Earth's Motions

What evidence do we have to provide evidence of Earth's motions and how do calculate its elliptical orbit?

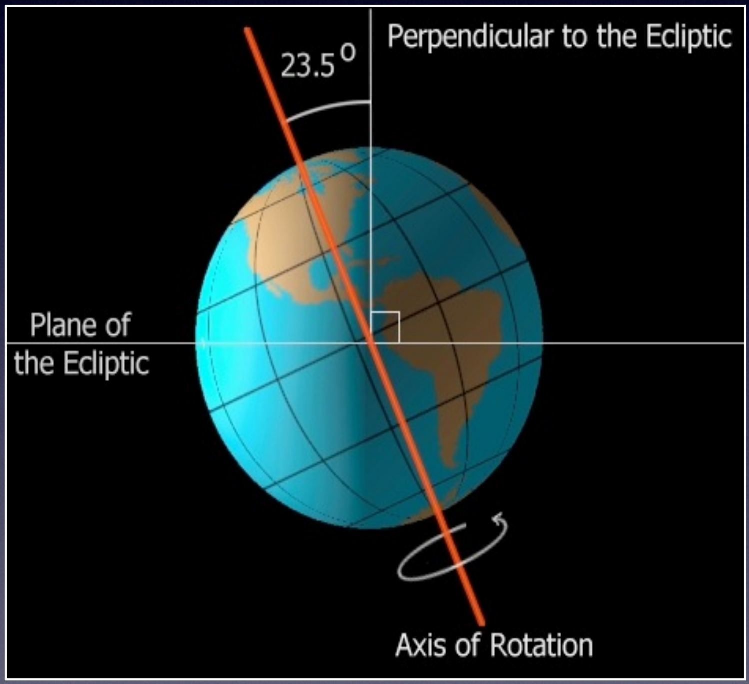
Earth's Motions

- Rotation - the movement of an object in a circular motion around a line of axis
- Period of Rotation - amount of time to make one complete rotation
    - Example: Earth rotates 360° in 24 hours

Earth’s Rotation

Earth's Motions

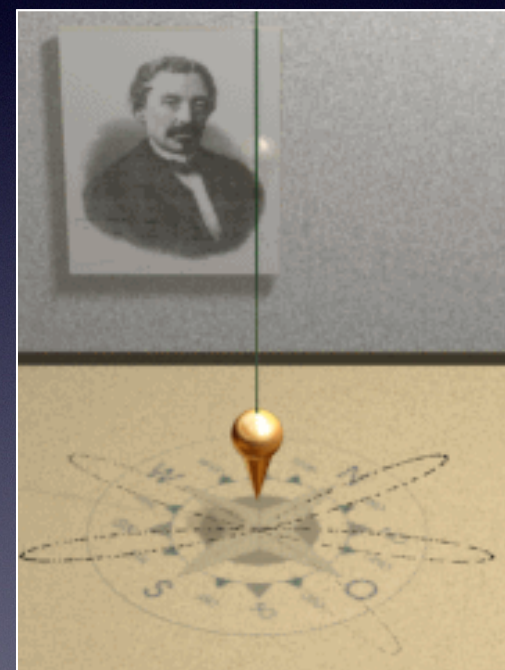
- Earth's axis of rotation is tilted 23.5°



Earth's Motions

Evidence of Rotation

- Foucault Pendulum - large pendulum that when allowed to swing freely changes its path due to Earth's rotation

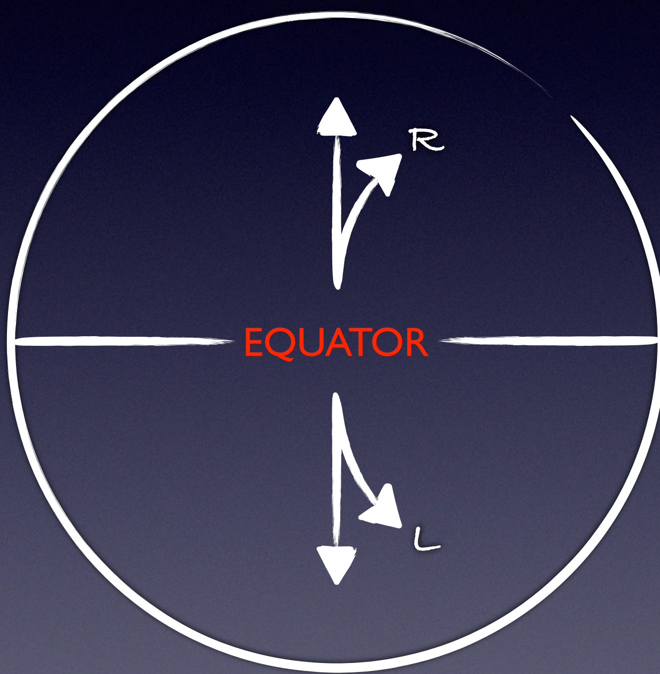


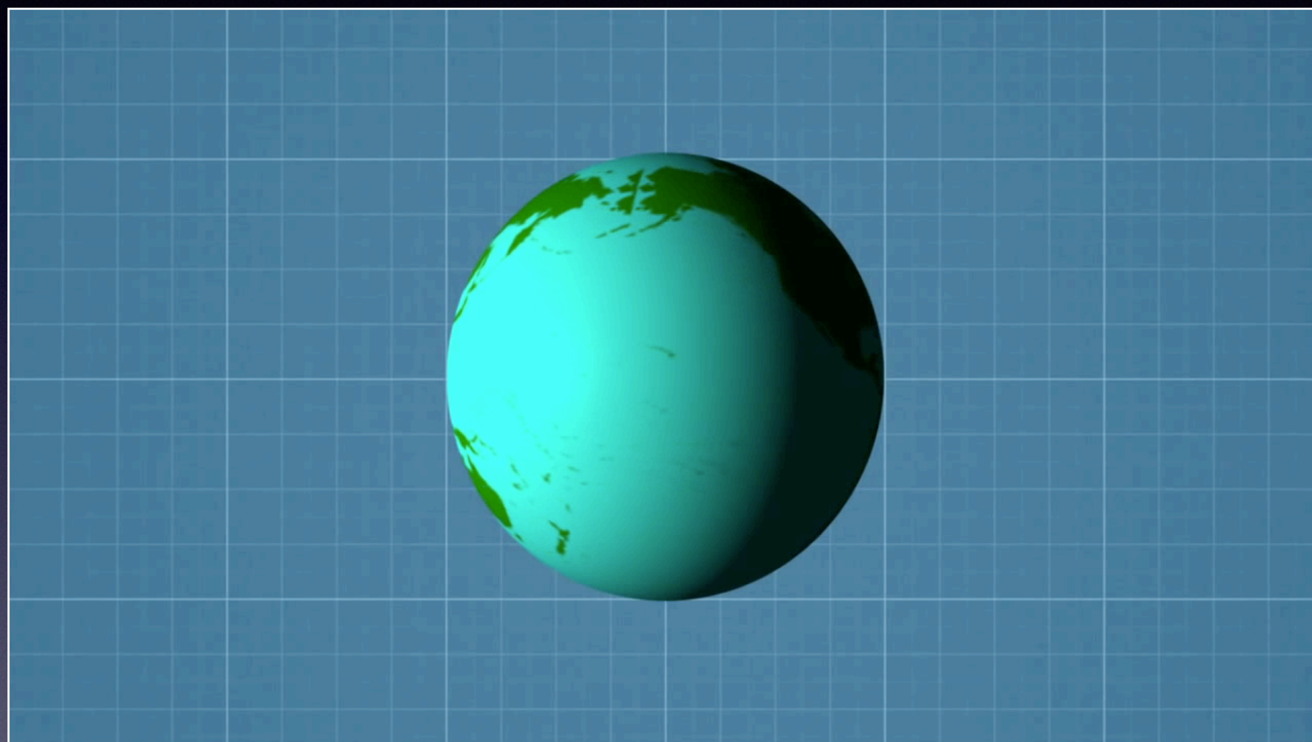
Foucault Pendulum

Earth's Motions

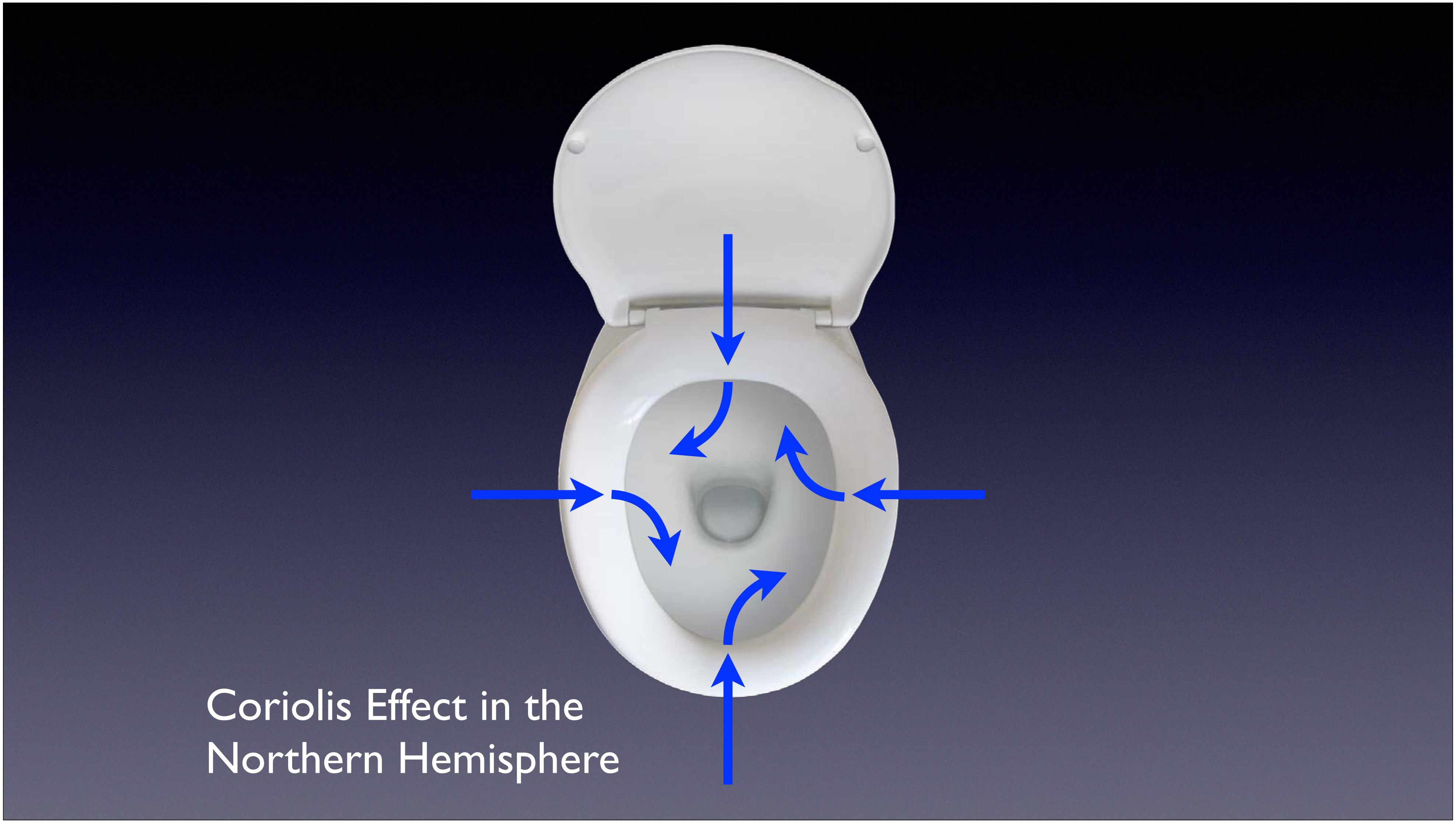
Evidence of Rotation

- <u>Coriolis Effect</u> - the tendency of all particles on Earth's surface to be deflected from a straight line
  - N. Hemisphere to the right
  - S. Hemisphere to the left

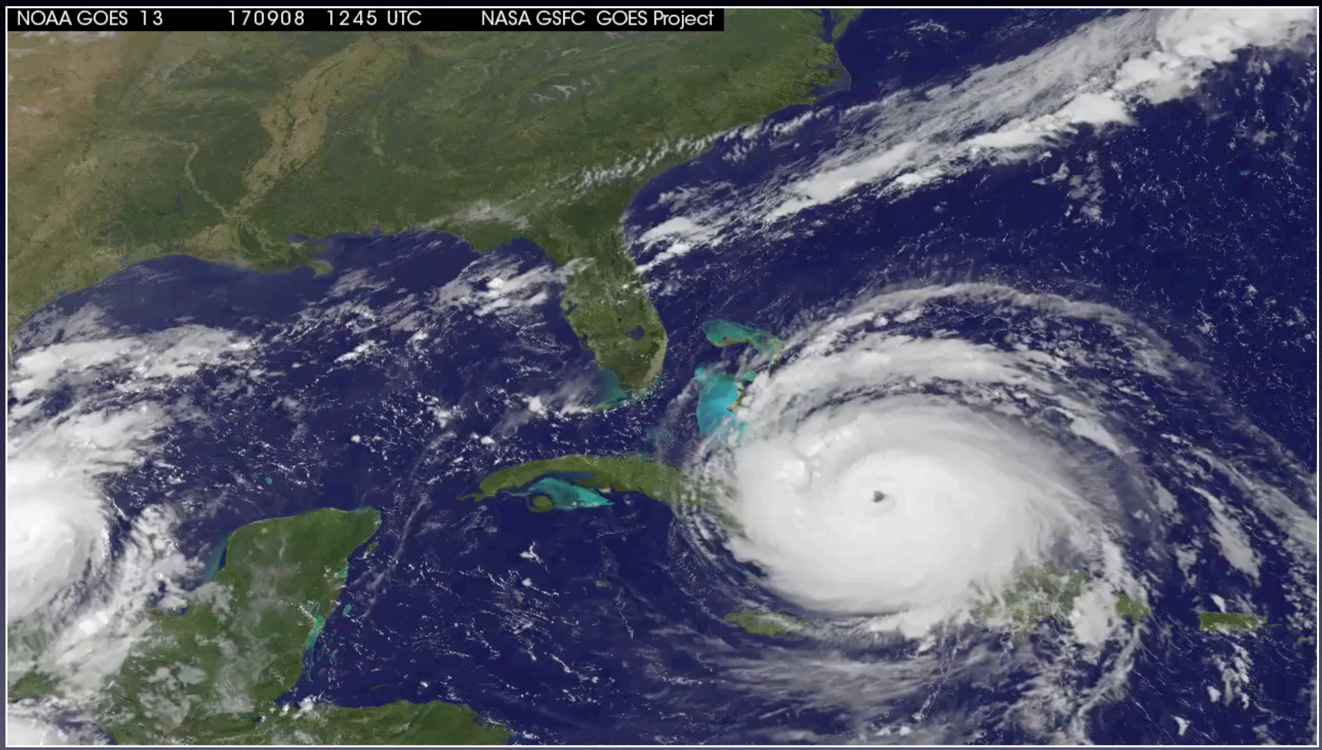




Coriolis Effect


Coriolis Effect in the
Northern Hemisphere

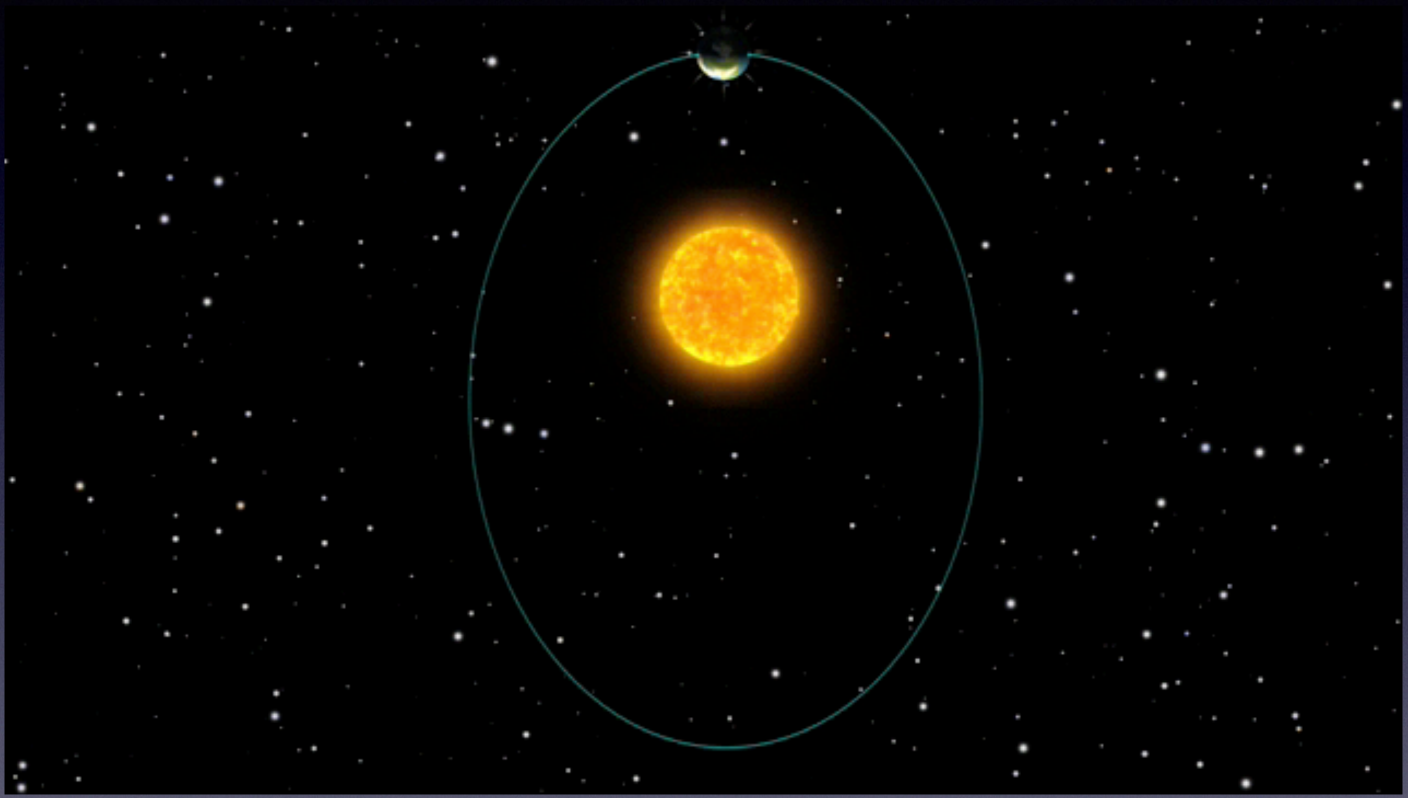
Coriolis Effect in the Southern Hemisphere



Hurricanes in the Northern Hemisphere

Earth's Motions

- Revolution - the motion of one body around another in an orbit
- Period of Revolution - the amount of time required to orbit the Sun one time
    - Example: Earth orbits the Sun in 365.25 days



Earth's Revolution

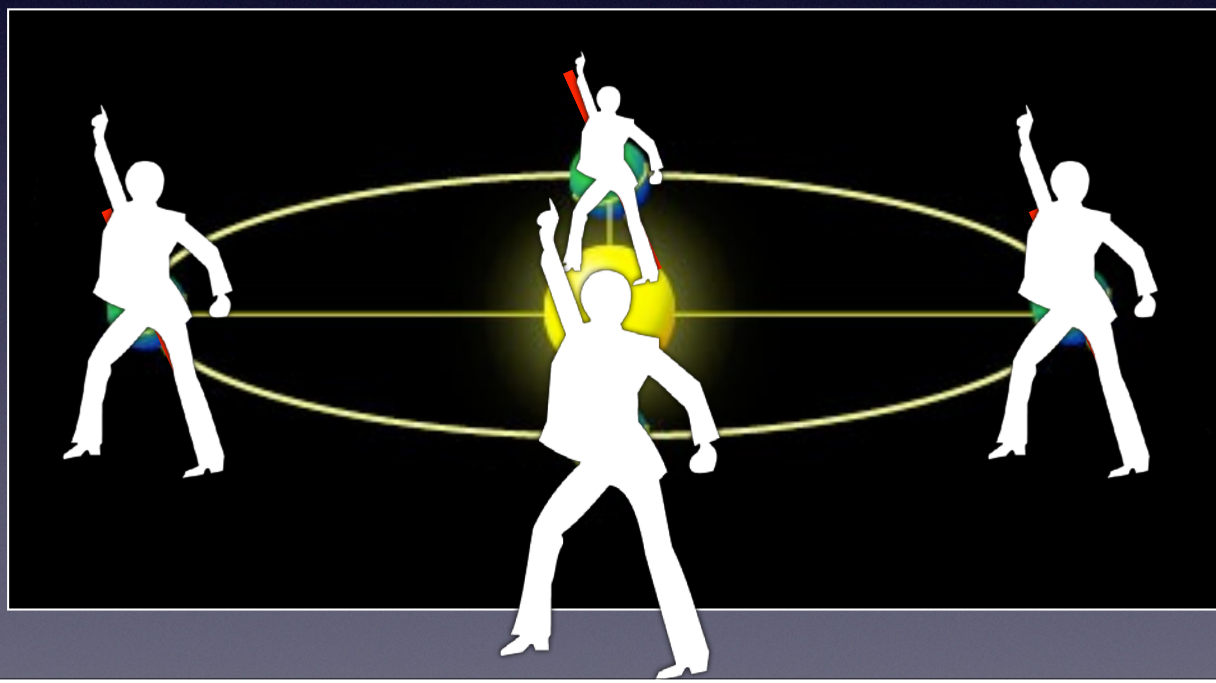
Earth's Motions

Evidence of Revolution

- Parallelism of Earth's Axis - Earth's tilted axis of 23.5° is always pointed to the same location in the sky giving us our different seasons

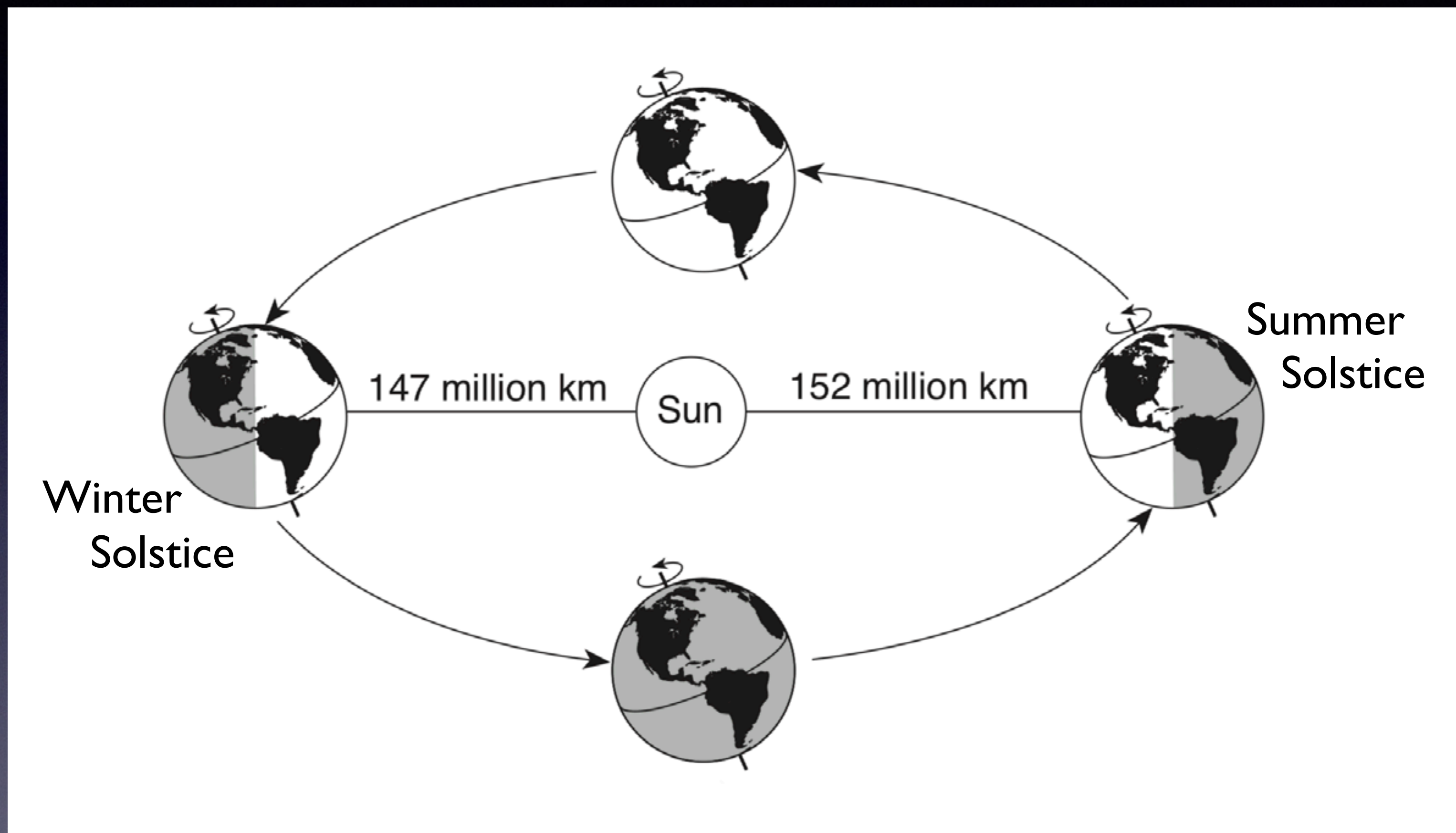
Earth's Motions

Evidence of Revolution



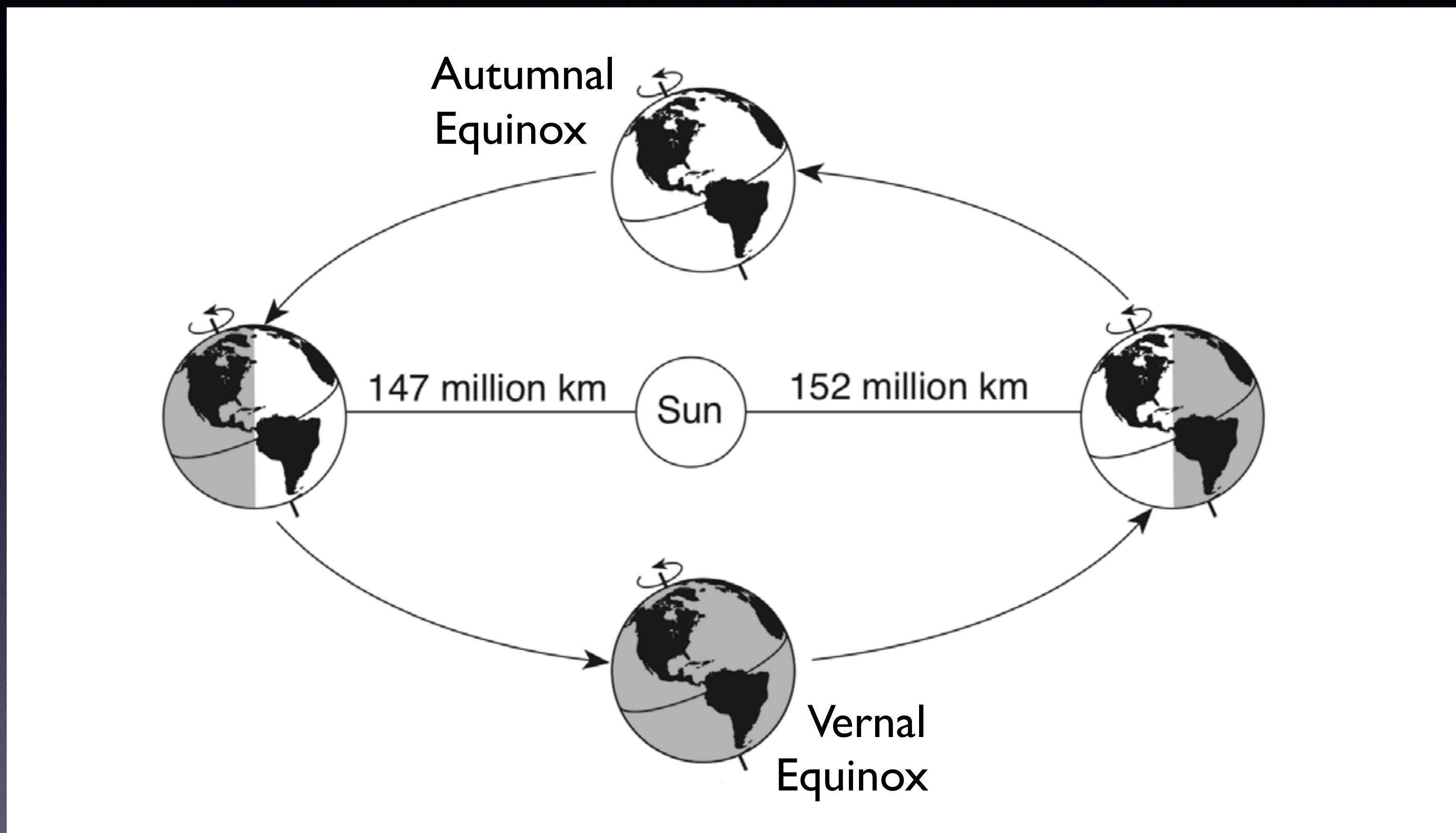
Earth's Motions

- Winter Solstice - first day of winter [N. Hemisphere] when the Earth leans away from the Sun
  - Approximate Date: December 21
- Summer Solstice - first day of summer [N. Hemisphere] when the Earth leans towards the Sun
  - Approximate Date: June 21


Summer
Solstice
147 million km
Sun
152 million km
Winter
Solstice

Earth's Motions

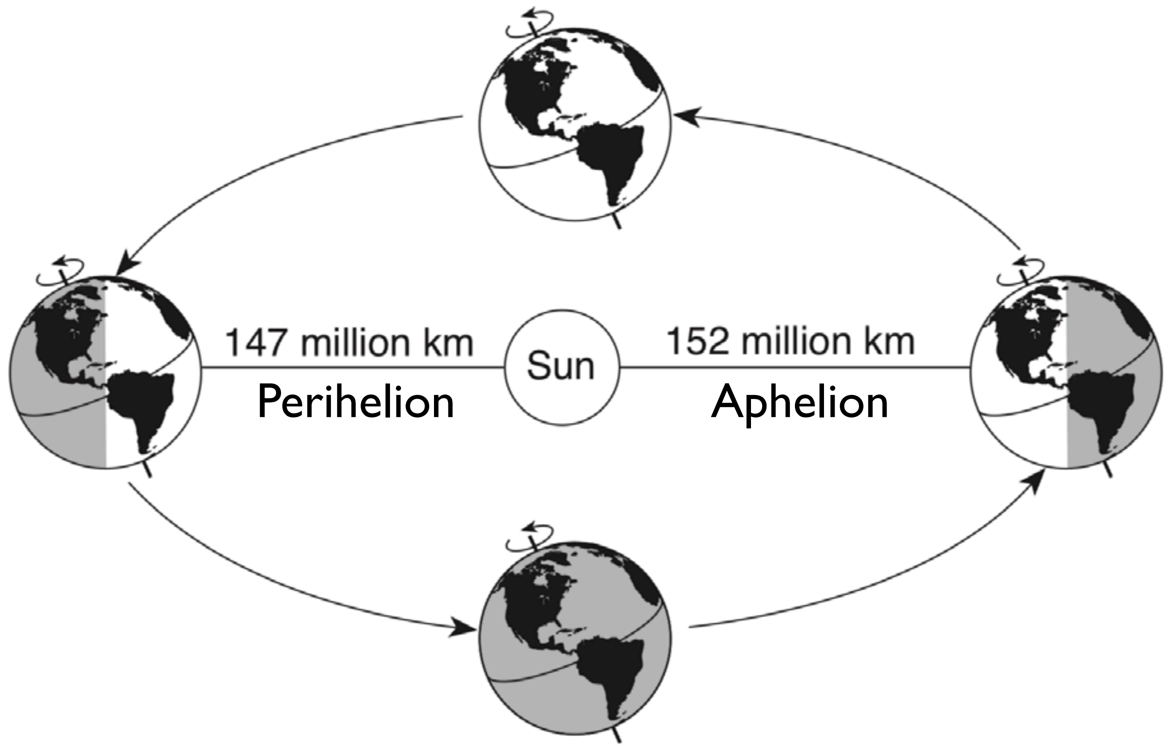
- Vernal Equinox - first day of spring [N. Hemisphere] when there are equal amounts of day and night
  - Approximate Date: March 21
- Autumnal Equinox - first day of fall [N. Hemisphere] when there are equal amounts of day and night
  - Approximate Date: September 21


Autumnal
Equinox
147 million km
Sun
152 million km
Vernal
Equinox

Kepler

Earth's Motions

- Ellipse - the oval shape of a planet's orbits
- Perihelion - the point in the orbit of Earth at which it is closest to the sun
  - Distance: 147,000,000 km
- Aphelion - the point in the orbit of Earth at which it is farthest from the sun
  - Distance: 152,000,000 km

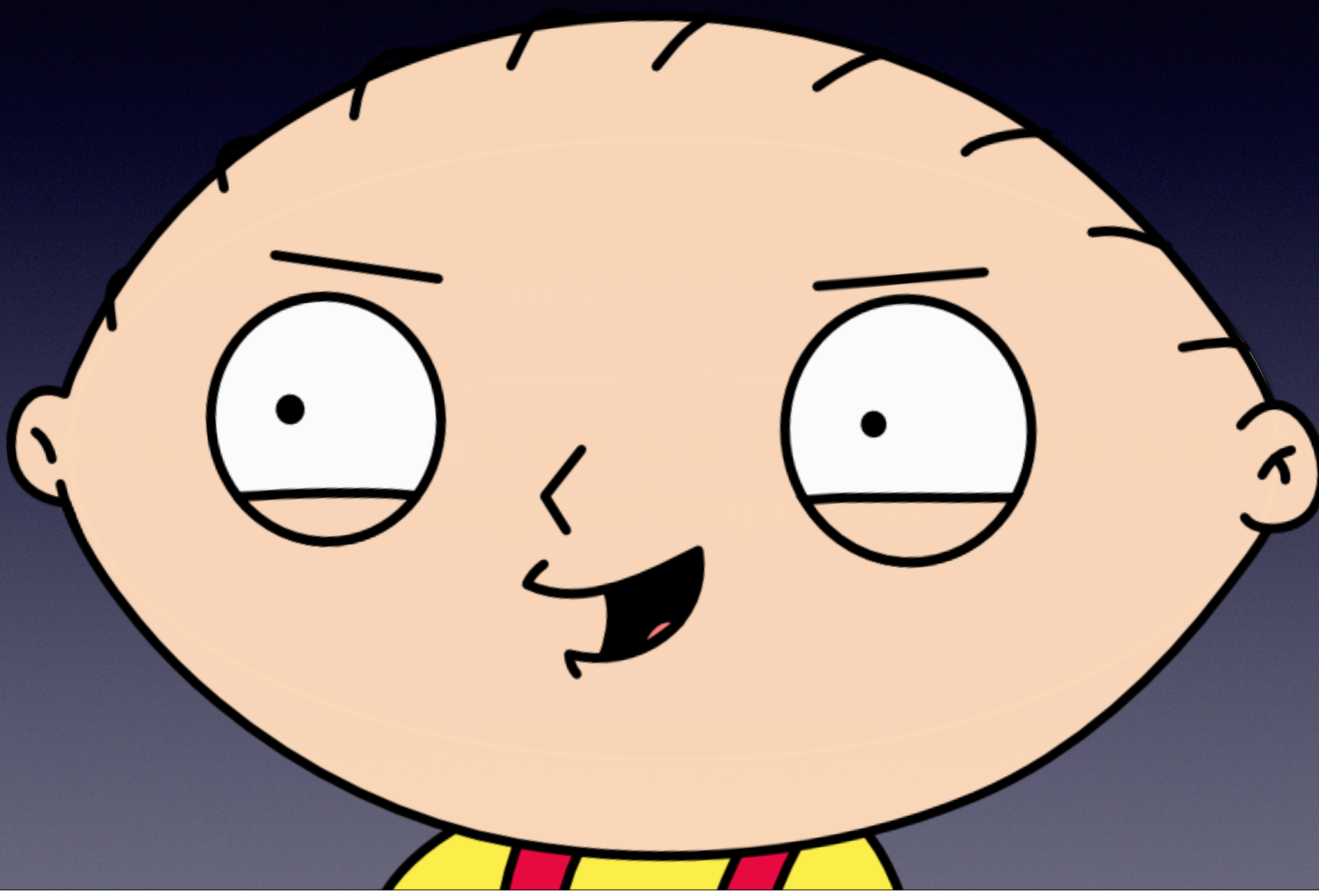

147 million km
Sun
152 million km
Perihelion
Aphelion

Earth's Motions

Parts of an Ellipse

- Eccentricity - the degree of "ovalness" of an ellipse
    - Eccentricity of a perfect circle is 0
    - Eccentricity of a flat line is 1
- Foci - two fixed center points of an ellipse
- Major Axis - the longest straight line distance across an ellipse

Earth’s Motions



Earth's Motions

Calculate Eccentricity

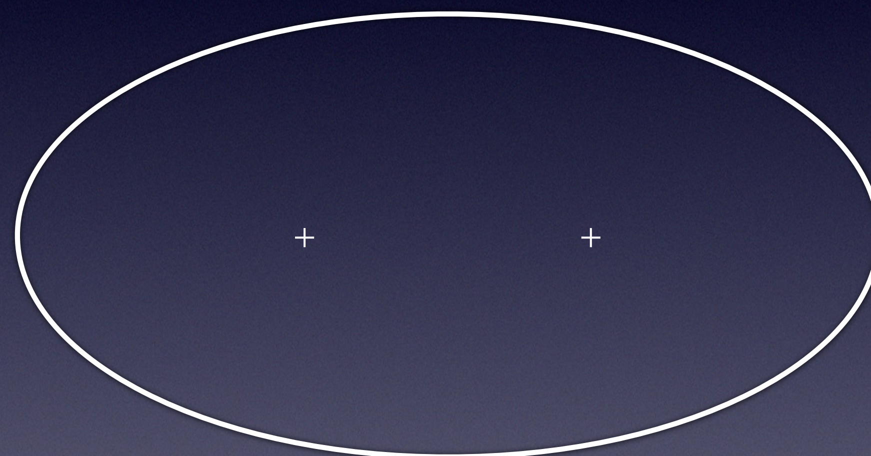
- Use the formula from the E.S.R.T

$$\text{eccentricity} = \frac{\text{distance between foci}}{\text{length of major axis}}$$

Earth's Motions

Calculate the eccentricity

$$\text{eccentricity} = \frac{\text{distance between foci}}{\text{length of major axis}}$$



Earth’s Motions

Celestial Object	Mean Distance from Sun (million km)	Period of Revolution (d=days) (y=years)	Period of Rotation at Equator	Eccentricity of Orbit	Equatorial Diameter (km)	Mass (Earth = 1)	Density (g/cm^3)
SUN	—	—	27 d	—	1,392,000	333,000.00	1.4
MERCURY	57.9	88 d	59 d	0.206	4,879	0.06	5.4
VENUS	108.2	224.7 d	243 d	0.007	12,104	0.82	5.2
EARTH	149.6	365.26 d	23 h 56 min 4 s	0.017	12,756	1.00	5.5
MARS	227.9	687 d	24 h 37 min 23 s	0.093	6,794	0.11	3.9
JUPITER	778.4	11.9 y	9 h 50 min 30 s	0.048	142,984	317.83	1.3
SATURN	1,426.7	29.5 y	10 h 14 min	0.054	120,536	95.16	0.7
URANUS	2,871.0	84.0 y	17 h 14 min	0.047	51,118	14.54	1.3
NEPTUNE	4,498.3	164.8 y	16 h	0.009	49,528	17.15	1.8
EARTH’S MOON	149.6 (0.386 from Earth)	27.3 d	27.3 d	0.055	3,476	0.01	3.3