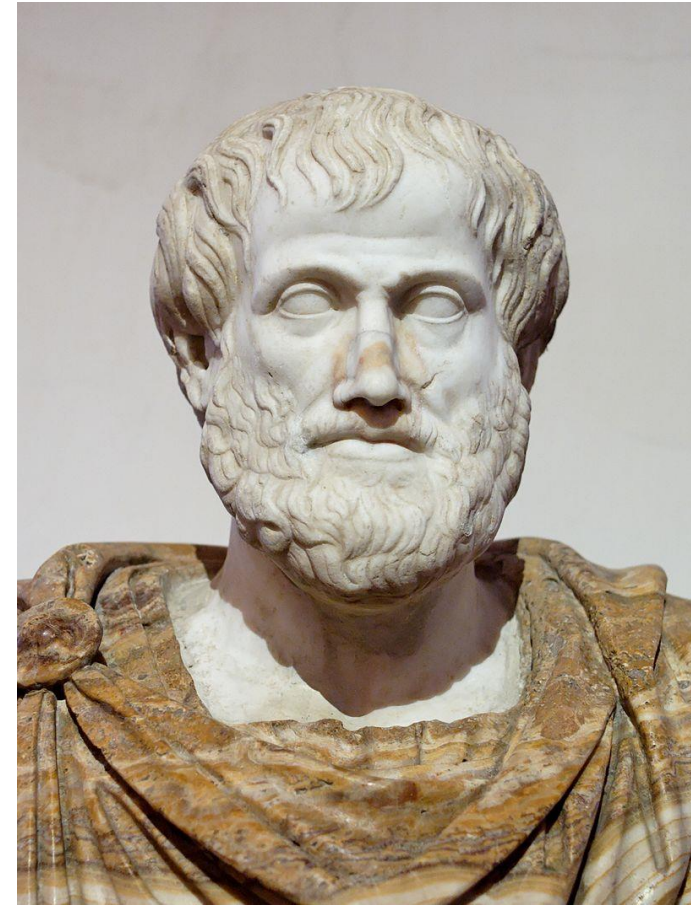


# The Heliocentric Solar System

Week 15

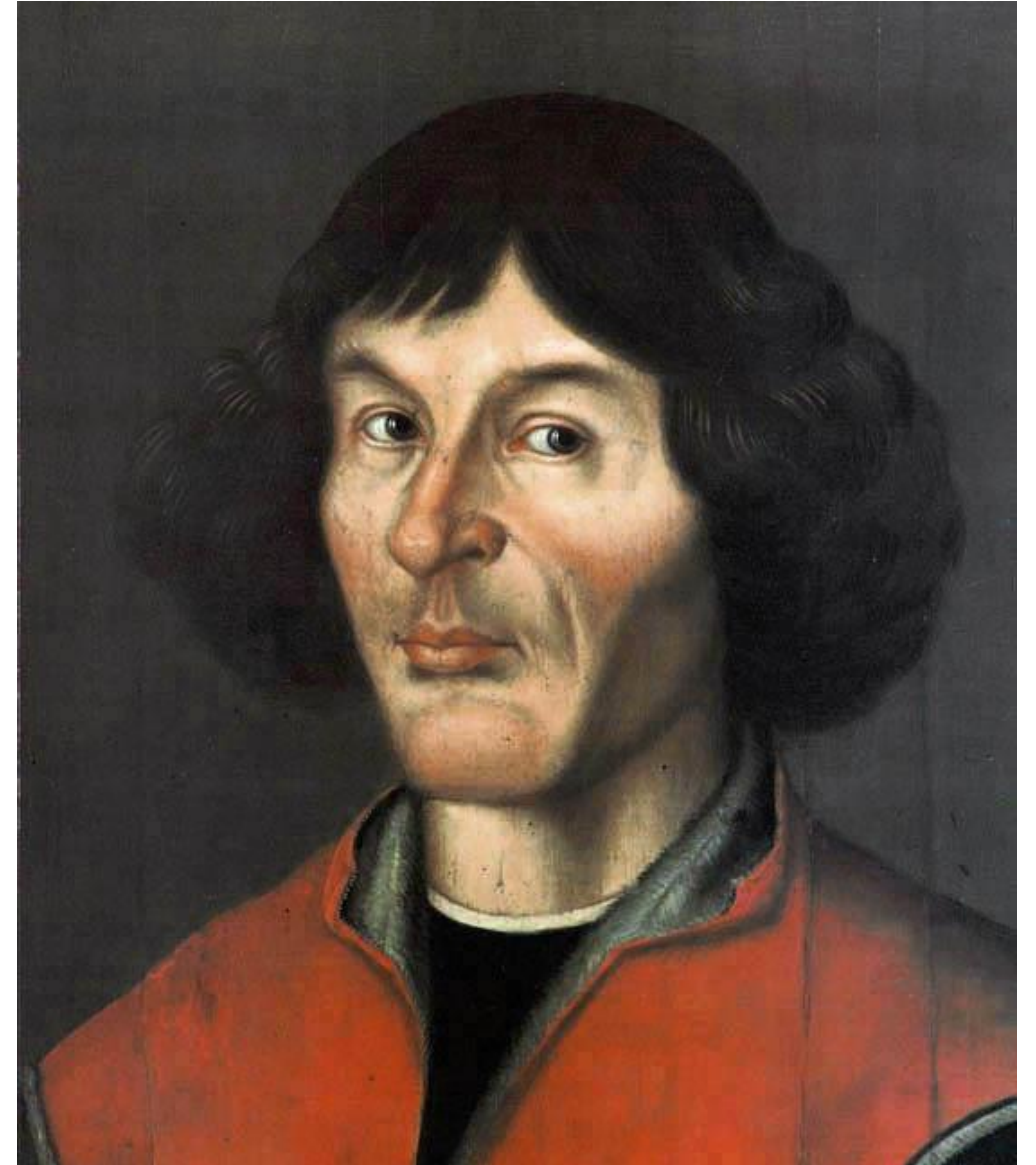
Ptolemy and Aristotle favoured the Geocentric model of the solar system



Nicolas Copernicus

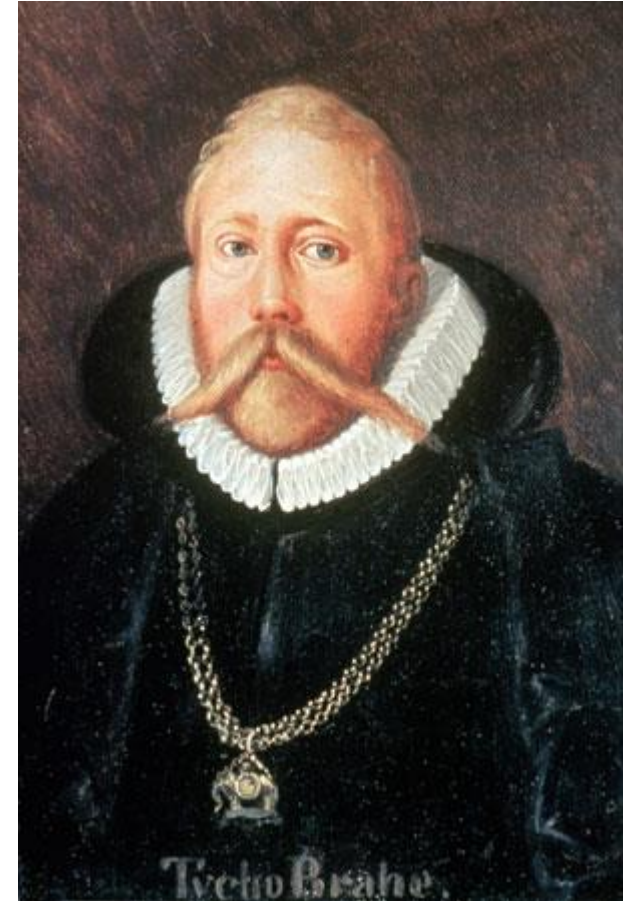
Suggested that the sun  
is at the centre of the  
solar system

The heliocentric model



# Tycho Brahe

A Danish astronomer known for his meticulous record keeping.





# Galileo – Invented the telescope



# Galileo – discovered...

Four of Jupiter's moons: Io, Europa, Ganymede and Callisto known as the Galilean moons

The moons had a 'retrograde motion' showing they must be orbiting Jupiter

Sunspots showing the sun rotated

Saturn's rings

Phases of the planet Venus

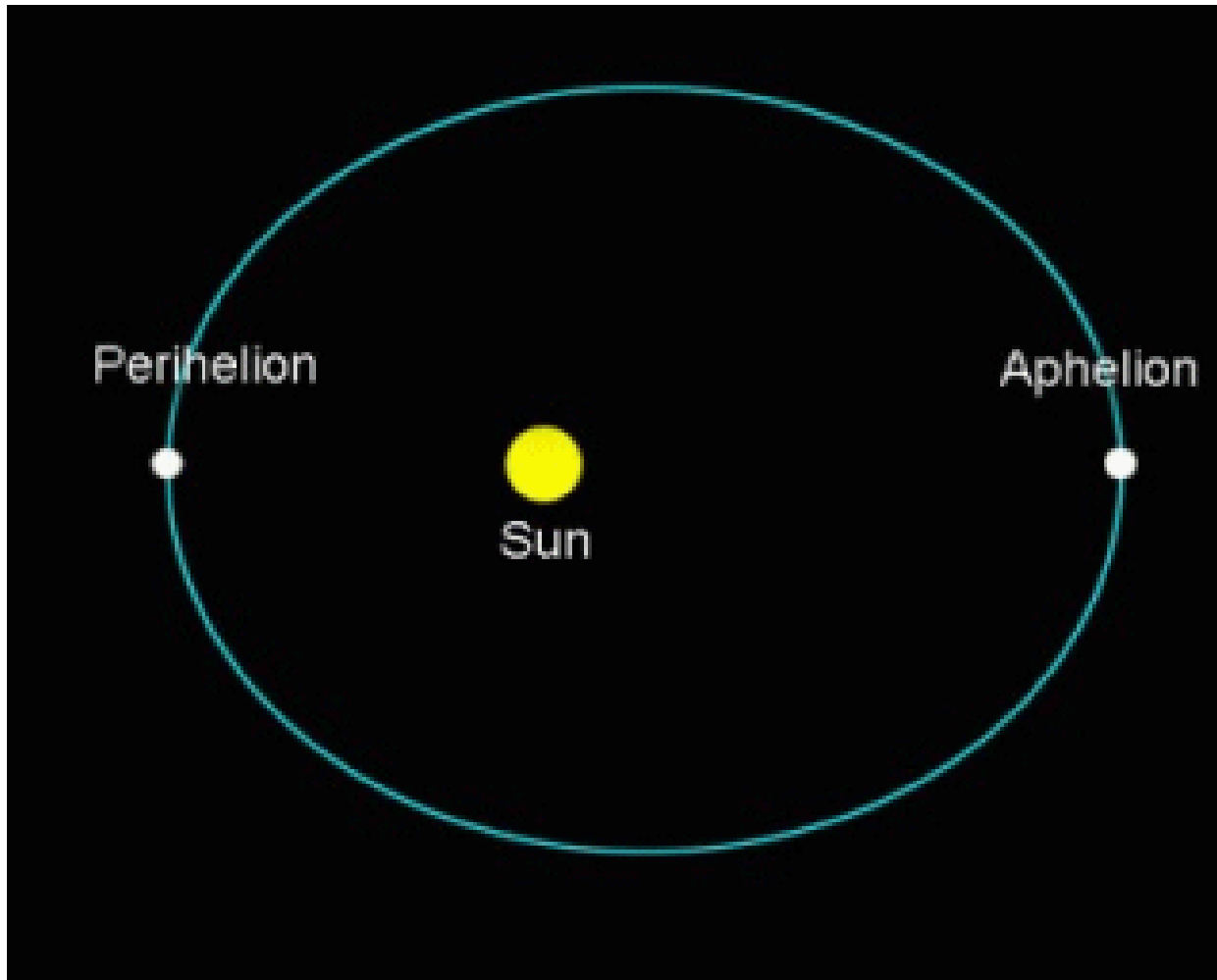


# Johannes Kepler

A German astronomer.

Tycho Brahe's assistant.  
He used Brahe's data  
to create Kepler's 3  
laws of planetary  
motion



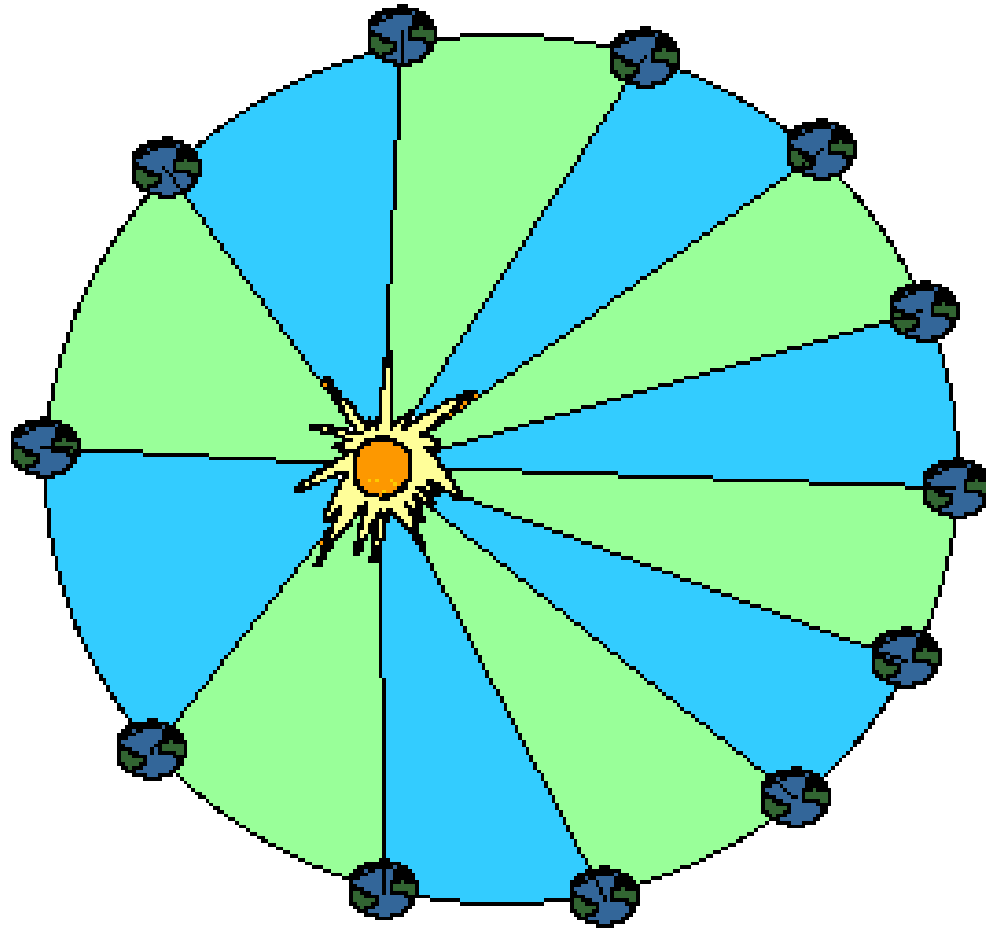


# Kepler's 1st Law

- All planets orbit the sun in an ellipse



## The Law of Equal Areas



**An imaginary line drawn from the sun to any planet sweeps out equal areas in equal amounts of time.**

## Kepler's 2<sup>nd</sup> Law

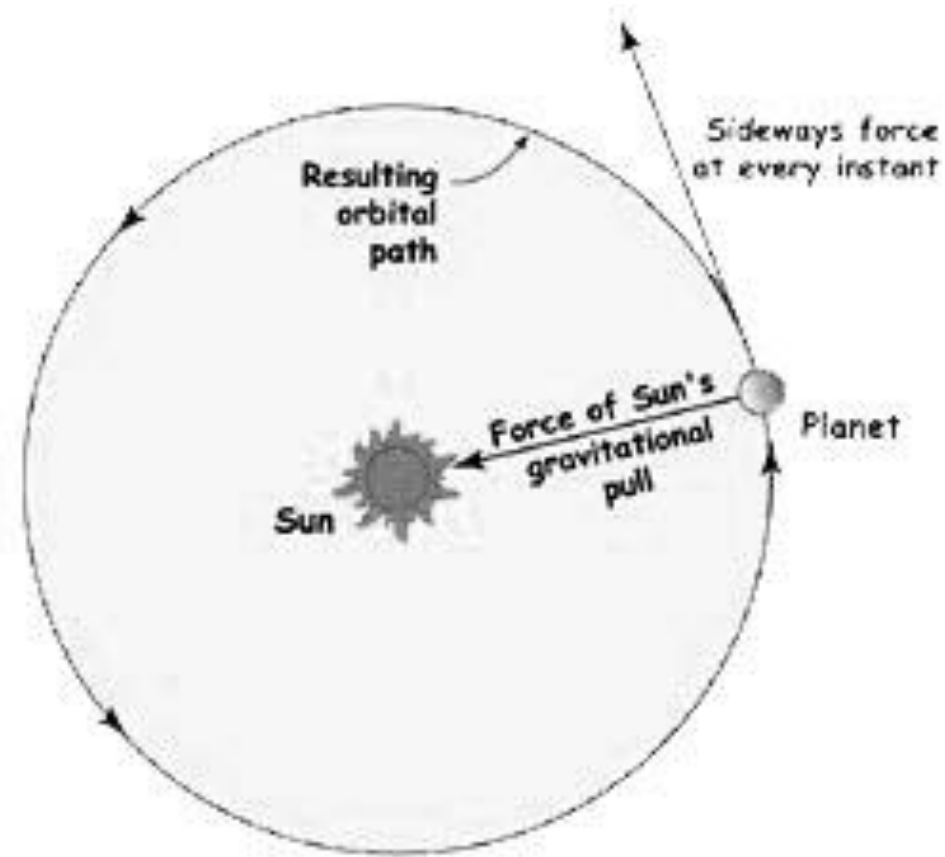
# Kepler's 3<sup>rd</sup> Law

Planet	Period (yr)	Average Distance (au)	$T^2/R^3$ (yr <sup>2</sup> /au <sup>3</sup> )
Mercury	0.241	0.39	0.98
Venus	.615	0.72	1.01
Earth	1.00	1.00	1.00
Mars	1.88	1.52	1.01
Jupiter	11.8	5.20	0.99
Saturn	29.5	9.54	1.00
Uranus	84.0	19.18	1.00
Neptune	165	30.06	1.00
Pluto	248	39.44	1.00

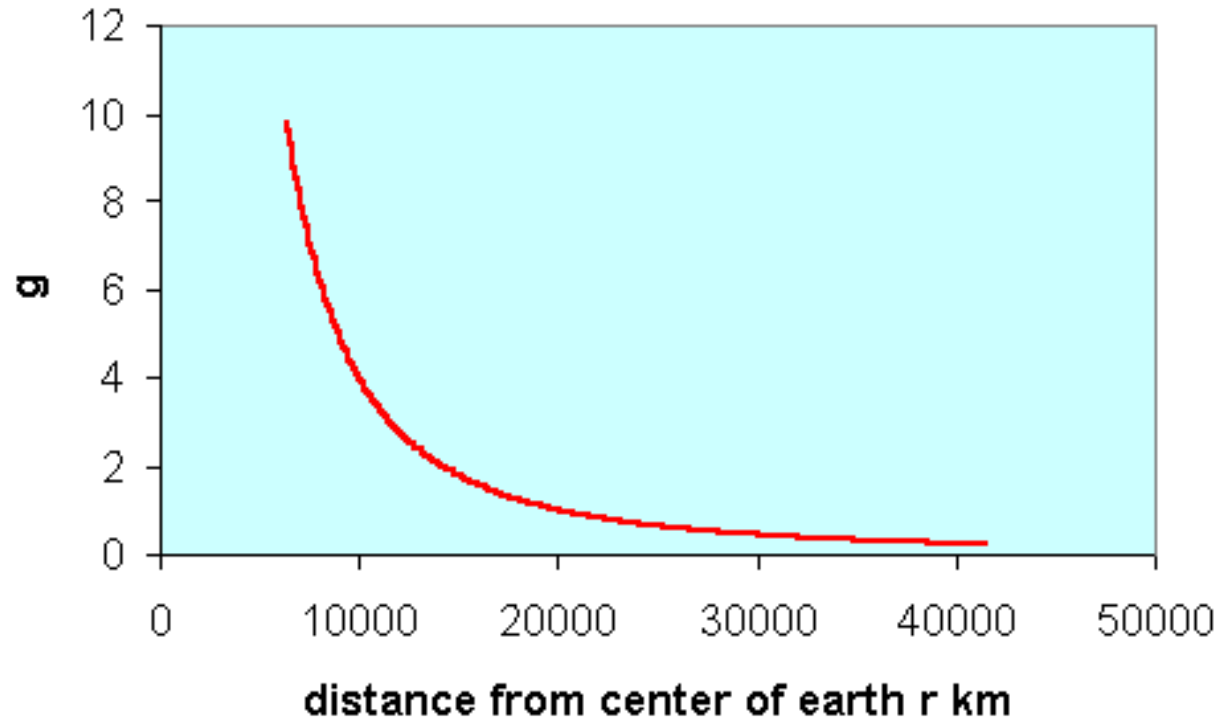
- The ratio of  $T^2$  to  $R^3$  is the same for all planets
- T is the time for one orbit
- R is the average distance from the sun to the planet

# What holds it all together?

- Gravity acts between all masses.
- But you need to get up the size of planets and moons to notice its effects.



variation of g with r



Gravity has an inverse square effect

The further you are away from a mass the less its gravity acts on you by a factor of distance squared



# Naked eye observations

- Mercury
  - Venus
  - Mars
  - Jupiter
  - Saturn
- 
- The further planets required telescopes to view them.

# Discovery of Uranus

- William Herschel 1781
- Herschel also discovered the spiral nature of the Milky Way
- And discovered the existence of Infra-Red waves

# Discovery of Neptune

- John Couch Adams 1846
- He predicted that there must be another planet-sized mass past the orbit of Uranus and his calculations were proved correct.
- A French mathematician named Le Verrier also calculated Neptune's position

# Discovery of Pluto

- Clyde Tombaugh 1930
- Predicted to exist because of fluctuations in the orbits of Neptune and Uranus.



# Discovery of Ceres

- Guiseppe Piazzi 1801
- Observed a planet-like object between Mars and Jupiter
- He observed for 41 days then fell ill.
- Kepler had noted the gap between Mars and Jupiter
- The mathematician Karl Frederich Gauss used the limited data to predict the path for Ceres
- Ceres is 945 km in diameter