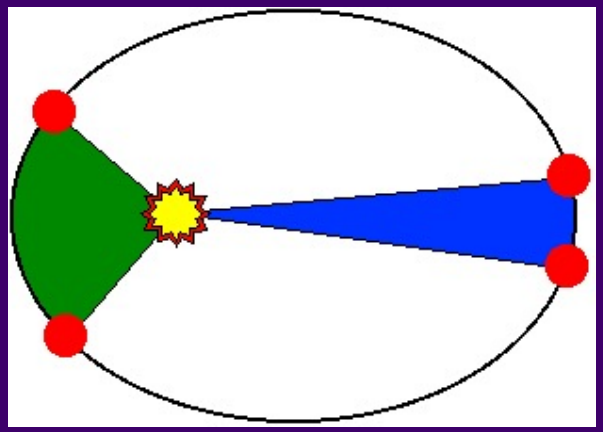


Kepler's Laws

Tycho Brahe

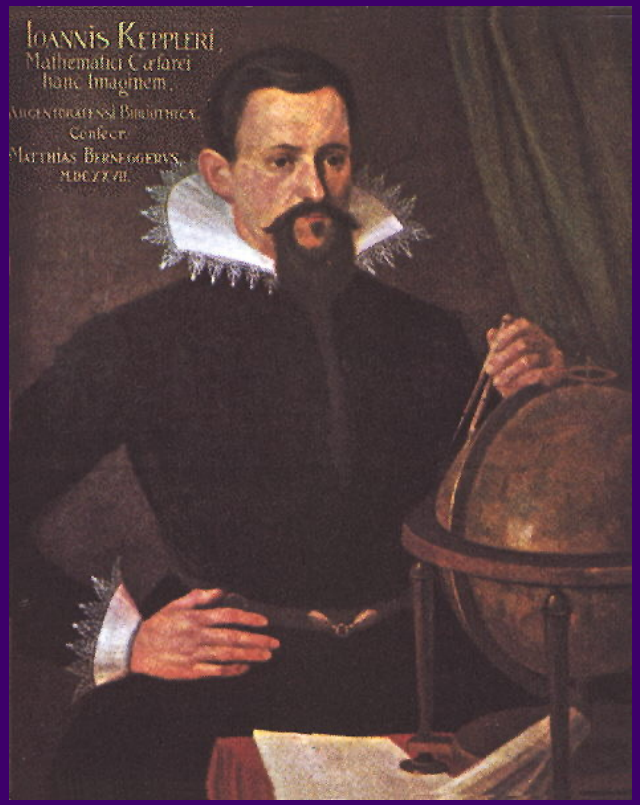
Danish astronomer, 1546 - 1601

Tycho made highly accurate (within 1/60 degree) naked-eye observations of the positions of stars and planets over many years.

He proposed a compromise model in which all the other planets orbit the sun, but the sun orbits the earth.

Johannes Kepler

German astronomer, 1571 - 1630

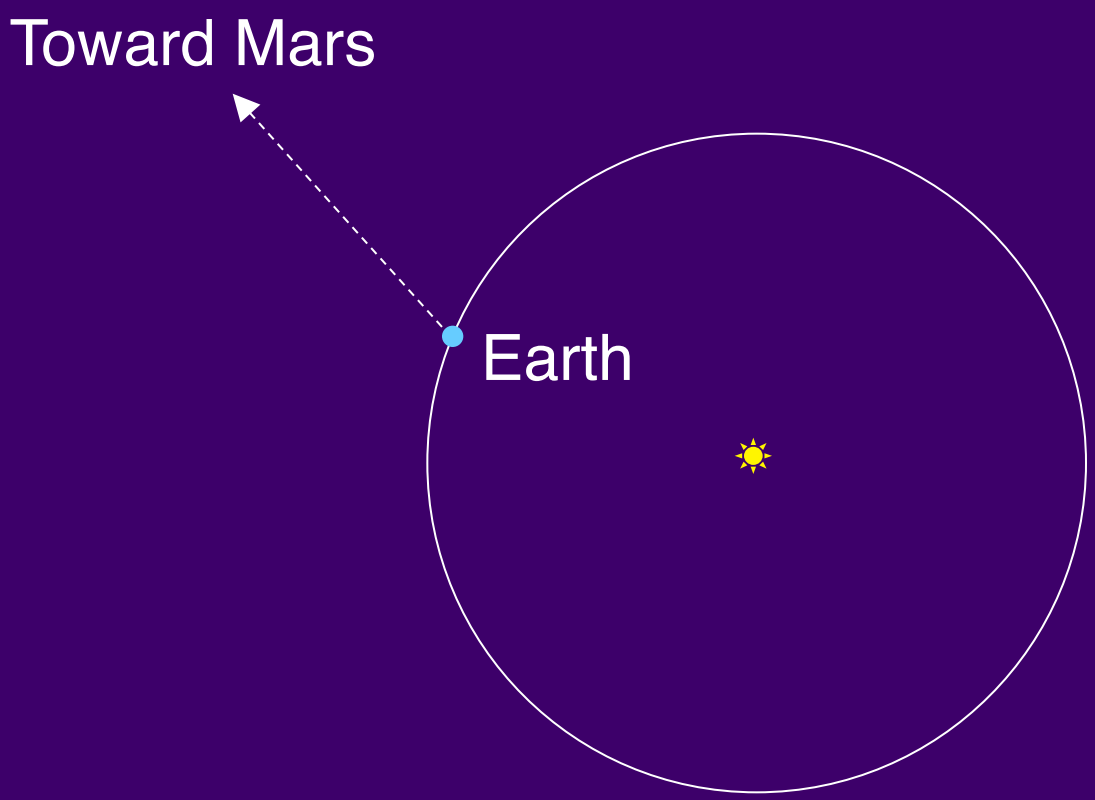


Kepler worked under Tycho during 1600 - 1601, then inherited the records of Tycho's detailed observations.

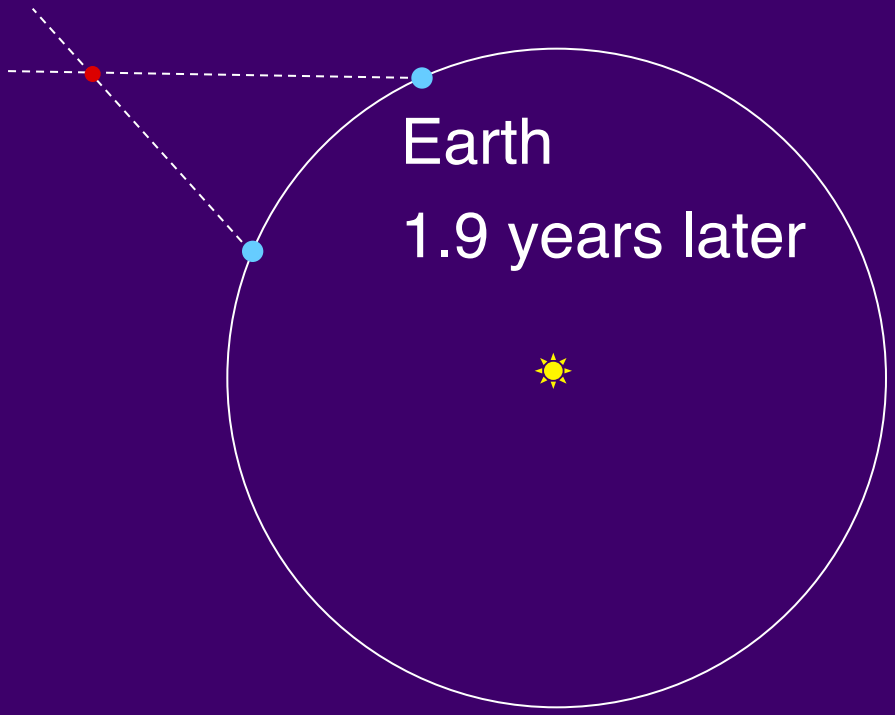
He accepted the Copernican hypothesis, but abandoned the assumption that all motions are circular.

The Orbit of Mars

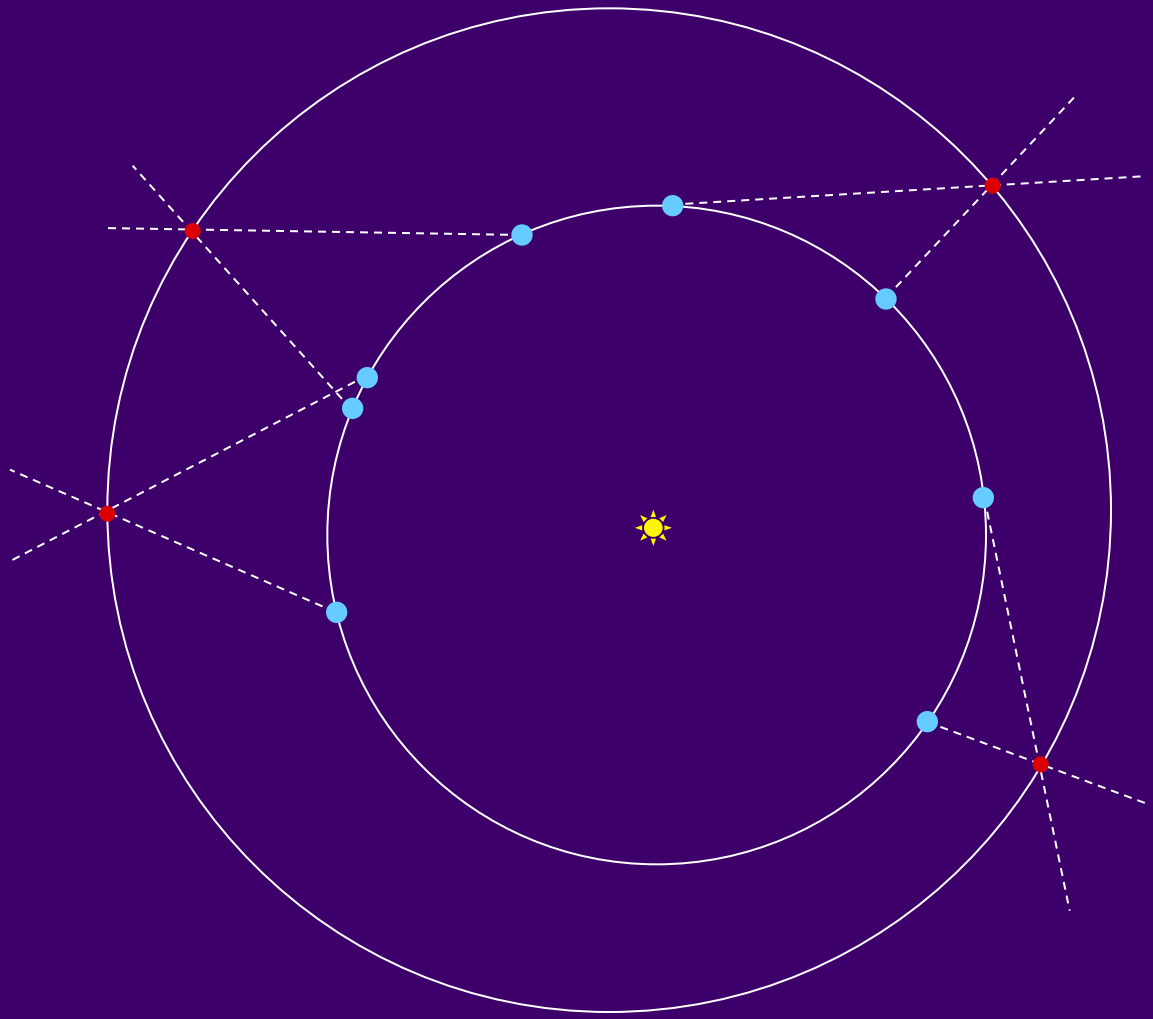
based on Tycho's observations



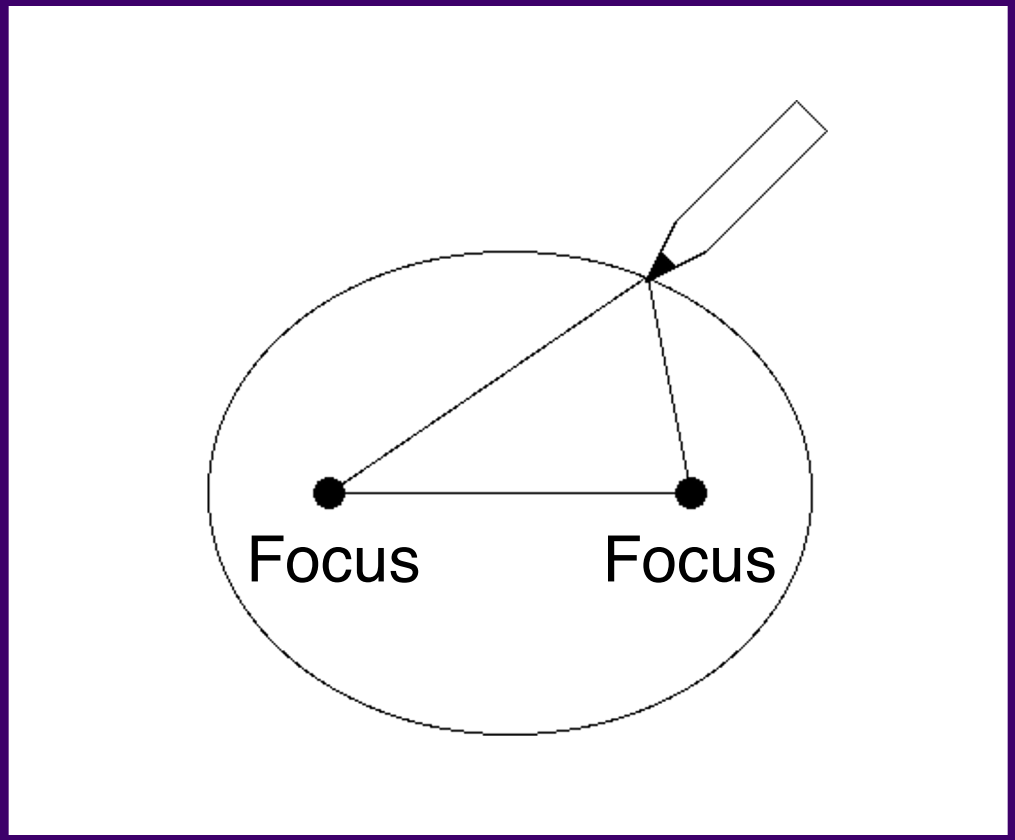
The Orbit of Mars



The Orbit of Mars

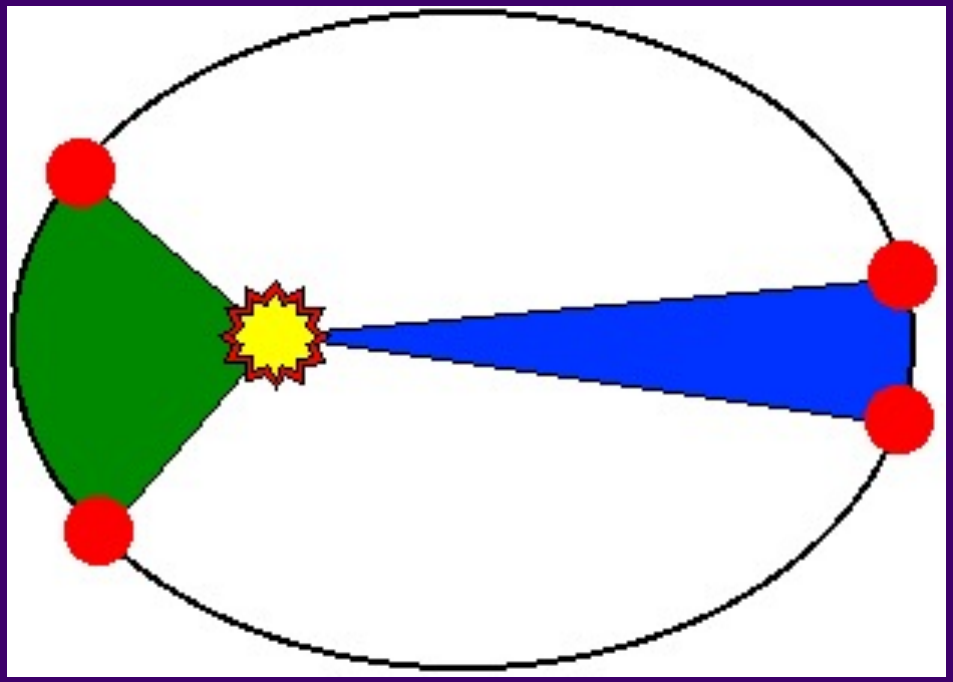


The Orbit is an Ellipse!



The sun is at one focus; there’s nothing at the other.

Planets go faster when they're close to the sun



A line drawn from the sun to the planet sweeps out equal areas in equal times.

Outer planets move slower than inner planets.

	Time (yr)	Radius (AU)		
Mercury	0.24	0.39		
Venus	0.61	0.72		
Earth	1.00	1.00		
Mars	1.88	1.52		
Jupiter	11.86	5.20		
Saturn	29.46	9.54		

Outer planets move slower than inner planets.

	Time (yr)	Radius (AU)	$(\text{Time})^2$	$(\text{Radius})^3$
Mercury	0.24	0.39		
Venus	0.61	0.72	0.37	0.37
Earth	1.00	1.00		
Mars	1.88	1.52		
Jupiter	11.86	5.20		
Saturn	29.46	9.54		

Outer planets move slower than inner planets.

	Time (yr)	Radius (AU)	$(\text{Time})^2$	$(\text{Radius})^3$
Mercury	0.24	0.39	0.058	0.059
Venus	0.61	0.72	0.37	0.37
Earth	1.00	1.00	1.00	1.00
Mars	1.88	1.52	3.53	3.51
Jupiter	11.86	5.20	140.7	140.6
Saturn	29.46	9.54	867.9	868.3

$$(\text{Time in years})^2 = (\text{Radius in AU})^3$$

Kepler's Laws

1. Orbits are ellipses, with sun at one focus.
2. Equal areas in equal times (faster when close to sun)
3. $(\text{Time in years})^2 = (\text{Radius in AU})^3$

Bottom line: The universe speaks math!