Chapter 1:
The Copernican Revolution

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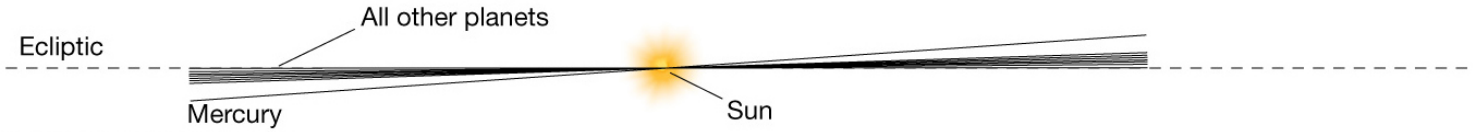
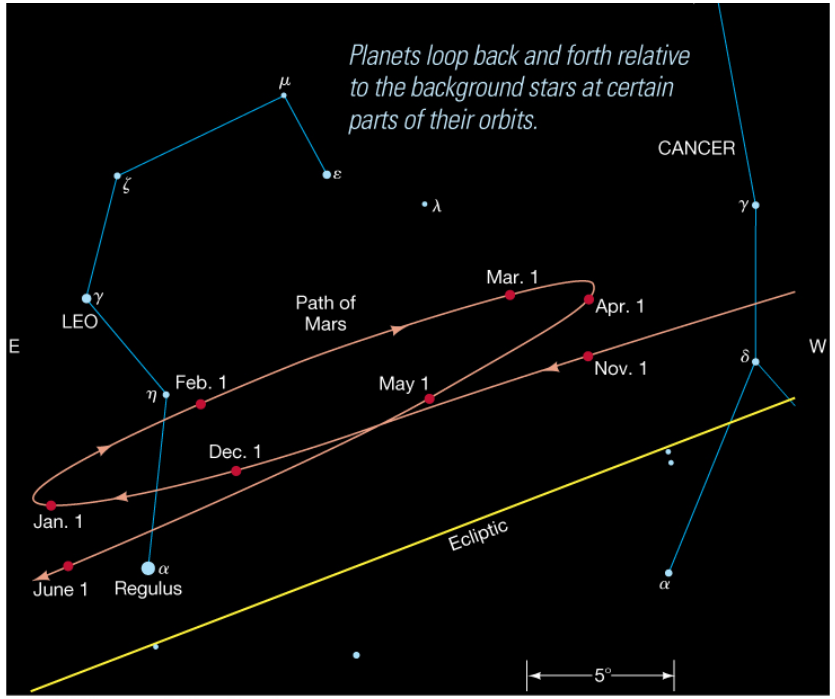
AST 1002

Features of Planets

This edge-on view shows the slight inclinations of the planetary orbits to the ecliptic.



Planets loop back and forth relative to the background stars at certain parts of their orbits.



Elliptical Orbits

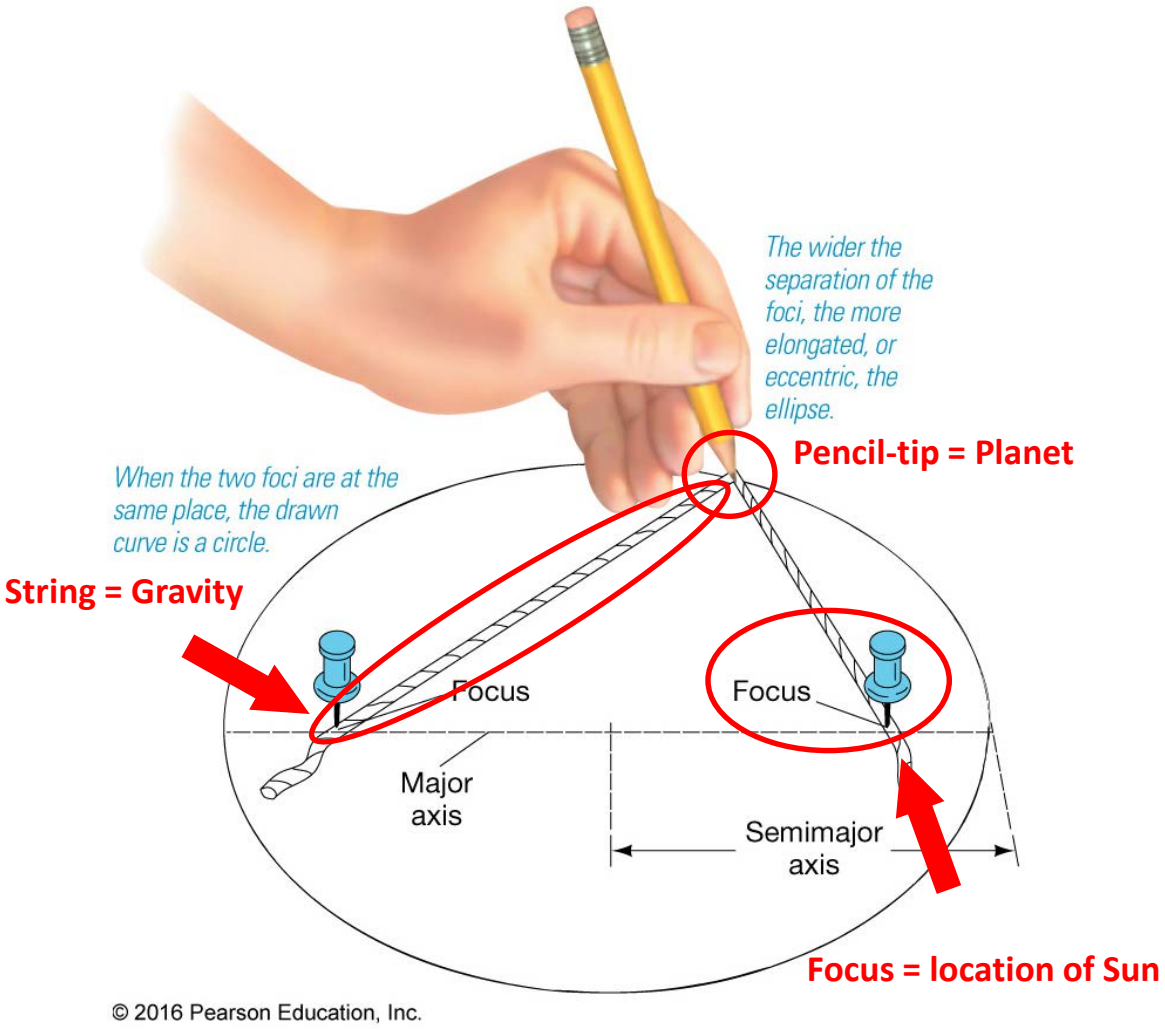
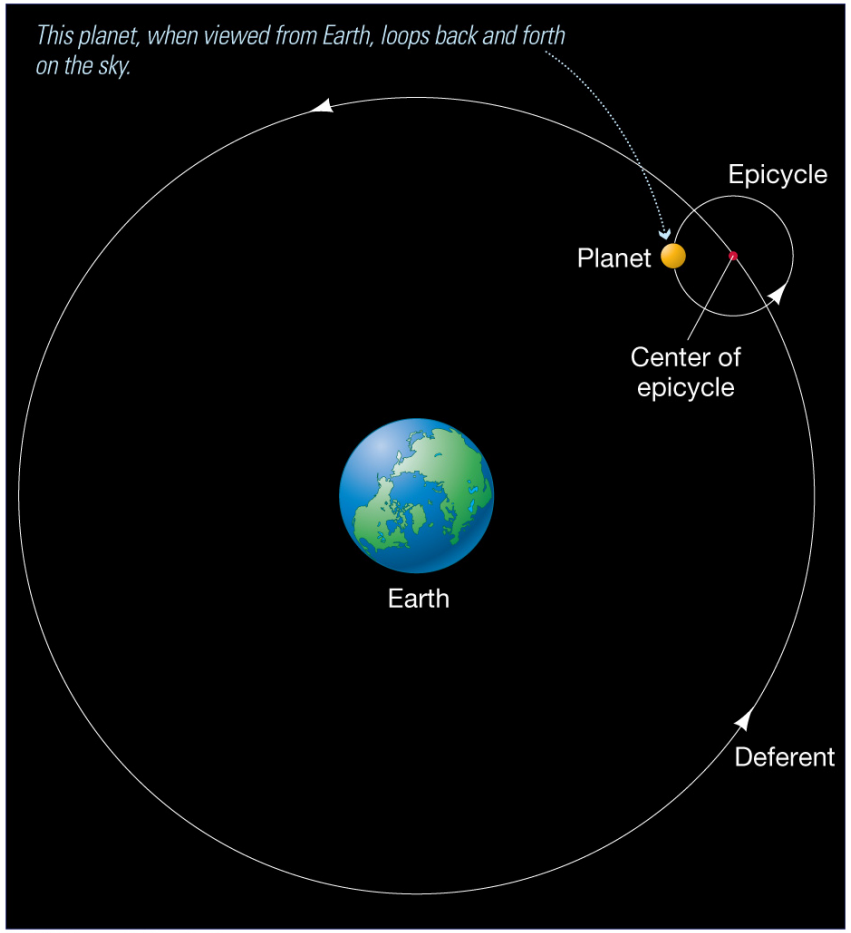


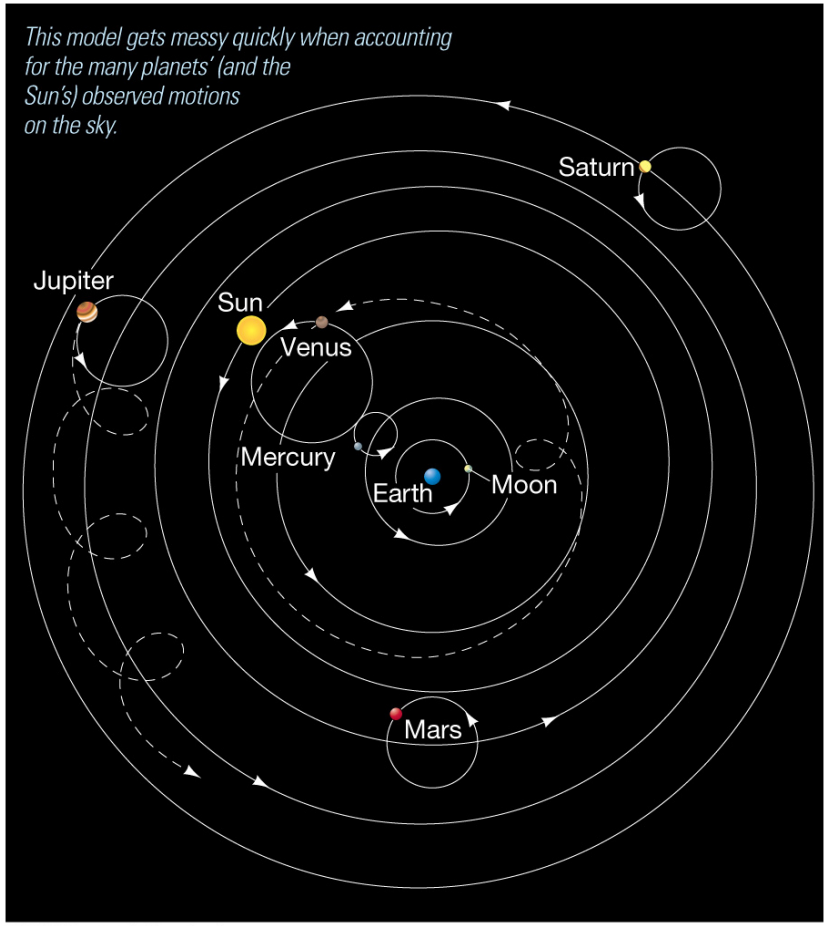
Table 3.1 Properties of Some Solar System Objects

Object	Orbital semimajor axis (AU)	Orbital period (Earth years)	Orbital eccentricity
Mercury	0.39	0.24	0.206
Venus	0.72	0.62	0.007
Earth	1.00	1.0	0.017
Mars	1.52	1.9	0.093
Jupiter	5.2	11.9	0.048
Saturn	9.5	29.4	0.054
Uranus	19.2	84	0.047
Neptune	30.1	164	0.009
Sun	—	—	—

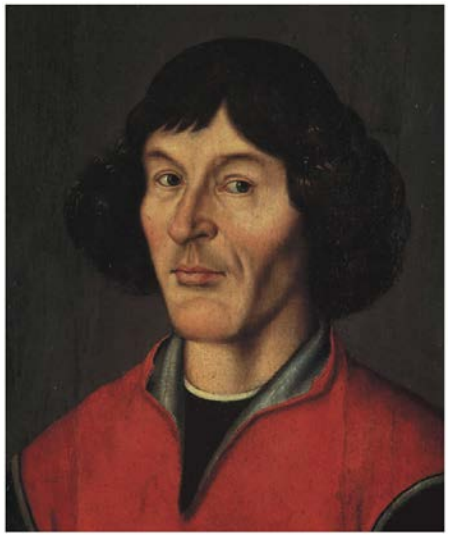
$$e = \sqrt{1 - \frac{b^2}{a^2}}$$

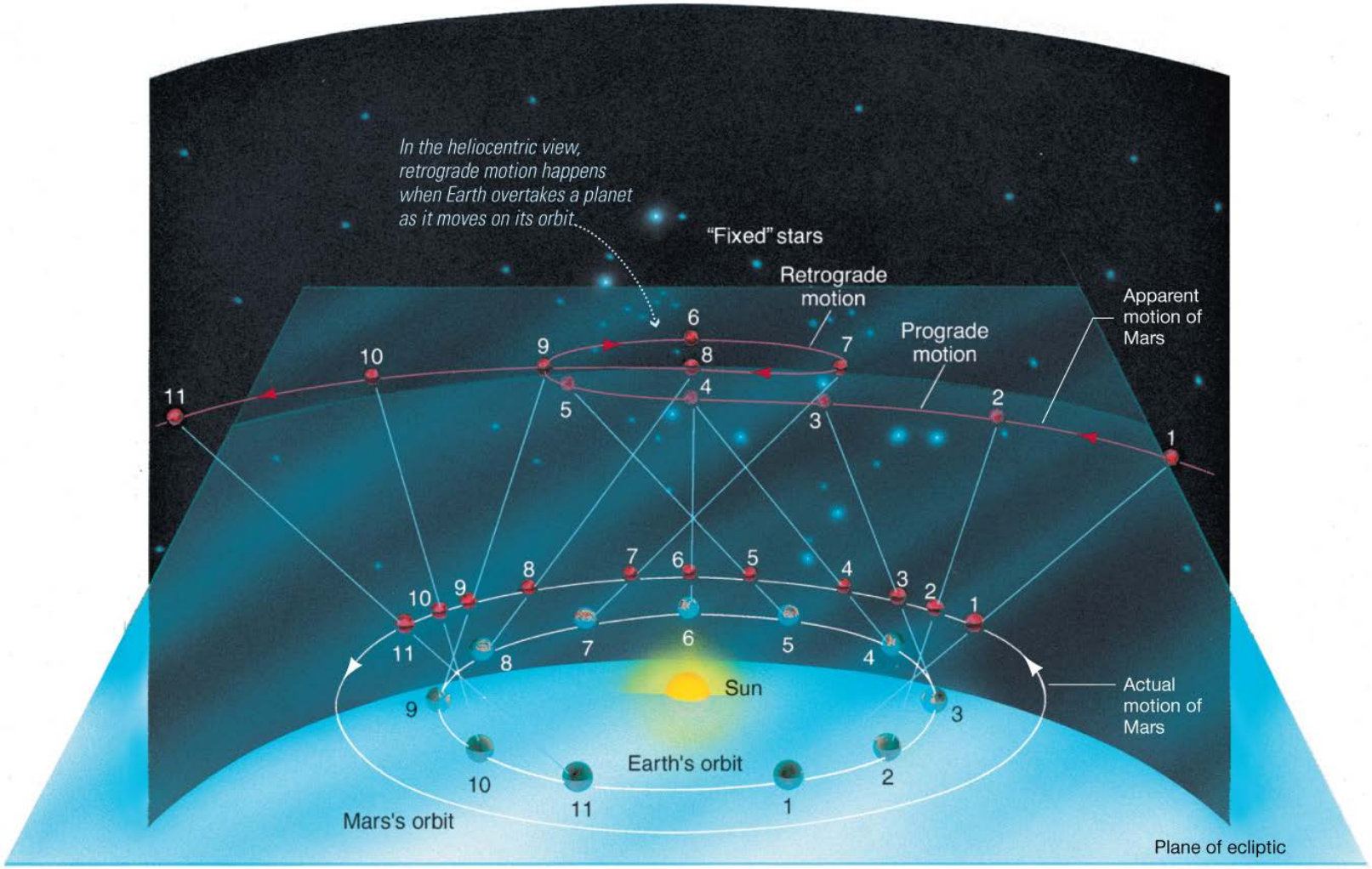
Ptolemaic Geocentrism



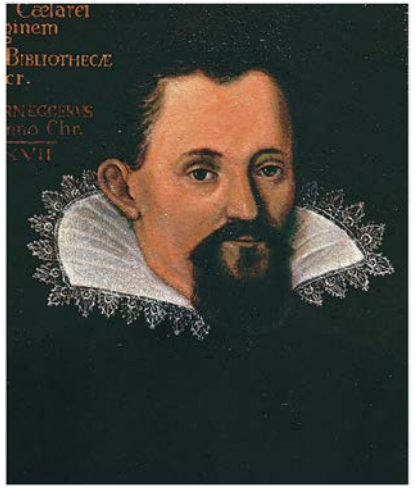


Heliocentrism (Copernicus)





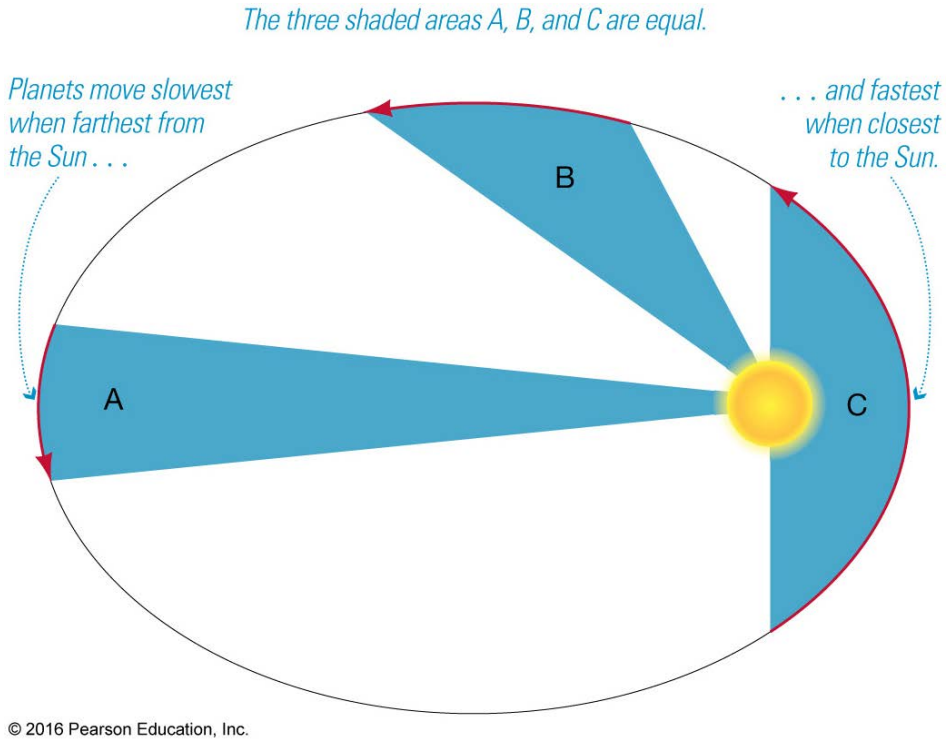
Kepler's Laws of Planetary Motion



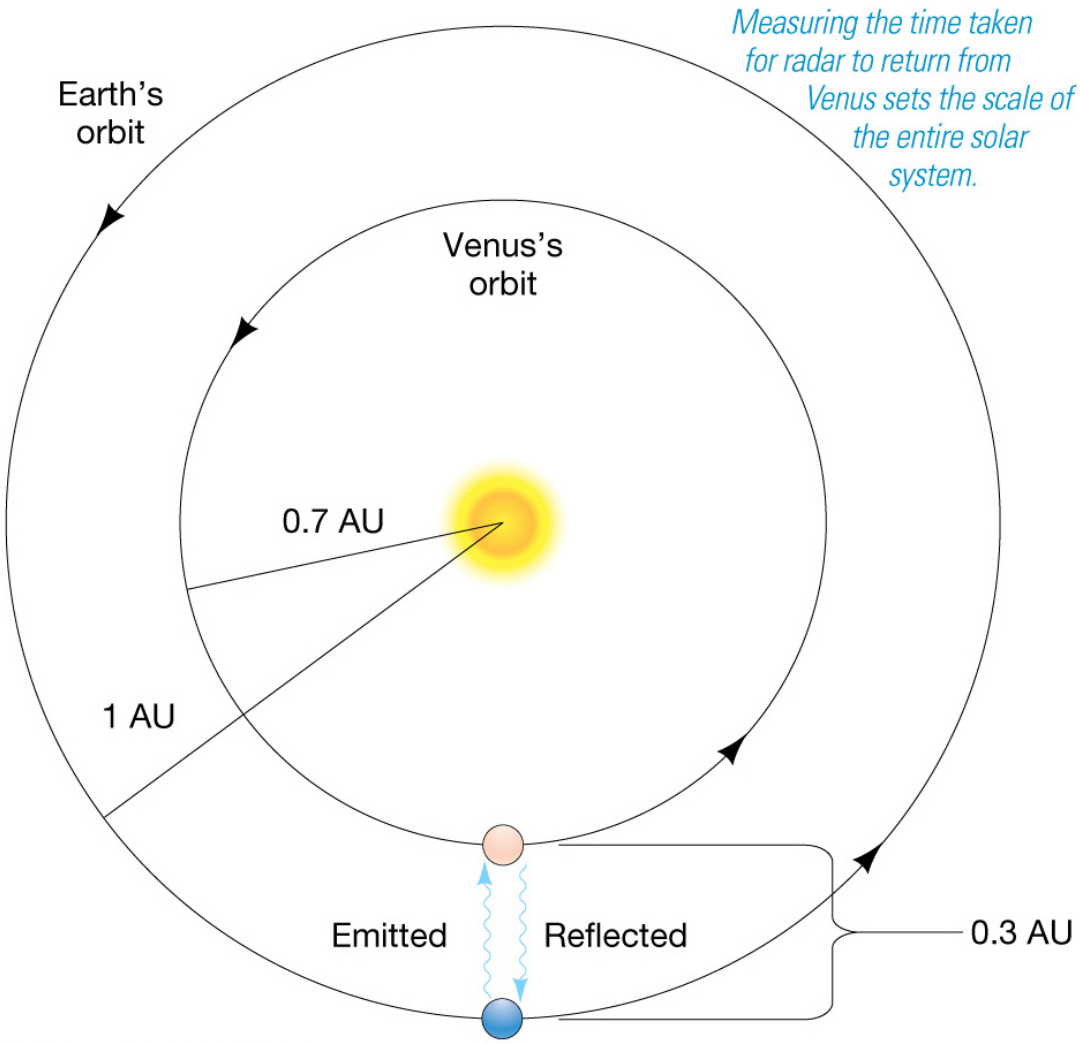
I. Planetary orbits are ellipses

II. A planet covers equal areas in equal times around the ellipse

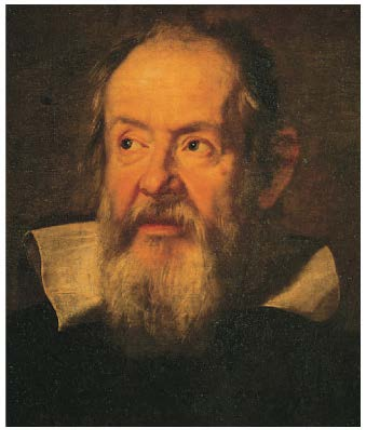
III. $P^2\ (\text{years}) = \dfrac{a^3\ (\text{AU})}{M\ (\text{solar masses})}$



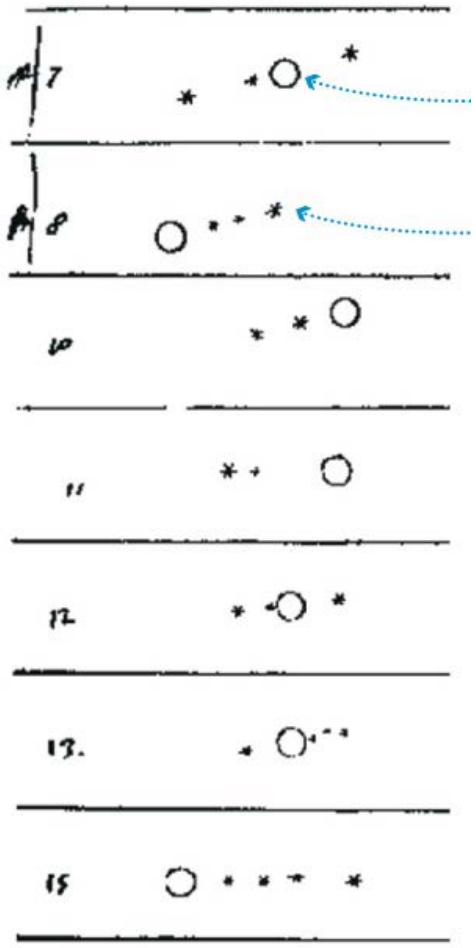
Using Kepler's Third Law



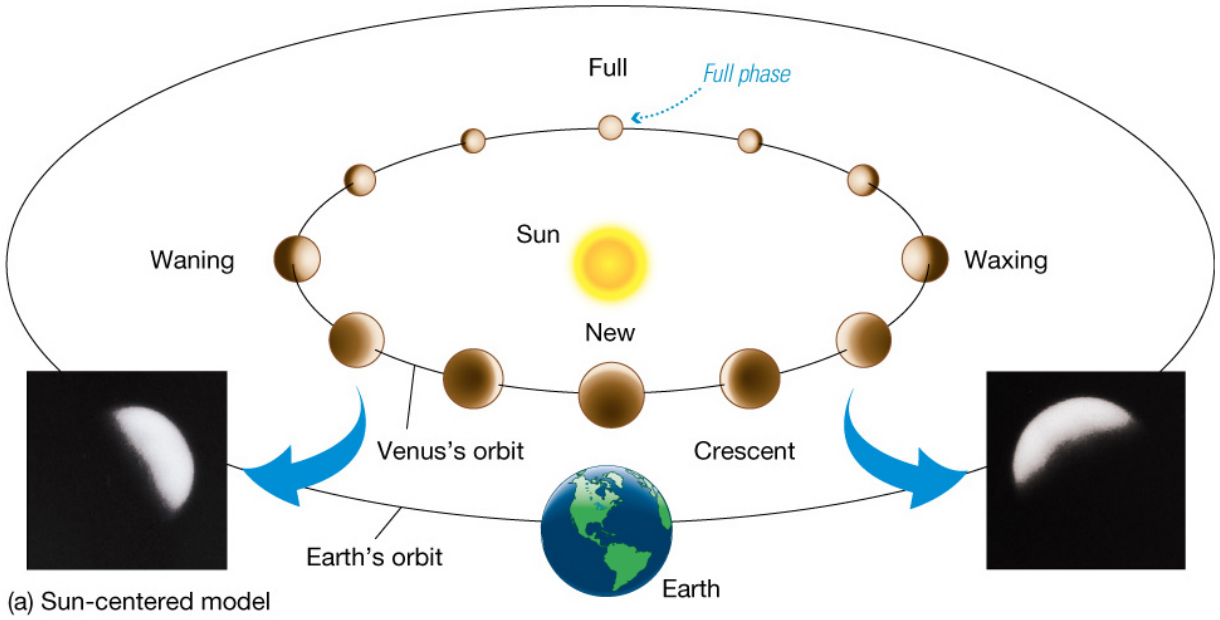
Heliocentrism (Galileo)



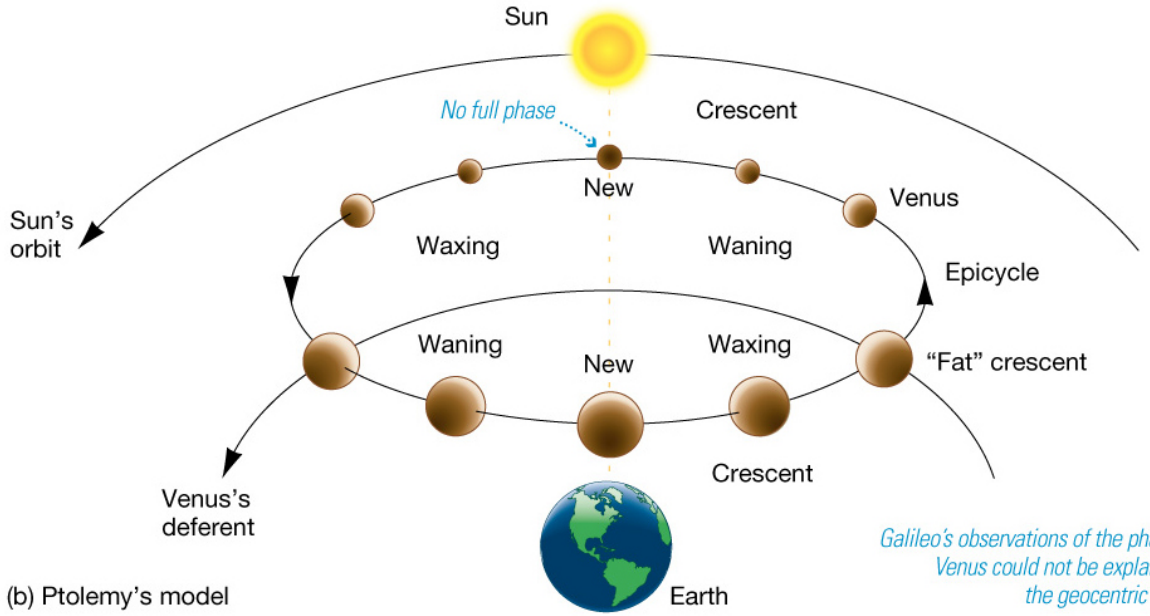
(a)



(c)



(a) Sun-centered model



(b) Ptolemy's model

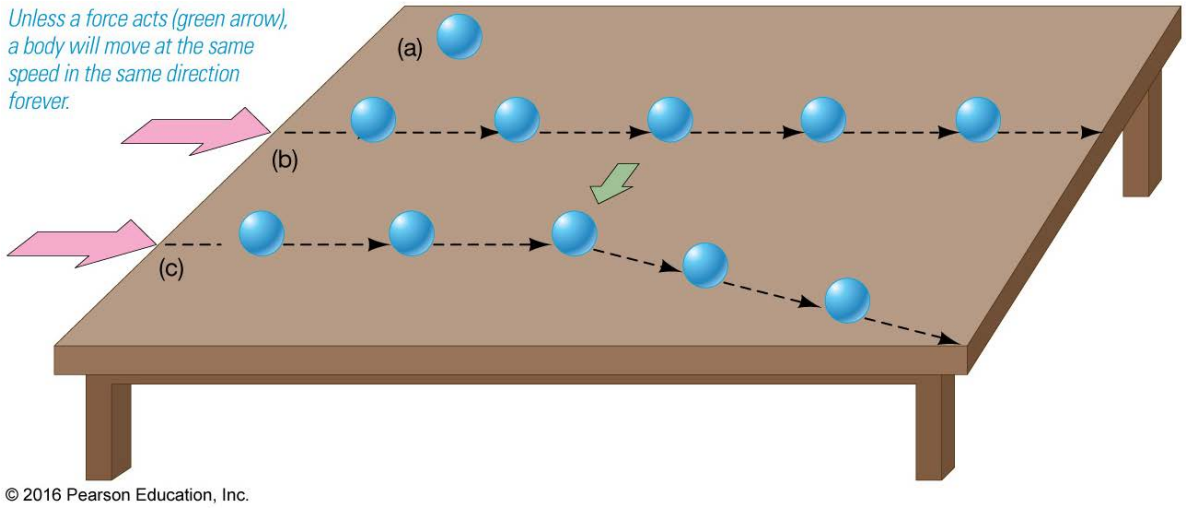
Galileo's observations of the phases of Venus could not be explained by the geocentric model.

Newton's Laws of Motion

I. An object at rest will remain at rest, and an object in motion will remain in motion, unless acted upon by a force.

II. $F = ma$

III. For every action, there is an equal and opposite reaction.



https://en.wikipedia.org/wiki/Newton%27s_cannonball

Newton's Law of Universal Gravitation

- Newton explained Kepler's laws by postulating that the force responsible for apples dropping on Earth and the force responsible for the motion of heavenly bodies are the same force: gravity.
- This is the concept of **universal gravitation**.
- Newton justified his postulate with his famous Cannonball Thought Experiment.
- To properly account for Kepler's laws, the force of gravity must decrease with distance.