

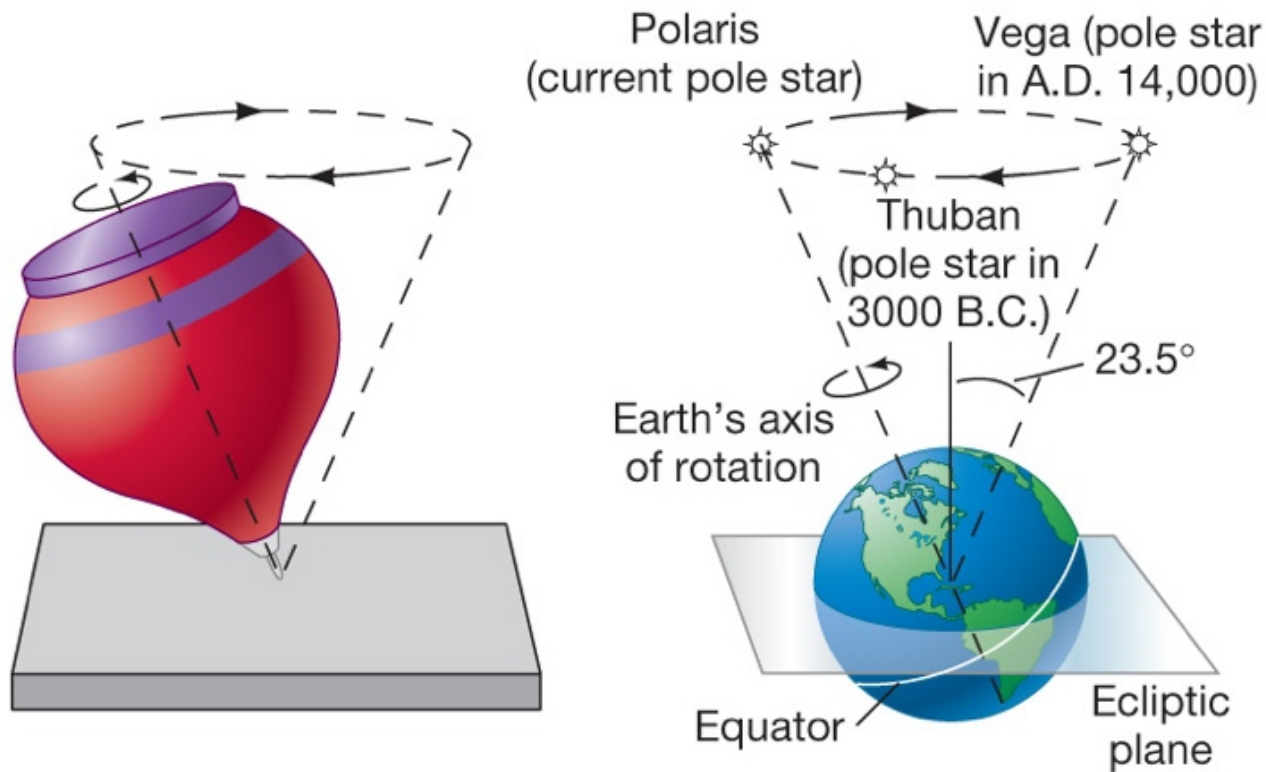
Lecture 04 – 22 January 2009



**Homework 01 is out
Due on Tuesday,
27 Jan at 11:59 pm**

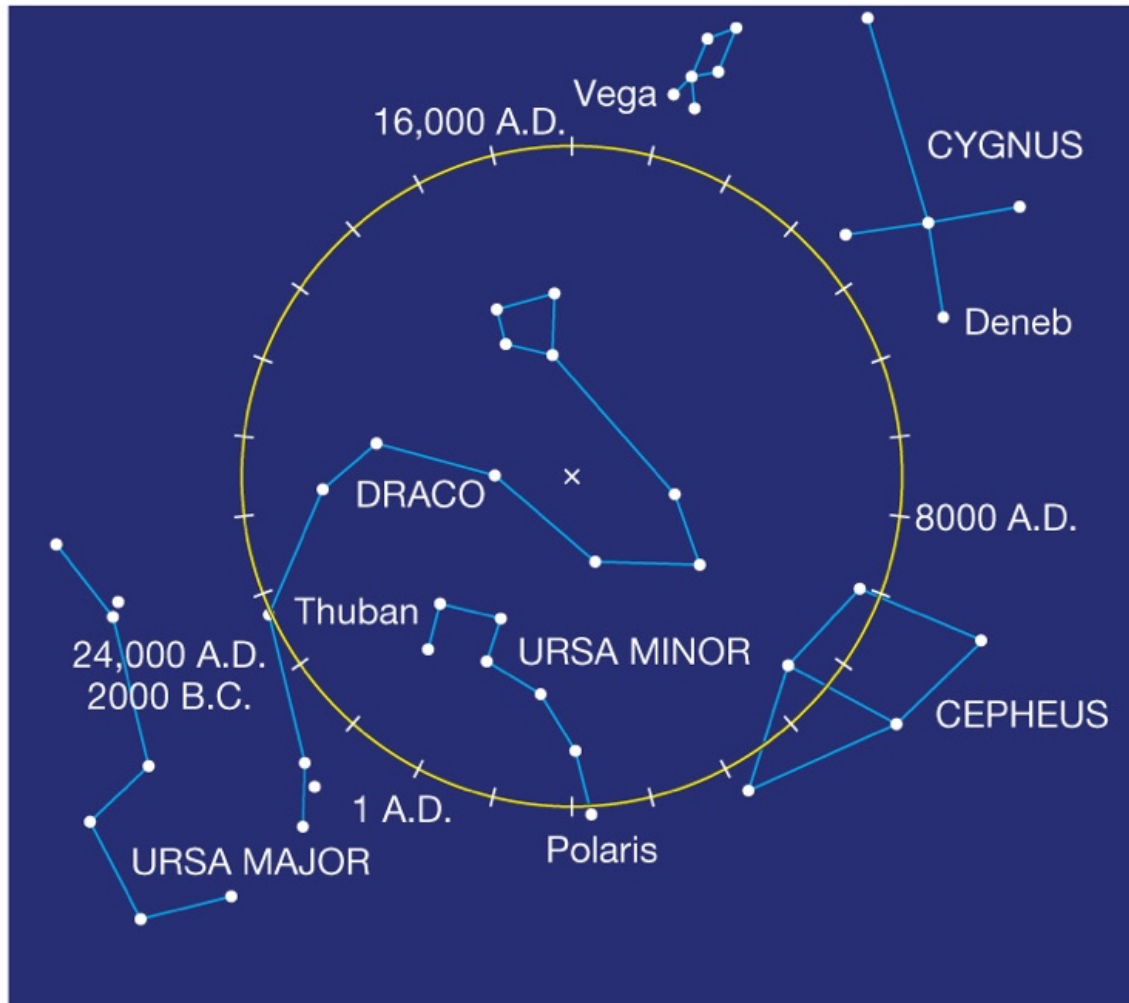
- **SCIENCE TOPICS:**
Darkness and Light, Winter and Summer (continued)
Geocentric and Heliocentric models
- **READING**
E2–E4, p.1–22
Ch. 1, Sec 1.1–1.3
- **EXTRA PRACTICE:**
p.22 Review: 1-2, 11-14
p.23 Self-Test: 2, 4–8, 11–15
p.23 Problems: 6–9

Precession of the equinoxes



The Earth's rotation axis **precesses** with a period of 26,000 years. At the moment it points close to Polaris.

Polaris not always the North Star

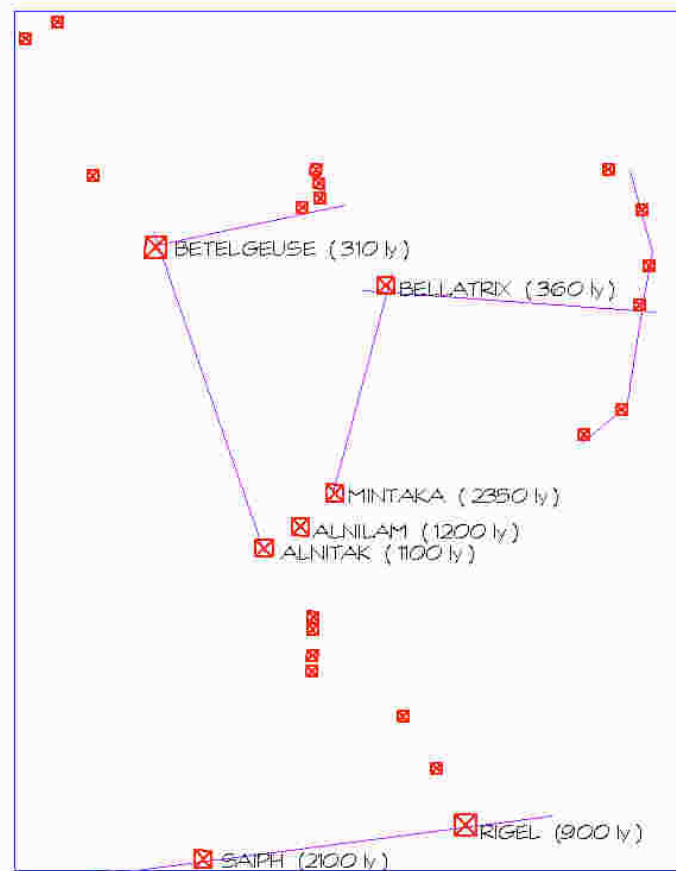


Astrological charts were devised in 131 BC.

What fraction of a precession cycle are they off?

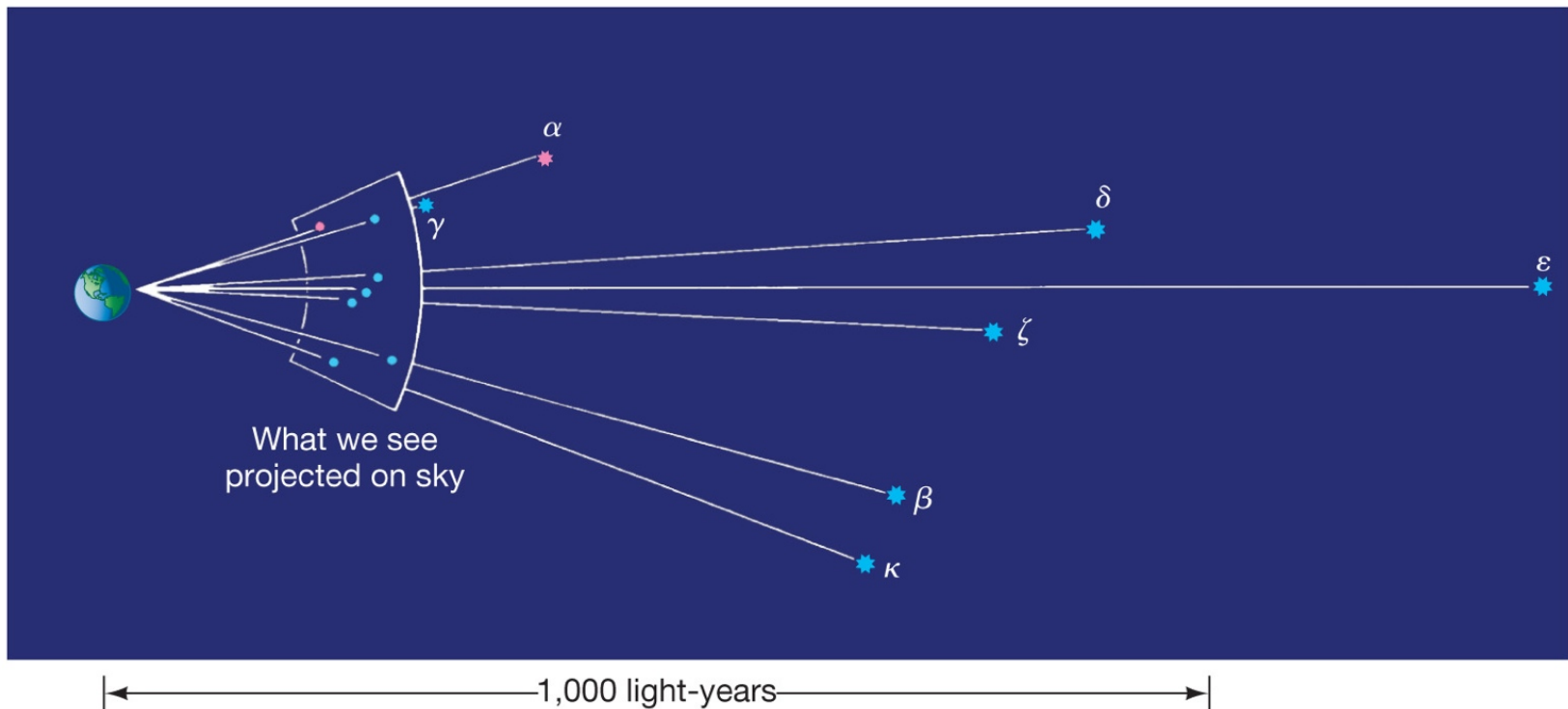
How many constellations does that offset correspond to?

Orion the Hunter



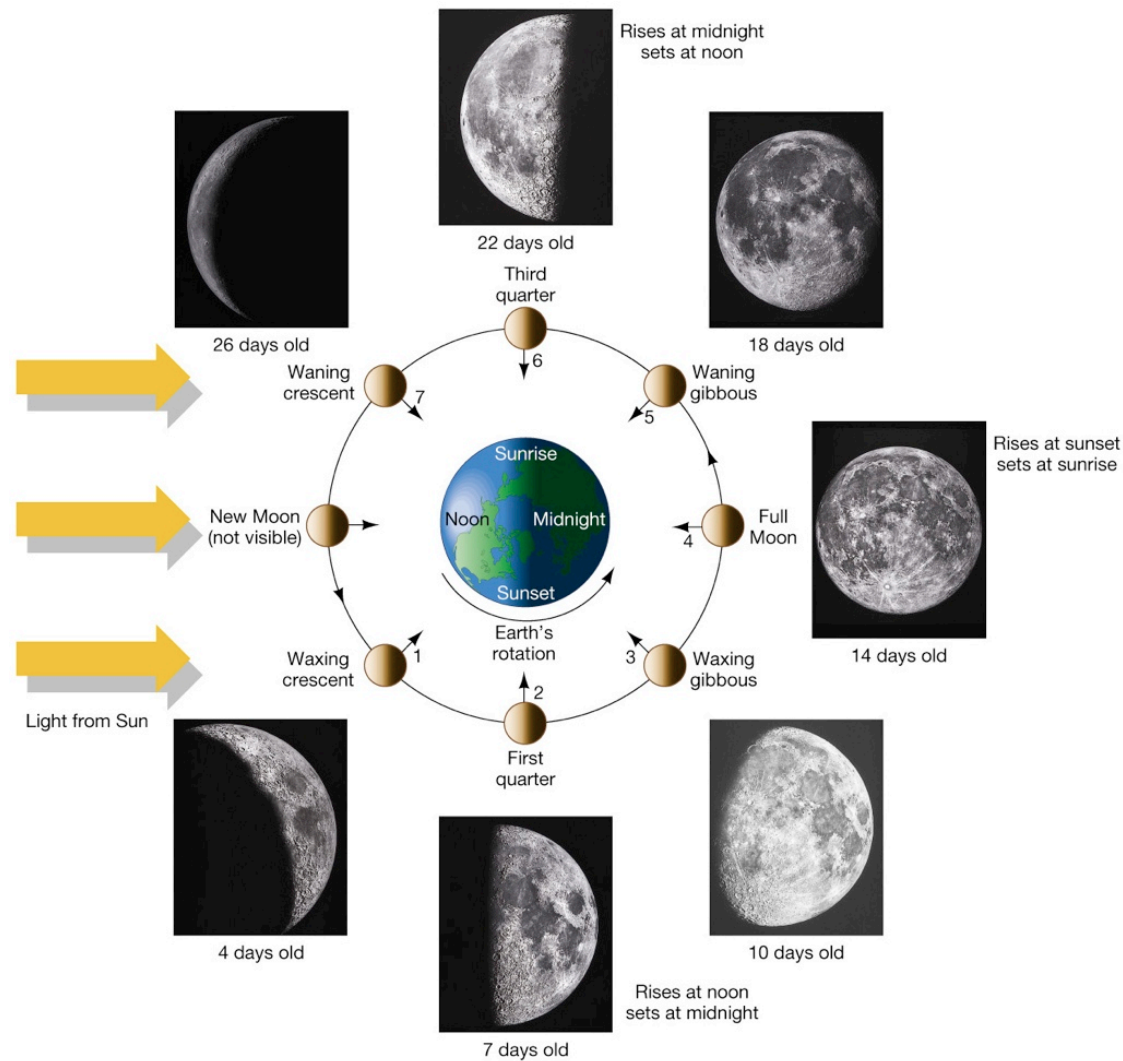
Was in love with Merope (one of the Pleiades), who did not love him back. Stepped on Scorpius...
Placed by the gods next to the river Eridanus with his two dogs (Canis Major, Canis Minor).

Stars in a constellation need not be close to each other. They are only **projected close to each other**

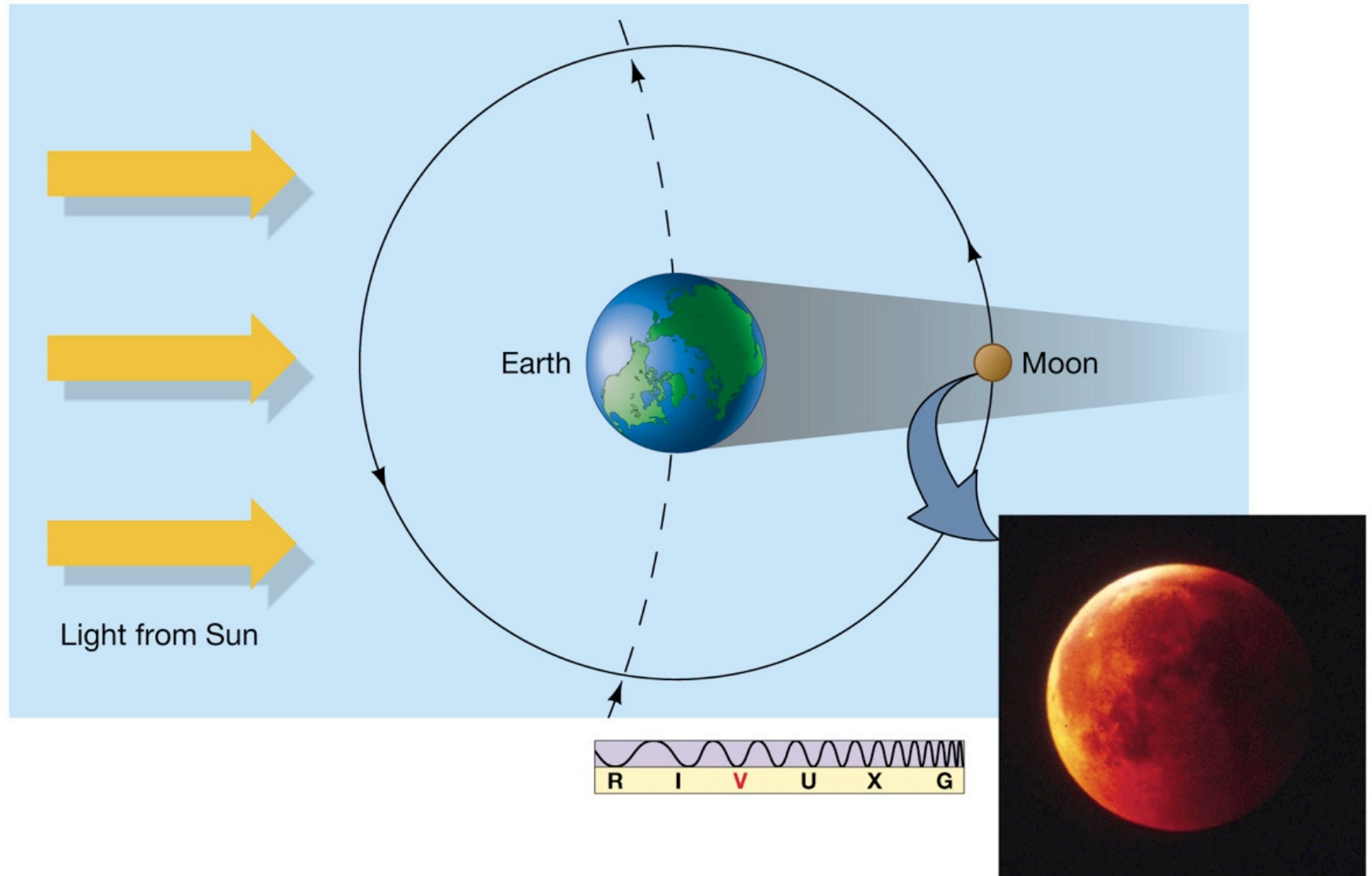


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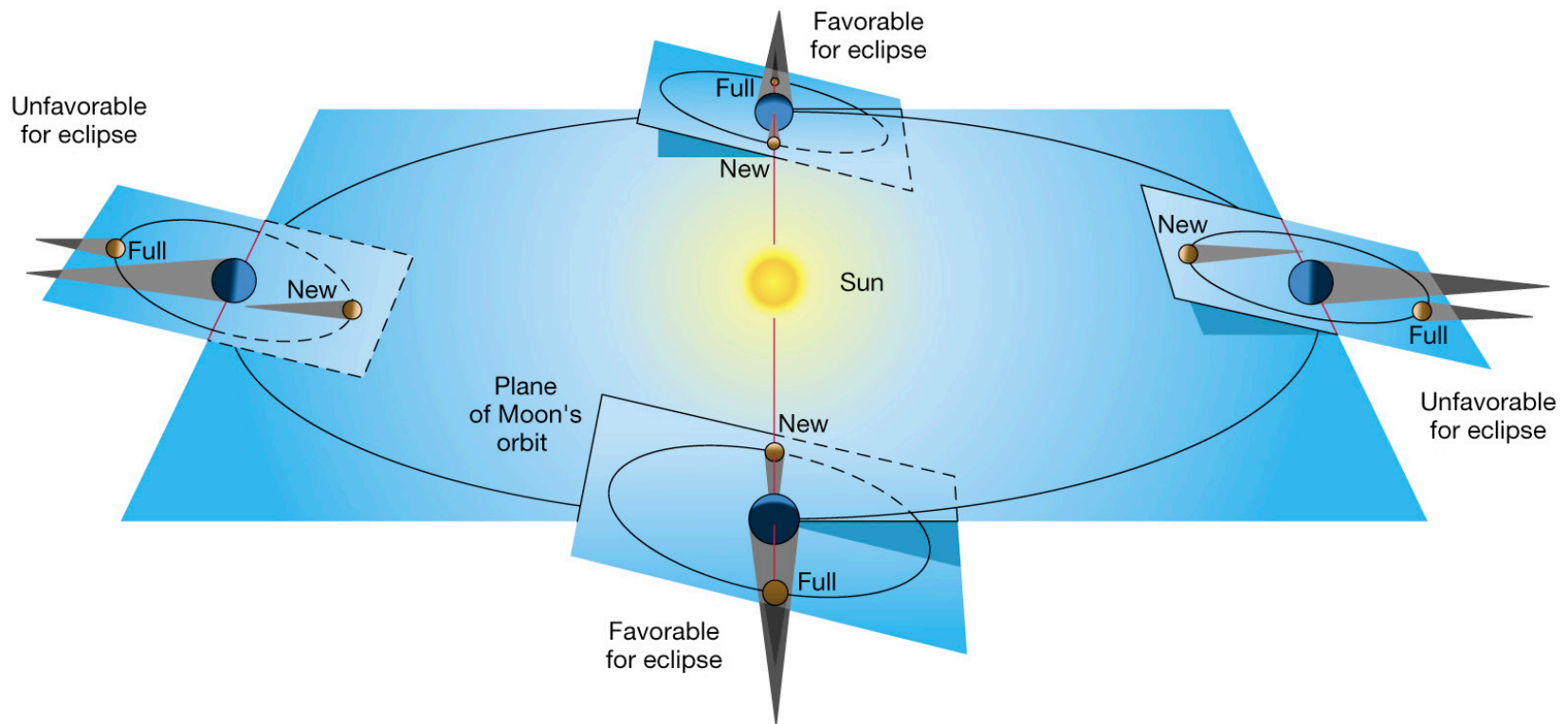
4. What causes the phases of the moon?



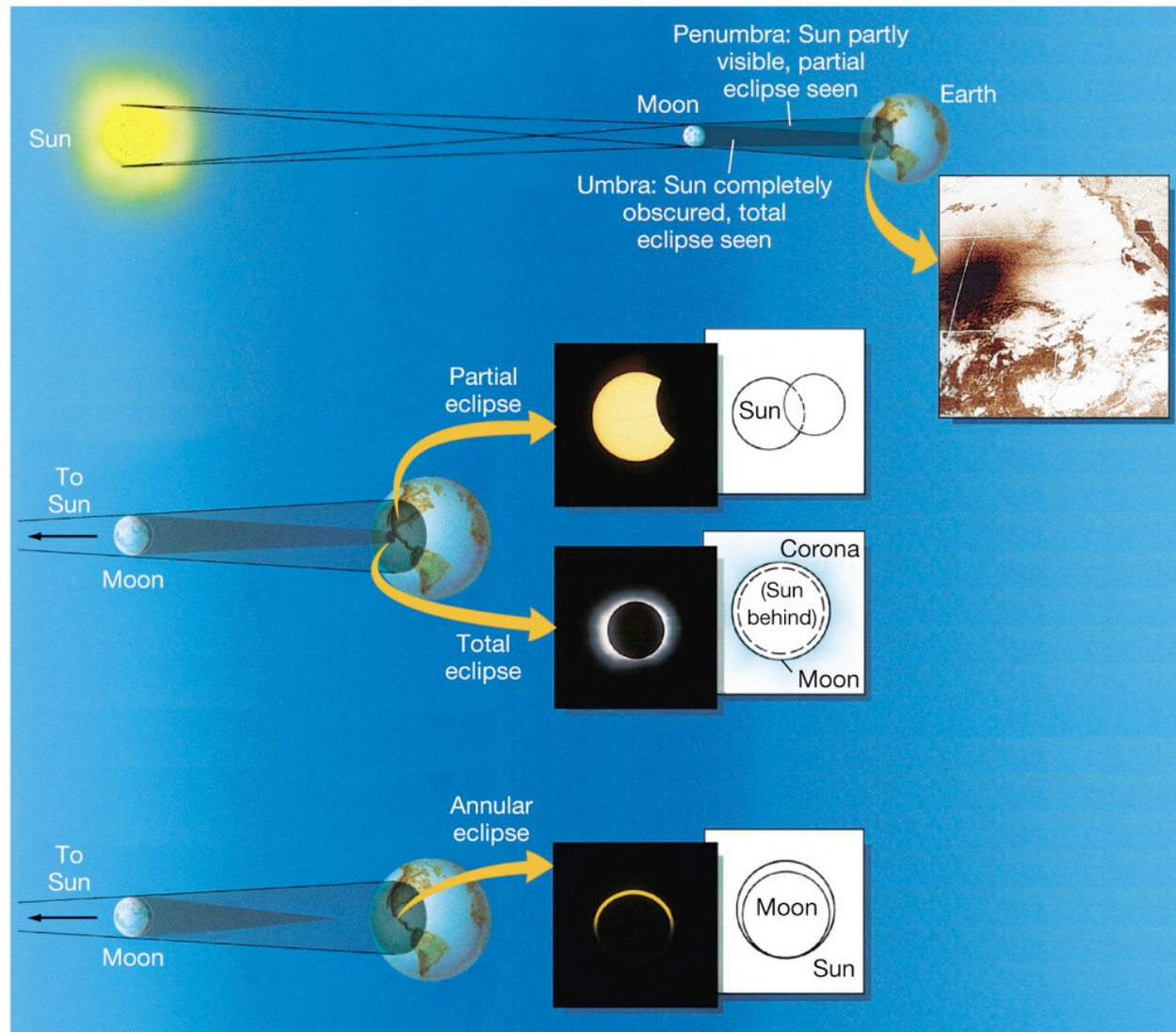
5. Solar and lunar eclipses



Geometry of eclipses



Solar eclipses



Solar Eclipse seen from the ISS



Solar corona seen during a total eclipse of the Sun.

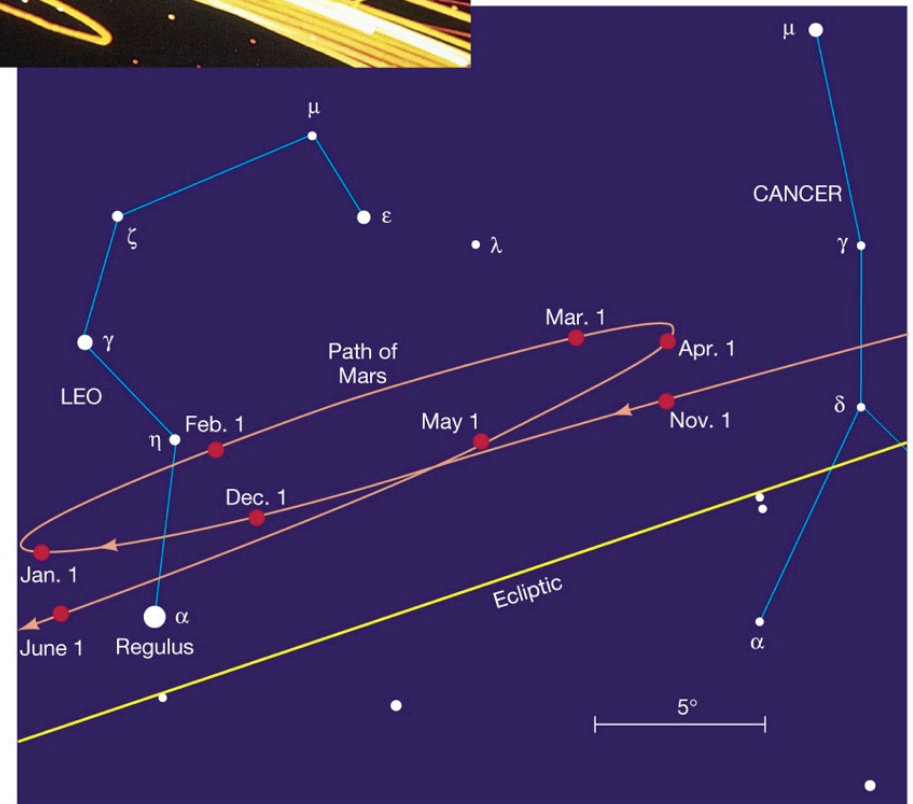


Motion of Planets in the Sky

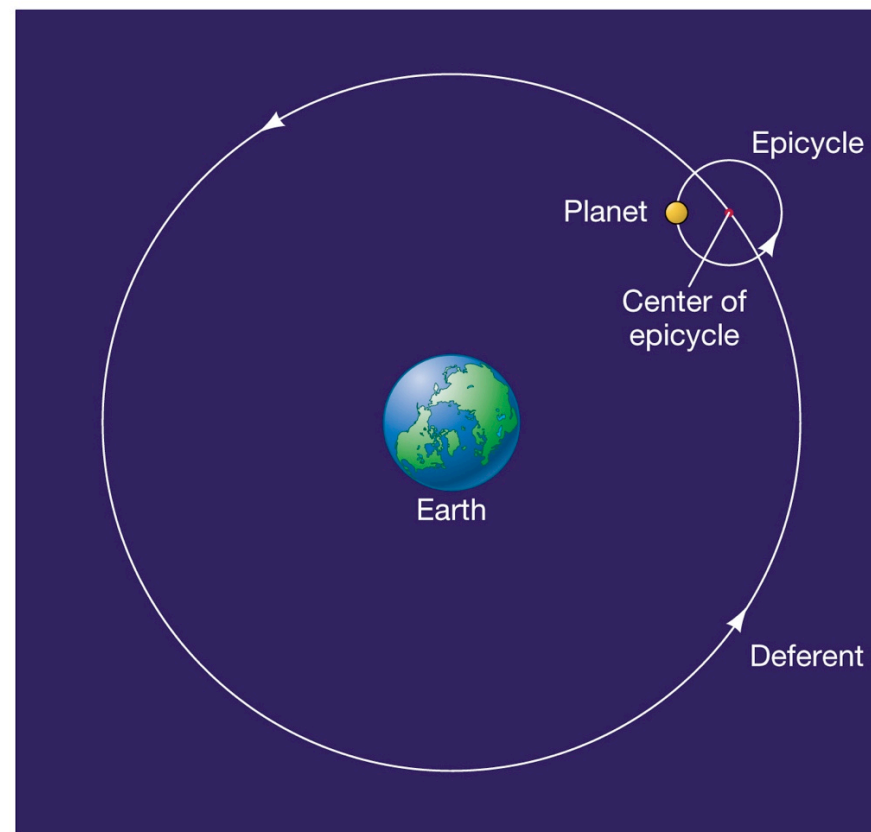
Motion of Planets in the Sky



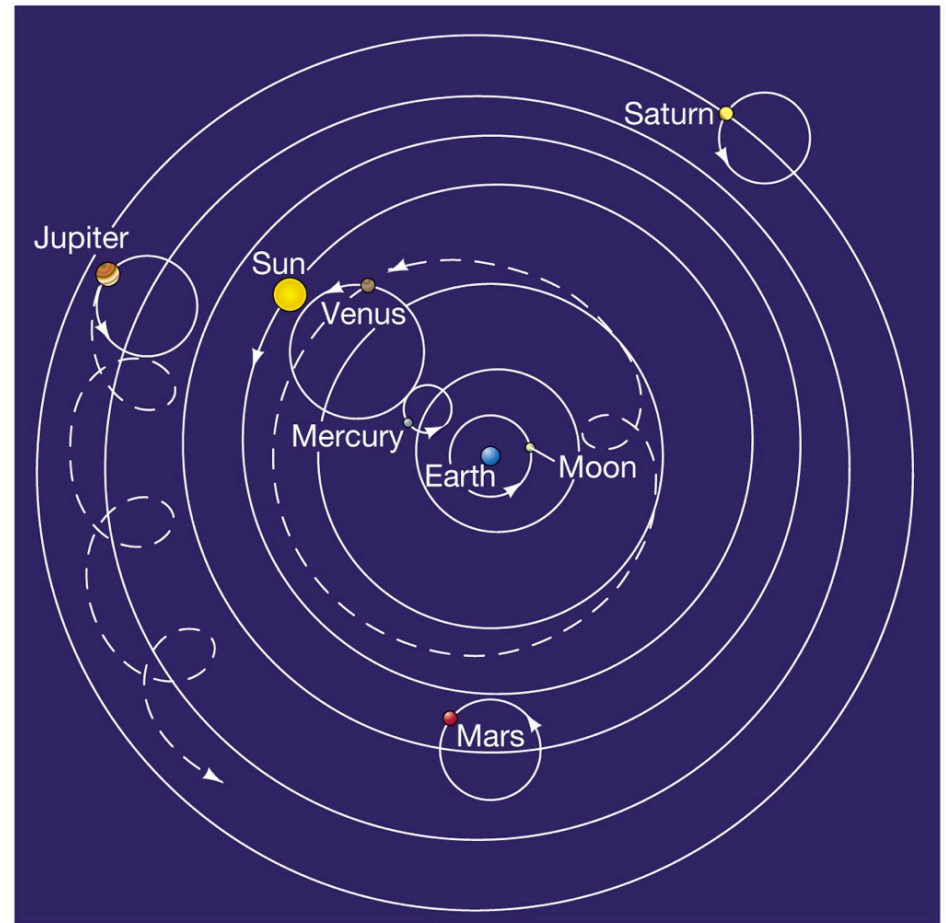
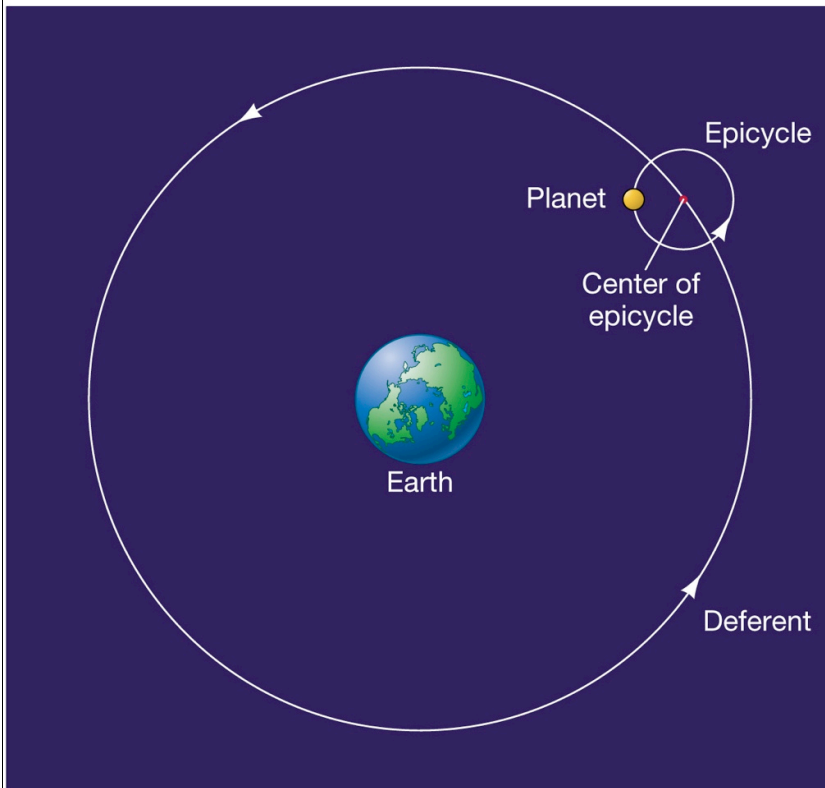
- They wander relative to the stars (found at slightly different places from one night to the next).
- Retrograde motion
- Brightness variations
- Some planets (Mercury, Venus) exhibit phases (cf, lunar phases)



The Geocentric model of the Solar System, according to Ptolemy



The Geocentric model of the Solar System, according to Ptolemy



Ptolemy

- Silent 'P'
- Around 85 - 160AD
Roman, lived in Egypt
- Earth is the centre
of the Universe
(geocentric model)
- Accepted until
Nicolaus Copernicus

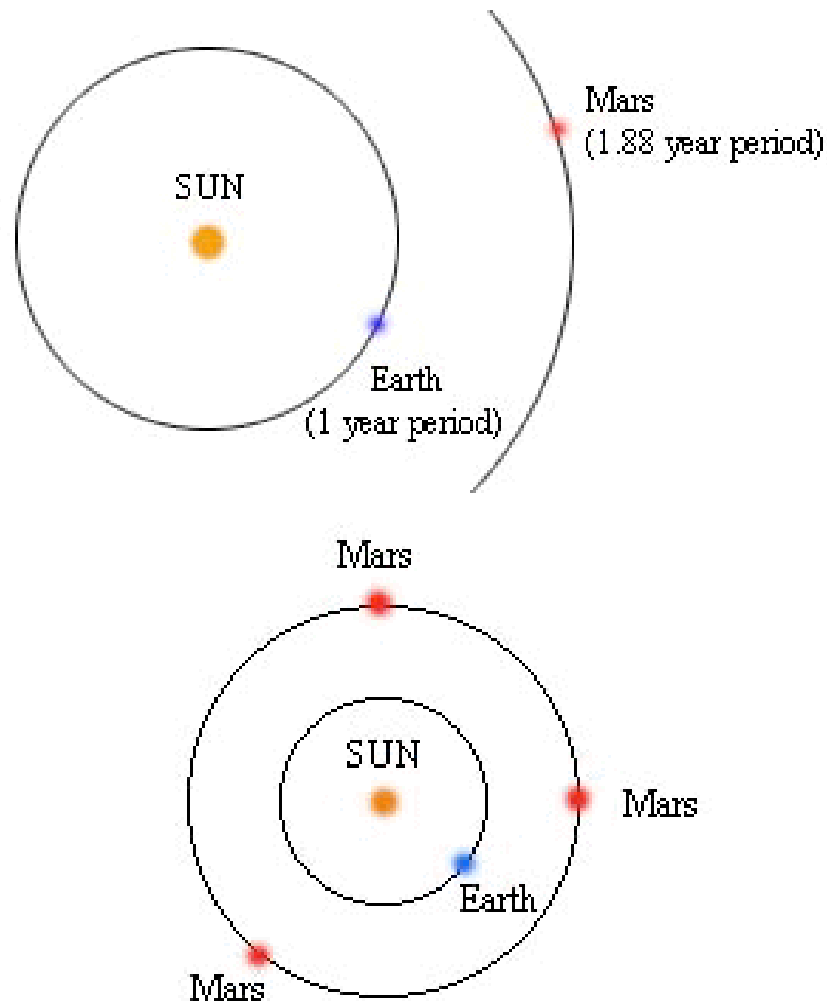


Nicolaus Copernicus

- 1473-1543
- De revolutionibus orbium coelestium (On the Revolutions of the Celestial Spheres), published 1543
- Put the Sun at the centre of the Universe (heliocentric model)

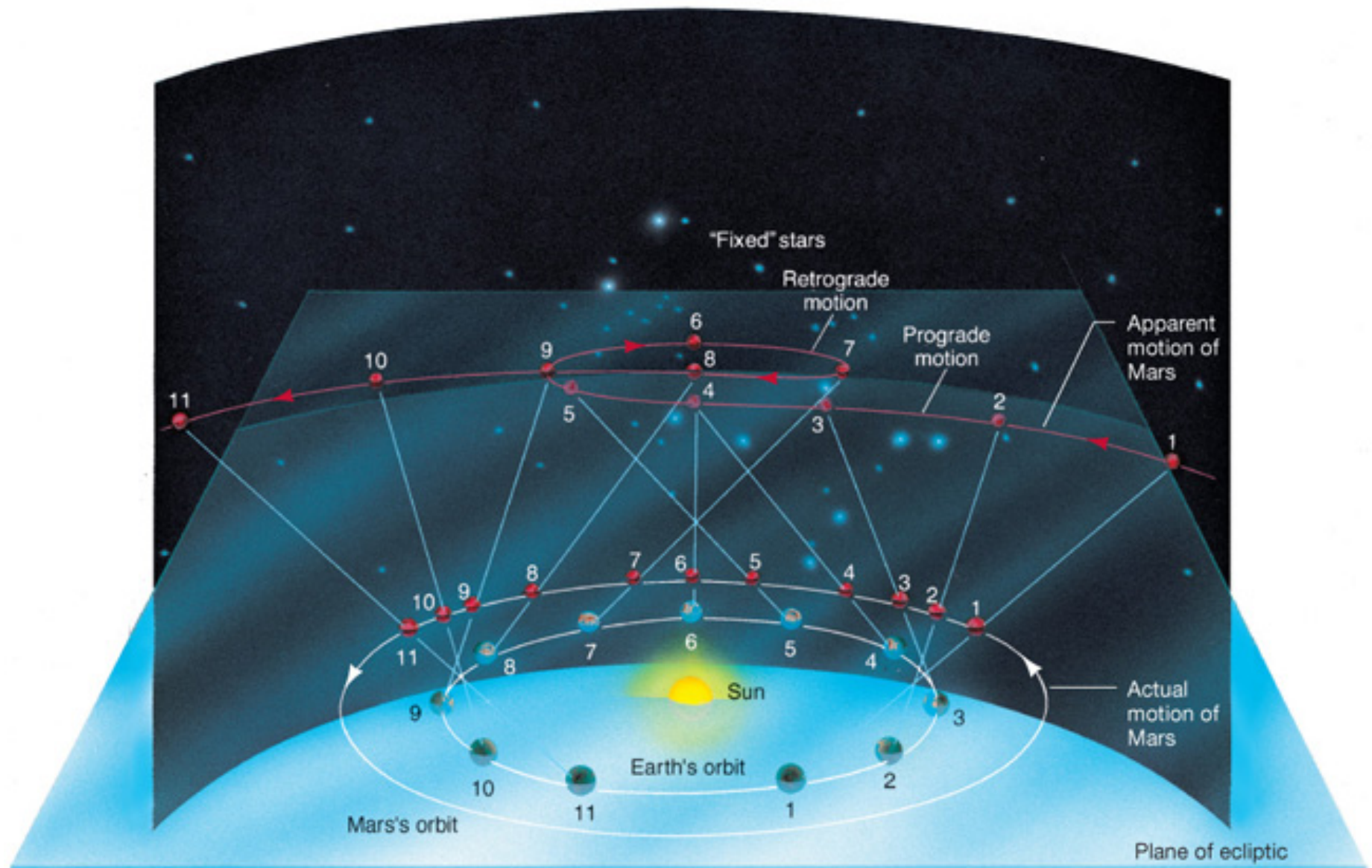


Orbit of Mars

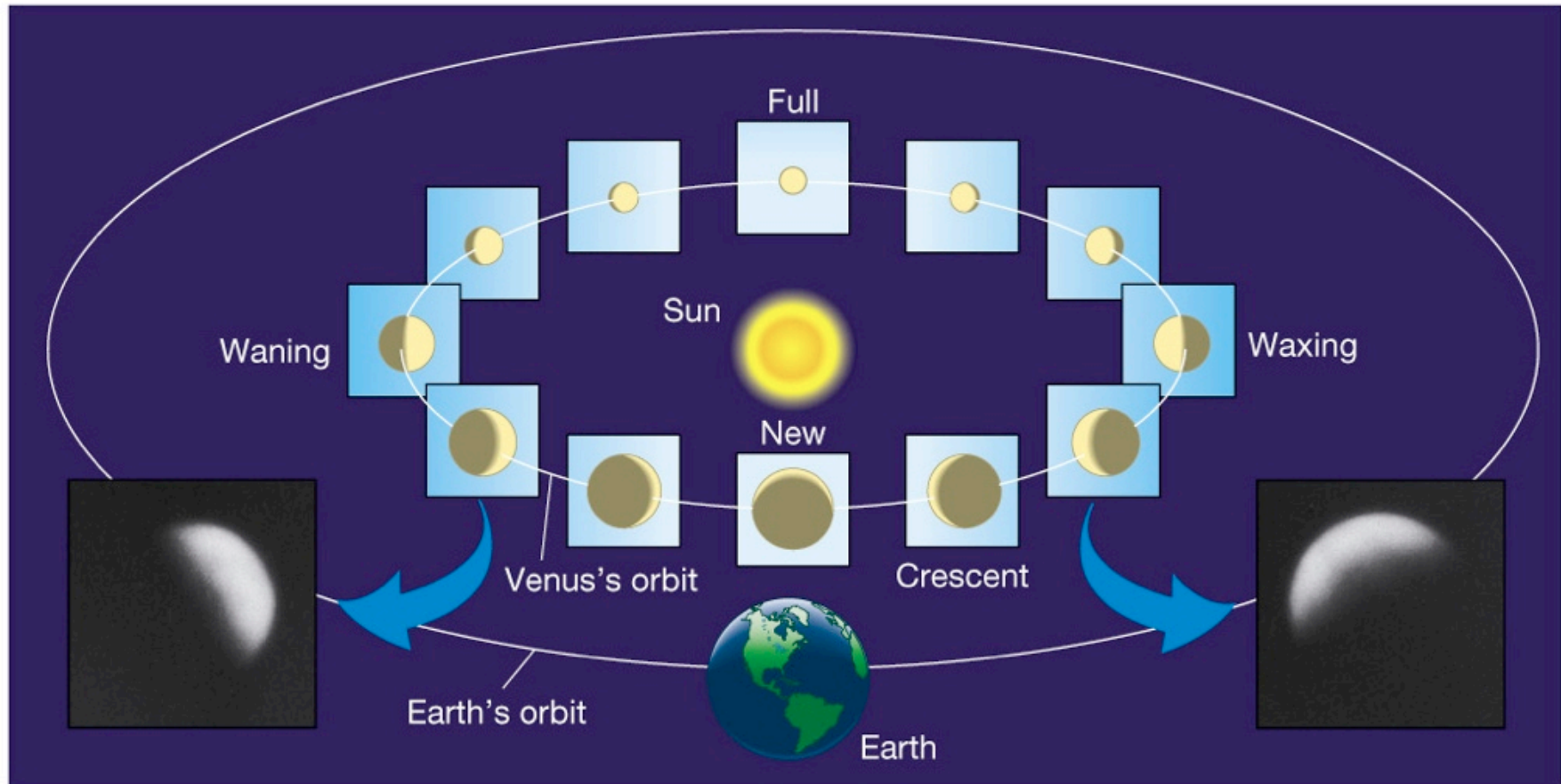


<http://cfa-www.harvard.edu/afoe/simulation/e3.html>

Mars's Retrograde Motion



Phases of Venus explained by the Heliocentric model



Galileo Galilei

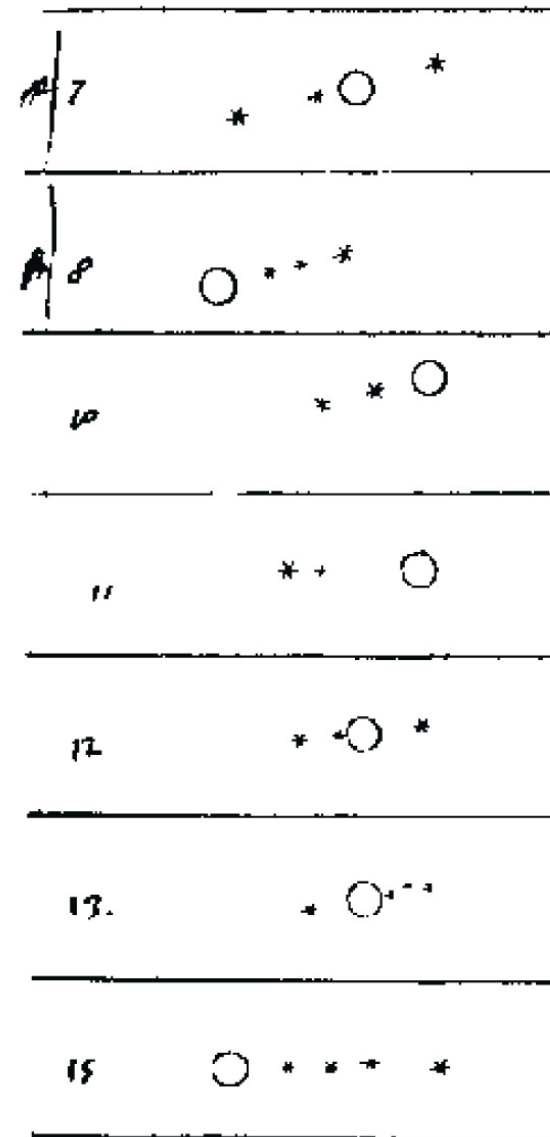


Invented telescope
in 1609

400 years ago!

2009 is the
International Year
of Astronomy

Galileo's Observations of Jupiter



Johannes Kepler

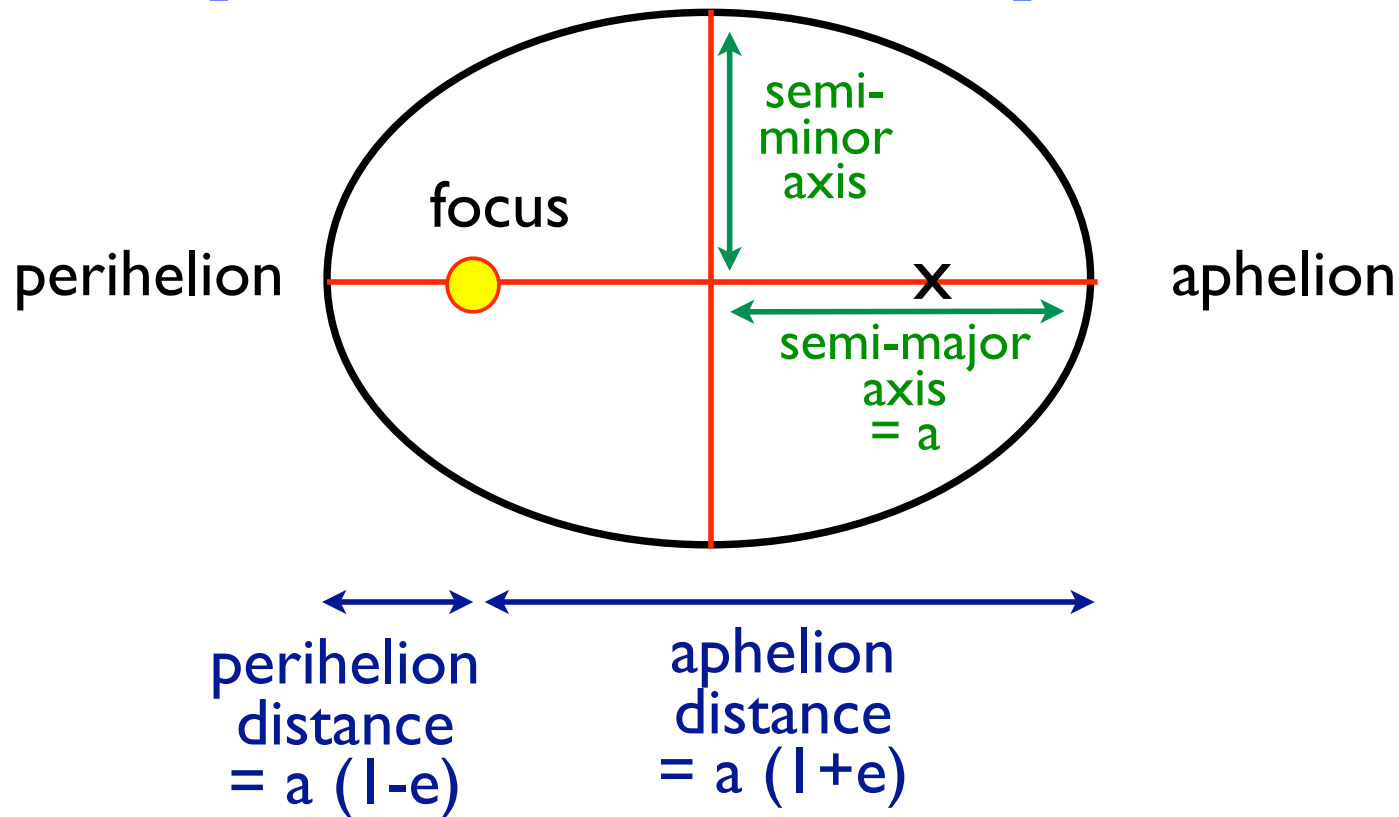
- 1571 – 1630 (same time as Galileo)
- Was German but worked with Tycho Brahe (another very famous astronomer) in Prague, Czech Rep.
- Made meticulous observations and has “Three Laws”



Kepler's Laws

1. The orbits of planets are ellipses with the Sun at one focus.
2. During their orbits around the sun, the planets sweep out equal areas in equal times (they move faster when they are closer to the Sun)
3. $P^2 = a^3$

Elliptical orbits of planets



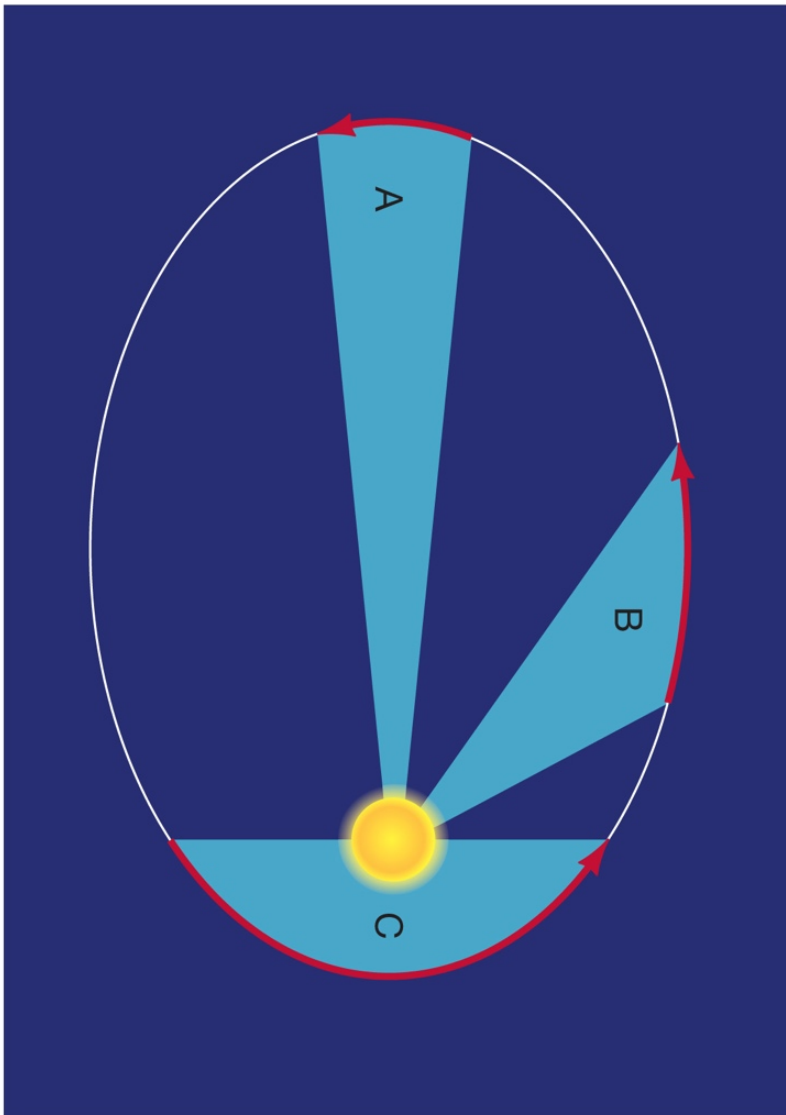
e is the eccentricity (measures the elongation)
 $e = 0$ means perfect circle
 e close to 1 means very elongated

Kepler's Laws

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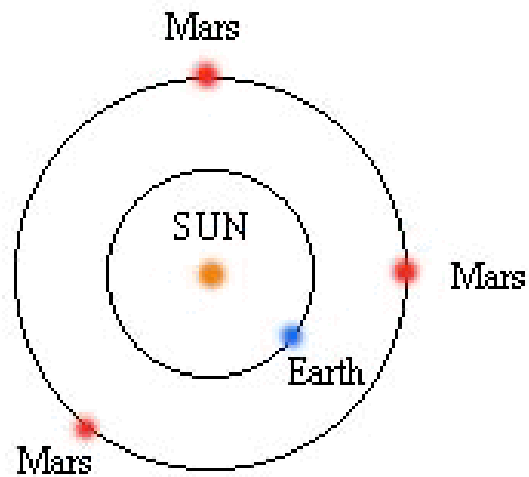
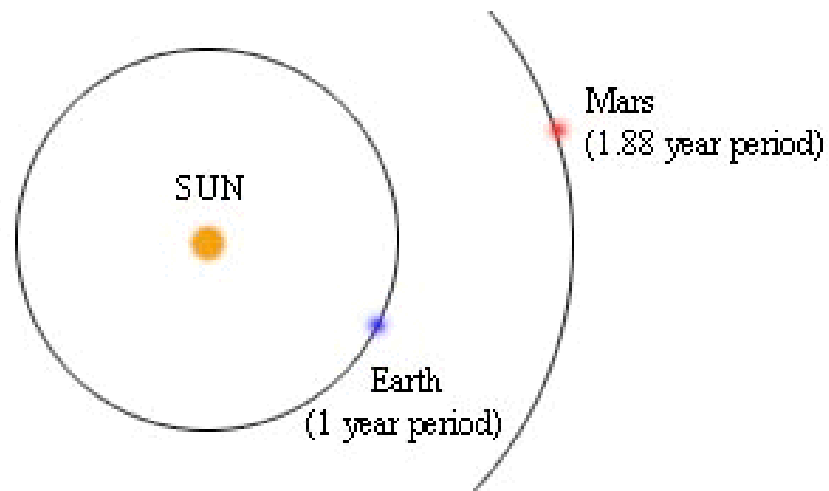
$$3. P^2 = a^3$$



Kepler's Laws

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Orbit of Mars



Planet	Orbital Period (yrs)	Distance (AU)	P^2	a^3
Mercury	0.24	0.387		
Venus	0.61	0.723		
Earth	1.00	1.00		
Mars	1.88	1.523		
Jupiter	11.9	5.204		
Saturn	29.6	9.582		
Uranus	84.3	19.23		
Neptune	164.8	30.4		

Planet	Orbital Period (yrs)	Distance (AU)	P^2	a^3
Mercury	0.24	0.387	0.058	
Venus	0.61	0.723		0.378
Earth	1.00	1.00	1.00	1.00
Mars	1.88	1.523		
Jupiter	11.9	5.204	141.6	
Saturn	29.6	9.582		879.7
Uranus	84.3	19.23		
Neptune	164.8	30.4		28,094