Pole



A Few Terms

- <u>Horizon</u>: Sky meets Earth
- <u>Zenith</u>: Directly overhead
- <u>Meridian</u>: Circle connecting Zenith with North & South on horizon
- Stellar location:
  - <u>Azimuth</u> (angle along the horizon – from N towards E)
  - <u>Elevation</u> (angle above horizon)
- Angles in the sky:
  - Size of moon on sky is ½ degree
  - 30 <u>arcmin</u> or 1800 <u>arcsec</u>

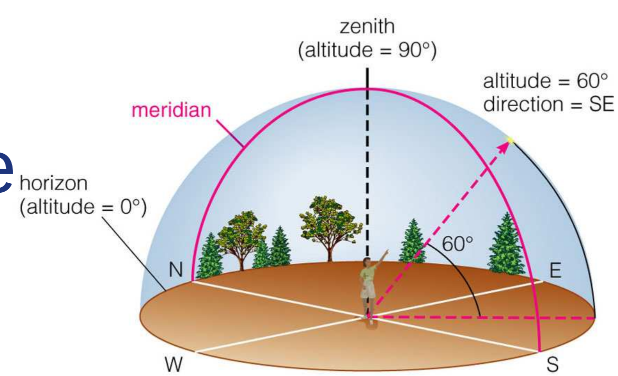


Fig 2.6

Yes, Stars Rise & Set Too

- Actually, our rotation makes them appear to, just like the Sun
  - Remember the star-trails picture?
- Circumpolar stars
  - Always in our sky

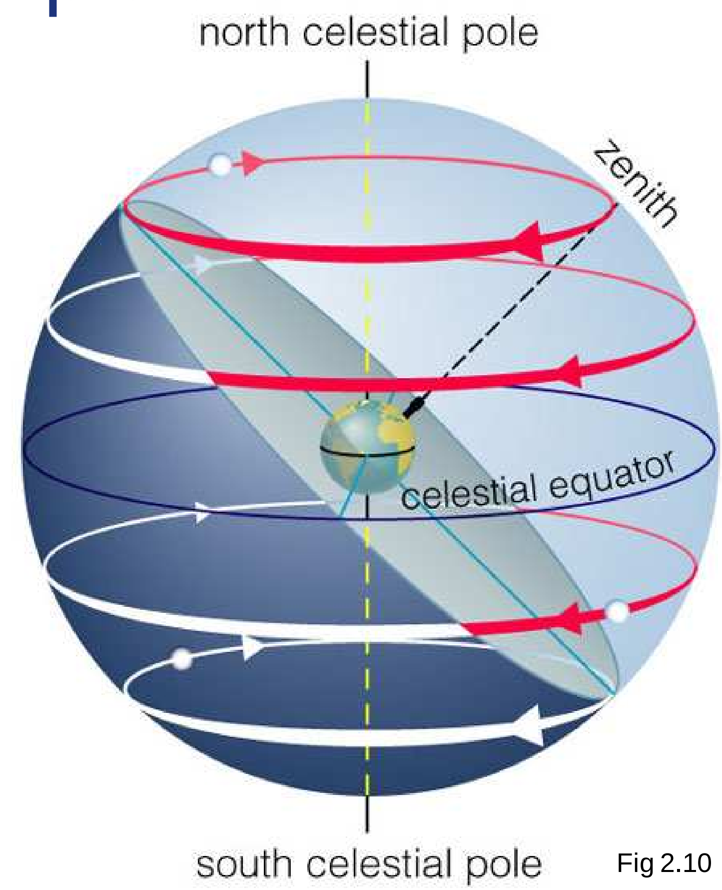


Fig 2.10

Planets in the Sky

- Planets = came from Greek word for “wanderer” (*planetes*)
- Retrograde motion

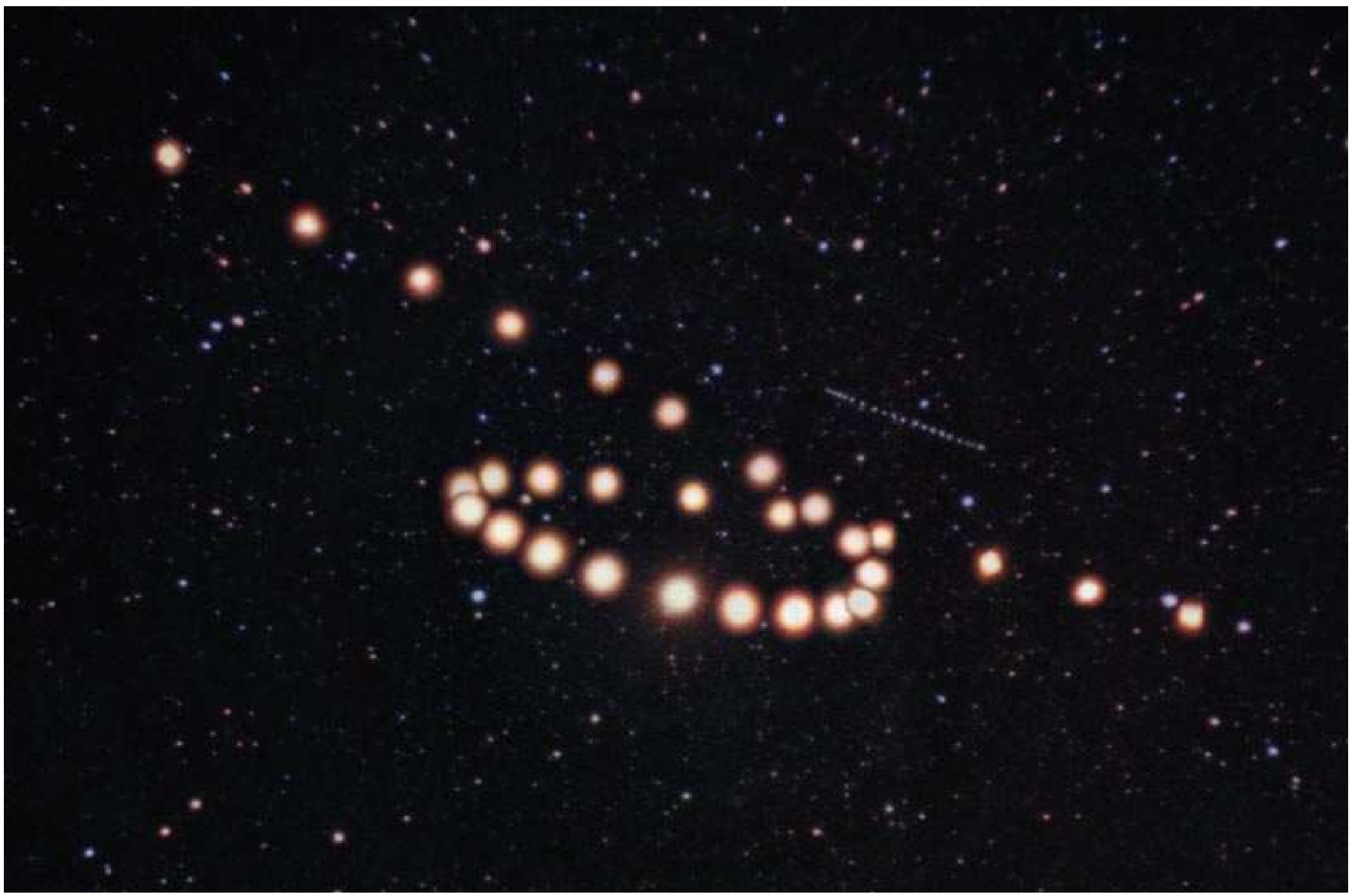


Fig 2.32 b

Stellar Parallax

- Ancient Greeks could not measure parallax and hence favored Geocentric view
- RECONS group at GSU uses stellar parallax to measure accurate distances to nearby stars
- Parallax is an angle
  - degrees
  - arcmin = 1/60 degree
  - arcsec = 1/60 arcmin
- Stellar parallaxes are typically measured in arcsec

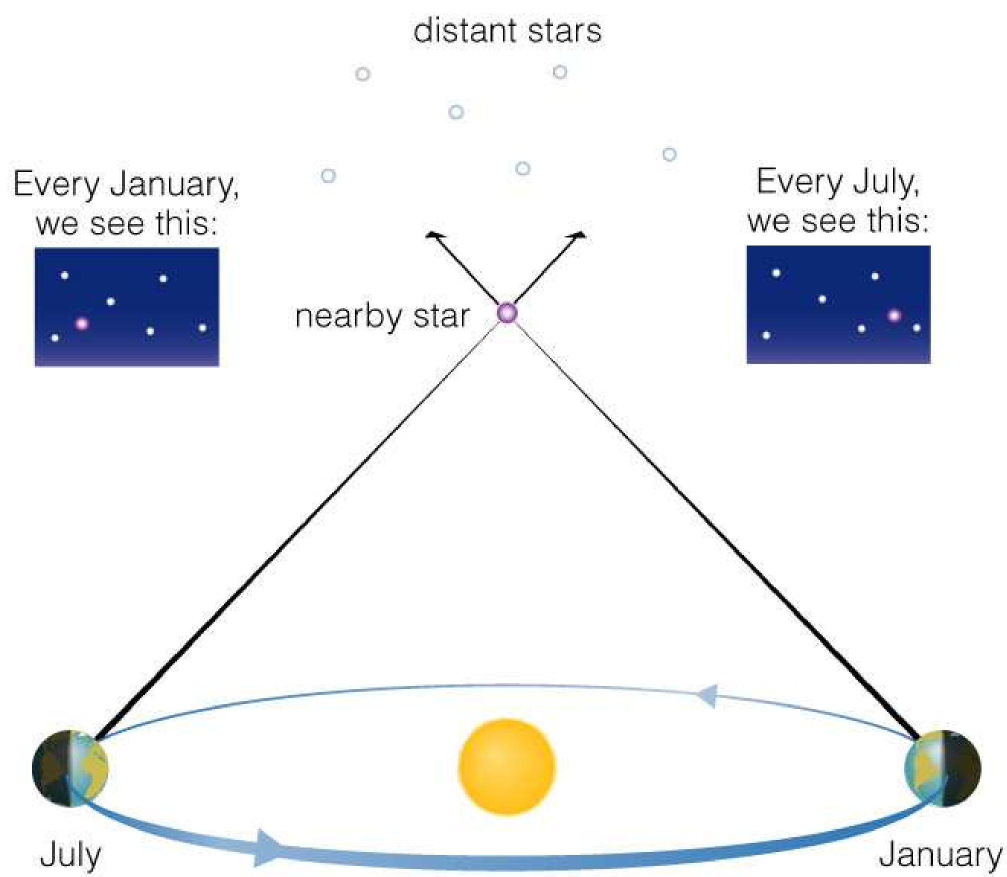


Fig 2.34

Another Distance Unit: parsec

- 1 parsec = distance at which a star would have a parallax of 1 arcsec

$$\text{Distance (in parsec)} = \frac{1}{\text{parallax (in arcsec)}}$$

- 1 parsec = 3.26 light years

Timekeeping: Day

- ***Sidereal Day:*** One rotation 23h 56m
  - “Stellar” day
- ***Solar Day:*** Noon to noon (24 hours)

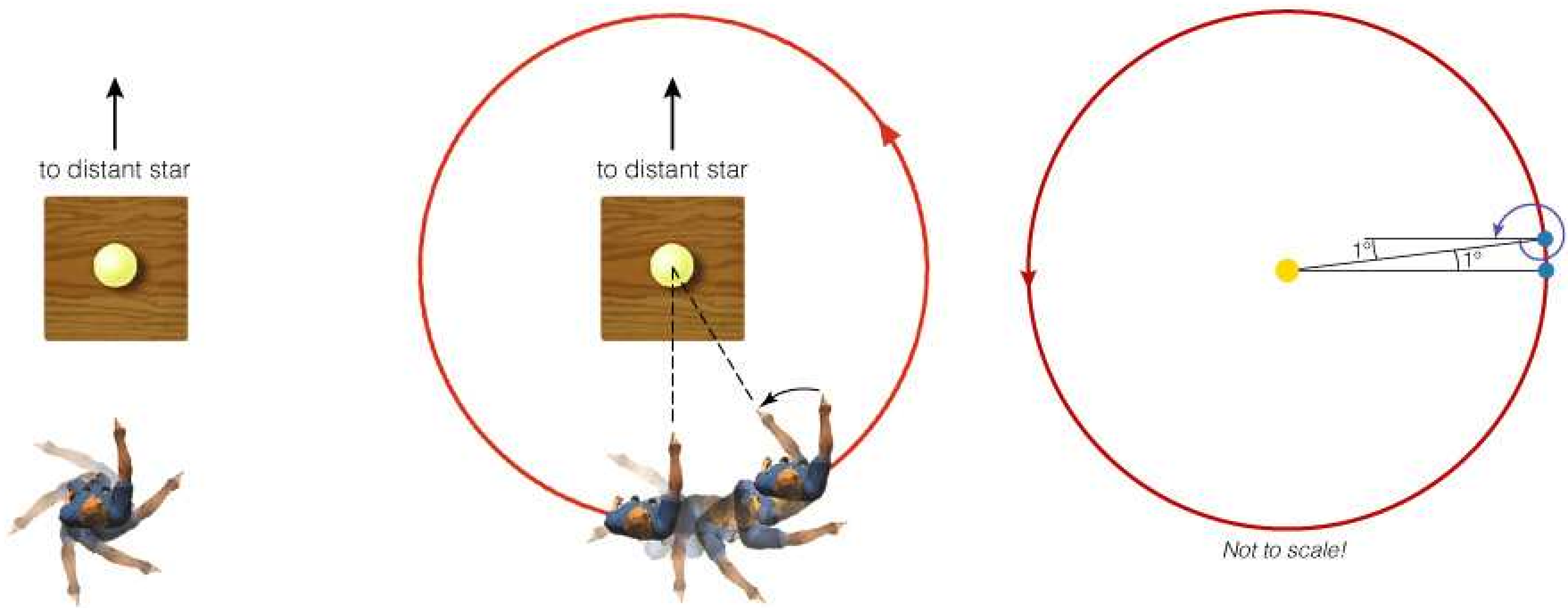


Fig S1.2

Timekeeping: Month

- ***Sidereal Month:*** Moon's orbital period (27.33 days)
- ***Synodic Month:*** New moon to New moon (29.5 days)

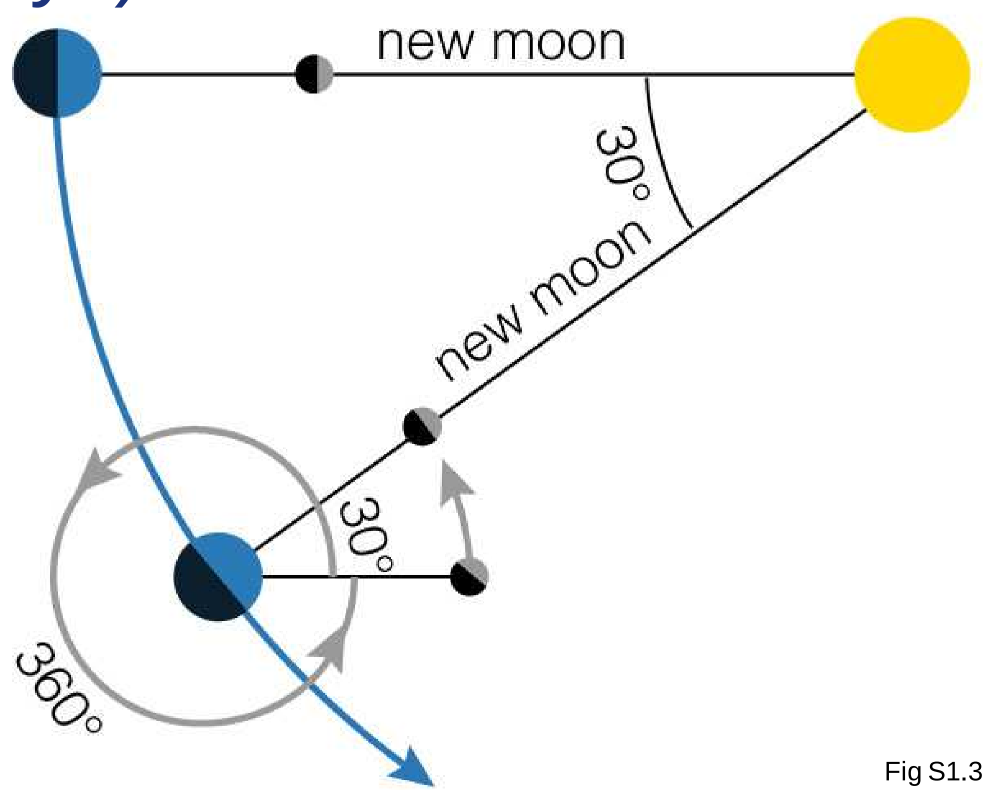
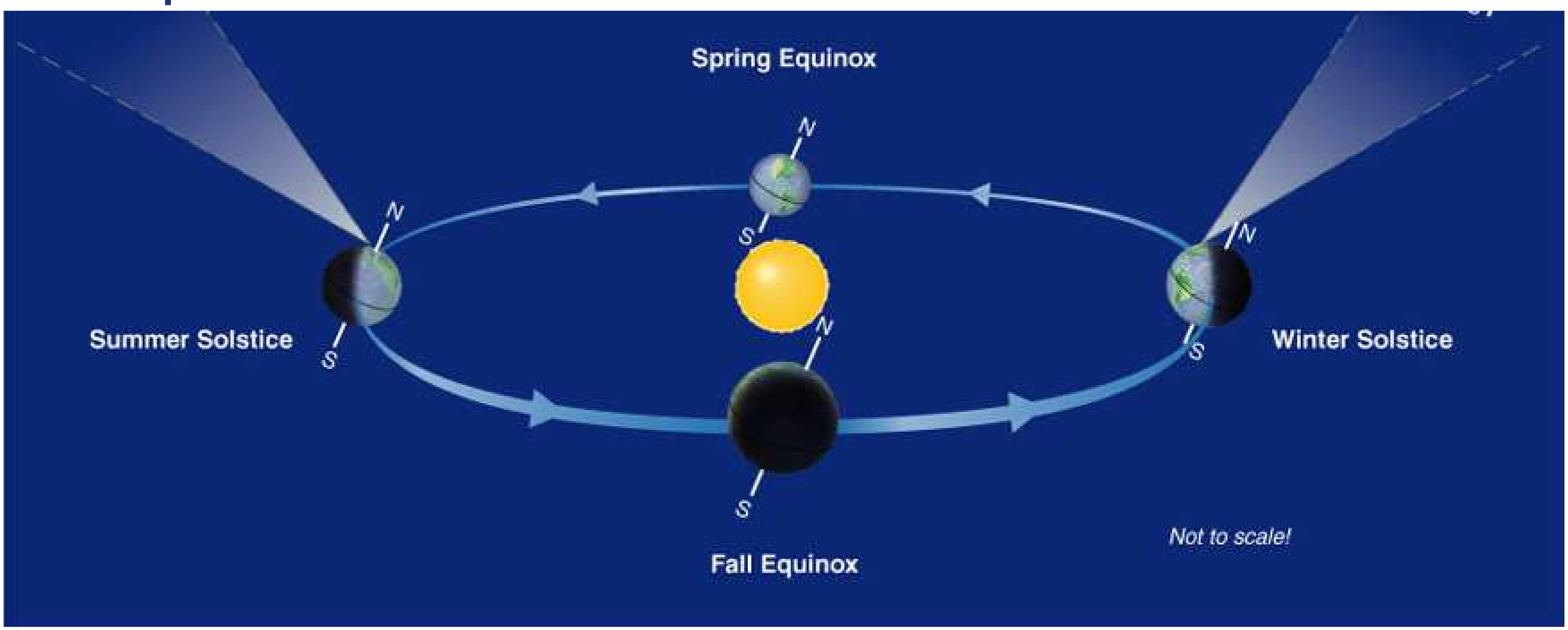


Fig S1.3

Timekeeping: Year

- ***Sidereal Year:*** Earth's orbital period
- ***Tropical Year:*** Cycle of seasons
  - 365 days 5 hours 49 minutes * reason for leap years
  - 20 minutes shorter than sidereal year due to precession



Timekeeping: Weeks

- Chosen to represent observable Solar System Objects
  - Sunday = Sun
  - Monday = Moon
  - Tuesday = Mars (Twisday, after Tyr)
  - Wednesday = Mercury
  - Thursday = Jupiter (Thor’s day)
  - Friday = Venus
  - Saturday = Saturn

Timekeeping: Time of Day

- Astronomers use UT or Universal Time
  - Observations across many time zones
  - UT = Time at longitude 0, Greenwich Mean Time
  - UT = EST + 5 hours or EDT + 4 hours

The Greenwich Meridian