

# Physics 102 - November 9, 2009

- Project groups - Select spokes person  
↳ let's meet
- Last week
  - Movie
  - lecture

Fundamental Particles

Fundamental forces

Relative Strength

Quarks

$u, d, c, s, t, b$

Fraction elect. chg  
bonded by STR. interaction

$(qqq)$  Baryons  
P, n

$(q\bar{q})$  meson  
 $\pi \equiv \text{pion}$

Lepton

$e, \mu, \tau$  1 unit of elect chg  
neutral  $\nu_e, \nu_\mu, \nu_\tau$  (NOT EM)

Gauge Bosons mediate force  
 $\gamma$  EM force photon  
 $g$  STRONG force gluon  
 $W^{+/-}, Z^0$  weak force

gravitation

graviton (undiscovered)  
infinite range

$10^{-40}$

Strong

Quantum Chromodynamics  
gluon  
 $10^{-15} \text{ m}$

$\sim 30$

Weak

$W^{+/-}, Z^0$   
 $10^{-18} \text{ m}$

1

Electromagnetism

$\gamma$   
infinite

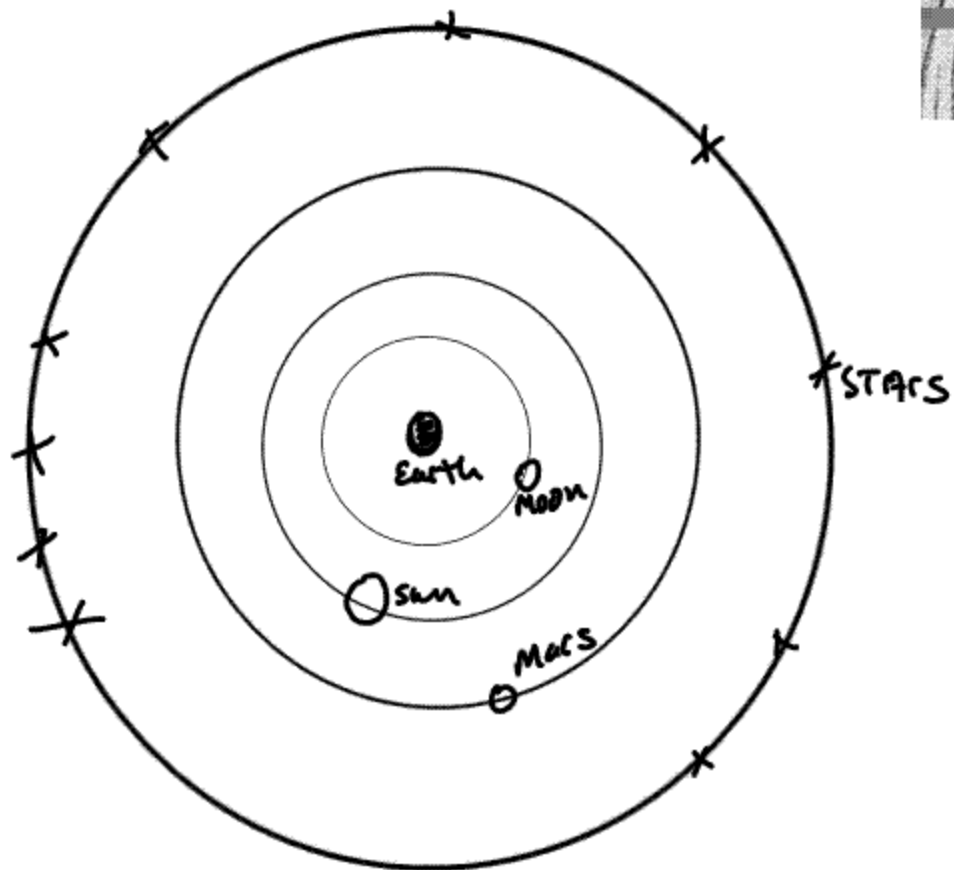
1

Higgs

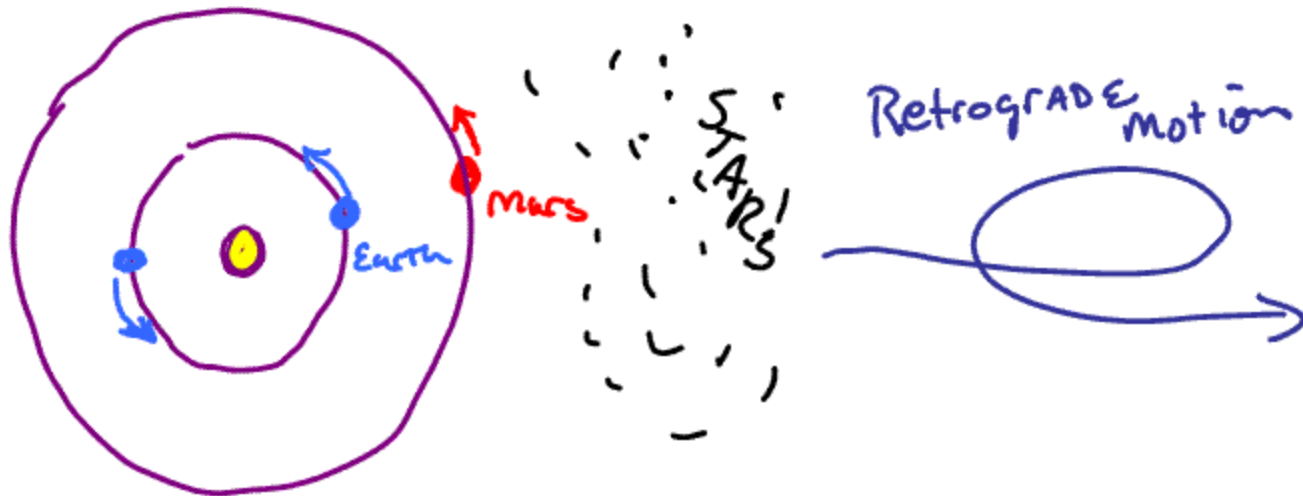
# Move from inner space to outer space

## Pythagorean theory

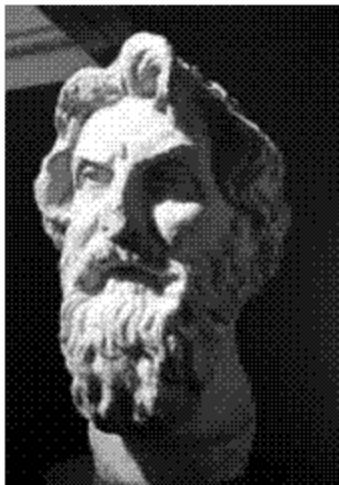
Early Greek view of the universe



Pythagoras  
of  
Samos  
~ 500BC

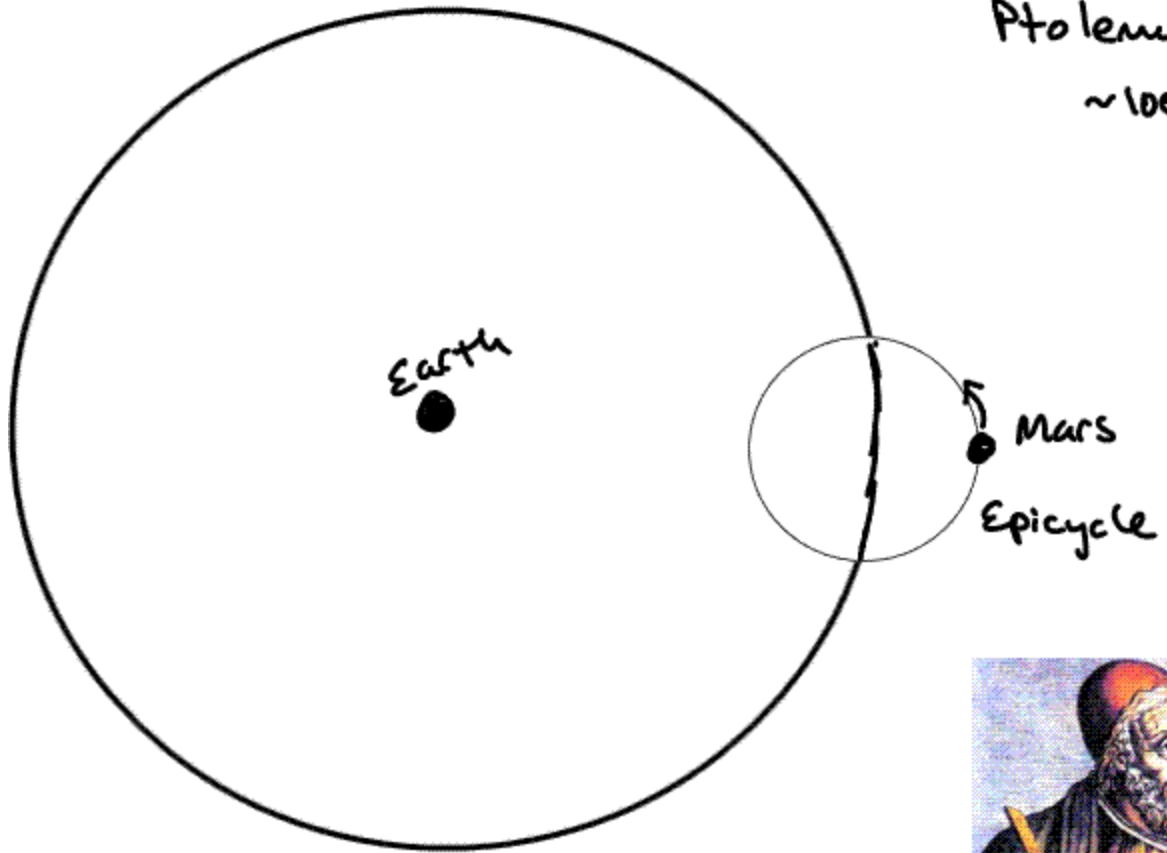


Plato ~ 400 BC ~ Multiple spheres



Aristarchus ~ 310 - 230 BC  
(Greek)

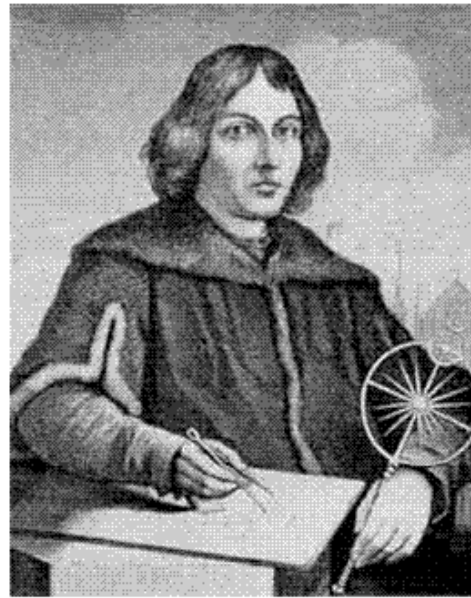
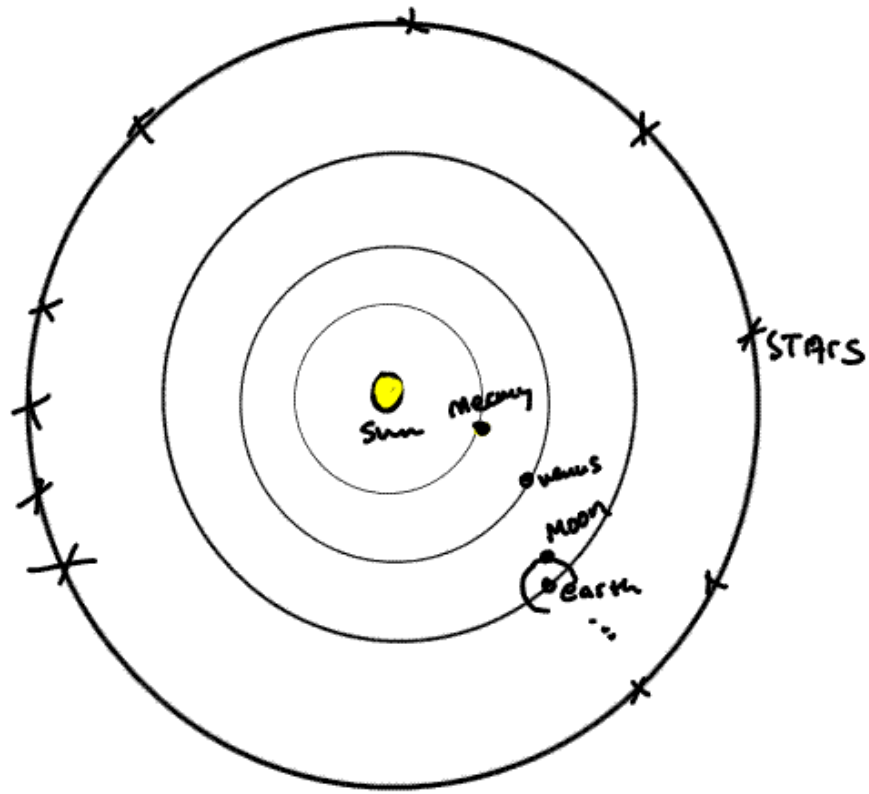
Proposed sun-centered universe  
→ rejected



Ptolemy  
~100 AD



Sun centered universe



Nicolaus Copernicus

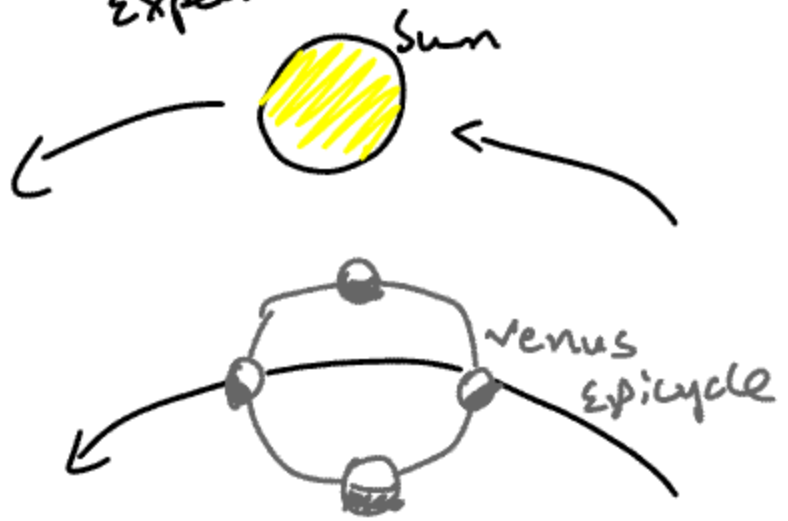
1473-1543

(Poland)

On the Revolutions of the  
Heavenly Spheres

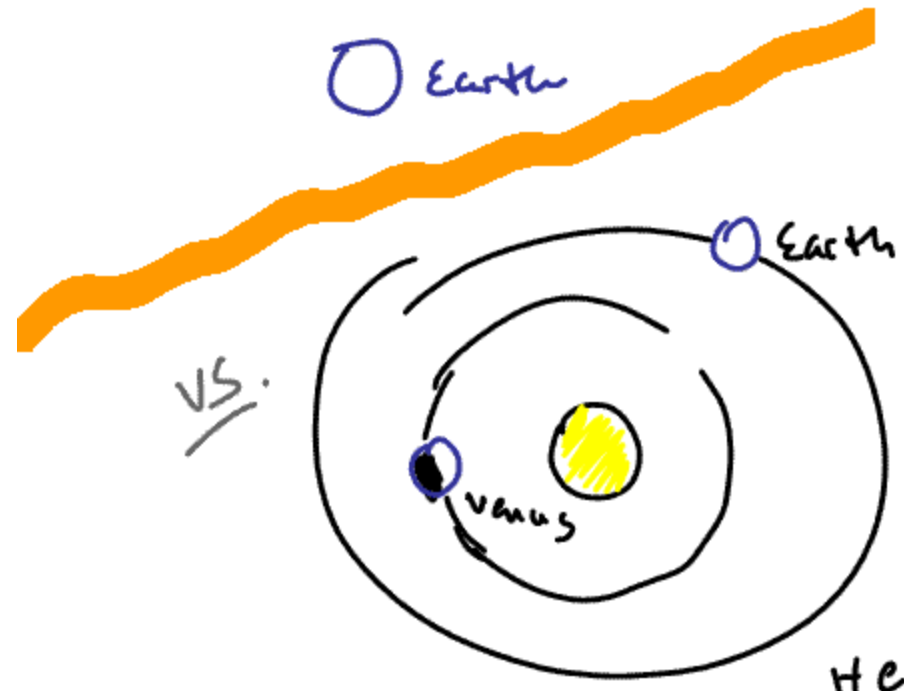
Please read "The Copernican Myths"  
in Reserve reading on Blackboard

Ptolemy  
Expectation



Galileo Galilei  
(1564 - 1642)

Observed phases  
of Venus



Heliocentric expectation



Tycho Brahe  
1546-1601  
(Dane)  
careful observations  
of positions  
of sun, moon, planets

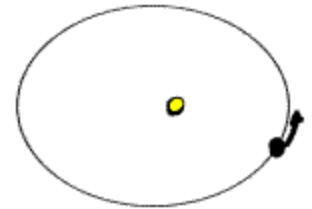


Determined 3 laws  
that mathematically  
describe orbits seen -  
relate periods, areas, axes . . . .

Brahe's data did NOT fit perfectly  
with Copernicus' theory



Johannes Kepler  
1571-1630  
(German)



⇒ Elliptical orbits  
fits the data!





Sir Isaac Newton  
1643-1727  
(England)

universal law of gravitation

$$F = G \frac{M_1 M_2}{r^2}$$

+

Laws of Motion

⇒ derived Kepler's

3 laws of planetary motion

## Copernican Principle:

Earth is not in a central, favored position in the universe.

Humans do not occupy a privileged position in the universe

## Mediocrity Principle:

There is nothing special about humans/Earth

If you observe a phenomenon (or an exceptional event), it should be assumed the event occurs other times/places under the correct circumstances

# Anthropic Principle

Brandon Carter - Australian astrophysicist

1973 "Although our situation is not necessarily central, it is inevitably privileged to some extent."

Weak anthropic Principle (Carter): Our location (space and time) in the universe is necessarily privileged to the extent of being compatible with our existence as observers.

Strong anthropic Principle: <sup>(Carter)</sup> The universe must be such as to admit the creation of observers within it at some stage

John Barrow, Frank Tipler (1986)

Weak anthropic Principle (Barrow + Tipler):

The observed values of all physical and cosmological quantities are not equally probable but they must take on values restricted by the requirement that there exist sites where carbon-based life can evolve and by the requirements that the universe be old enough for it to have already done so.

Strong anthropic Principle (Barrow + Tipler):

The Universe must have those properties which allow life to develop within it at some stage in its history.