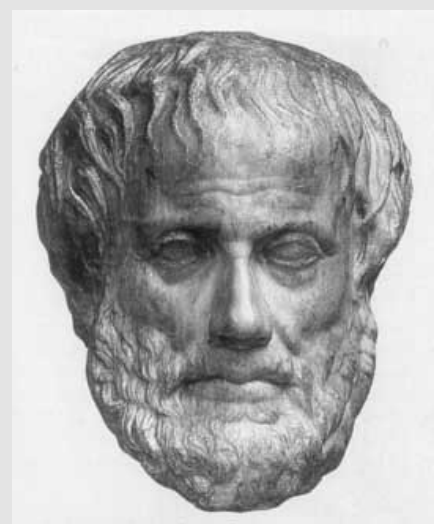


The Quest for Understanding Gravity

Phys 321: Theoretical Mechanics I

Spring 2018



Aristotle
(384-322 BC)

- Dogmatic view of the world
- Thought process is more important than experiments
- The earth is in the center of the universe

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Aristarchus of Samos
(310-230 BC)

Heliocentric model of the world

Rejected because:

- We do not “feel” the motion of the earth
- Stars show no parallax

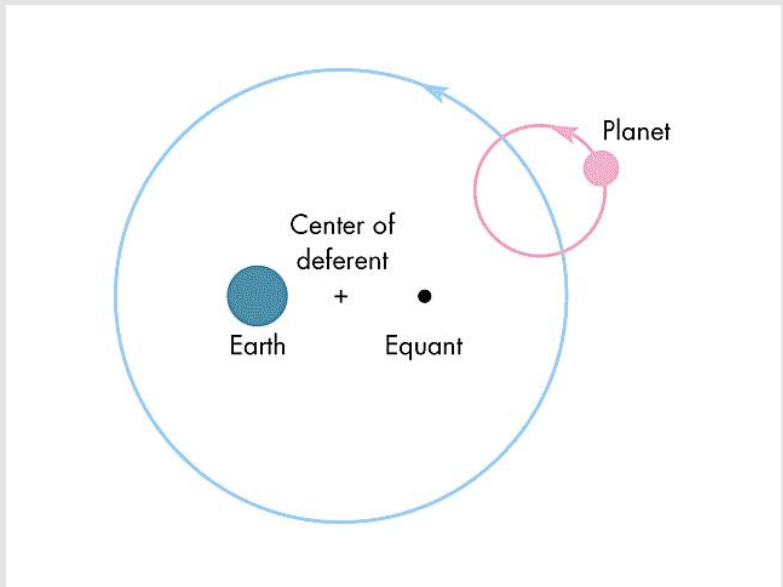


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Claudius Ptolemy
(ca. 100-170)

Epicycles!

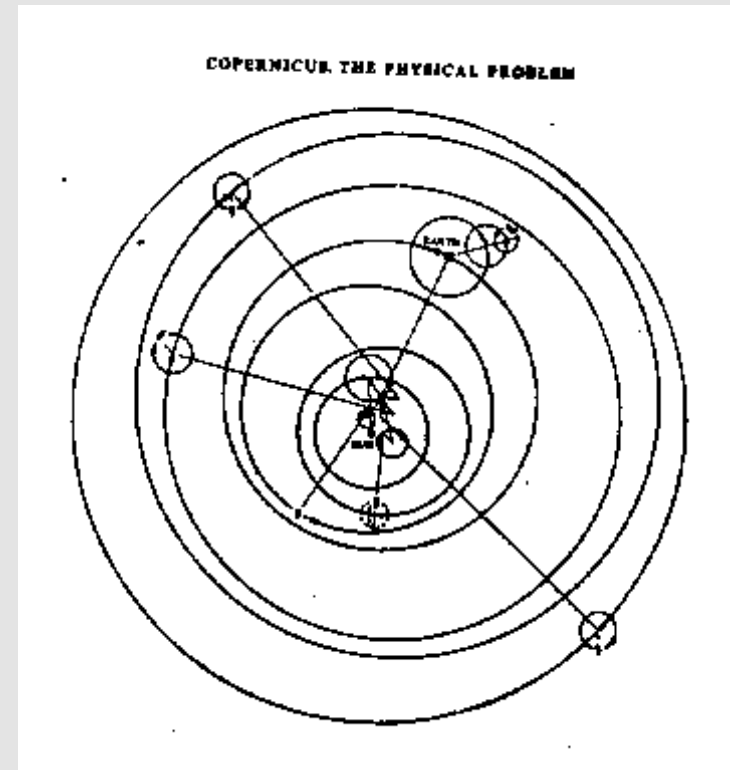


Some planets needed as many as 28 epicycles!



Nicolas Copernicus
(1473-1543)

Lack of symmetry leads to a heliocentric model



Needs at least as many epicycles!



Tycho Brahe
(1546-1601)

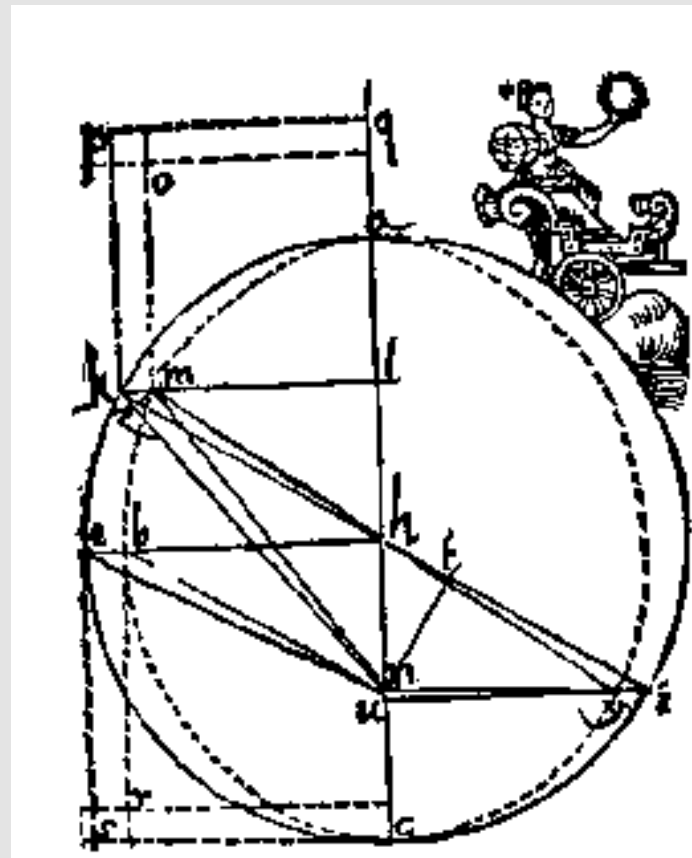
Highest quality observations before the discovery of the telescope





Johannes Kepler
(1571-1630)

Heliocentric model with elliptical orbits
3 laws of planetary motions



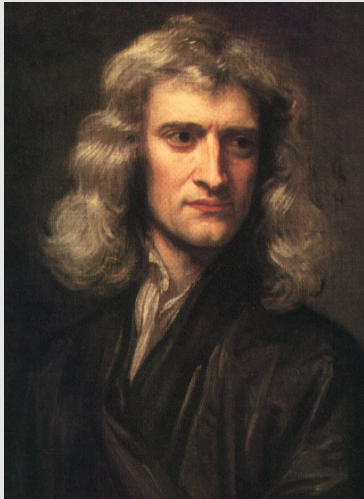
The orbit of Mars



Galileo Galilei
(1564-1642)

First observations made with a telescope

- **Venus has phases**
- **Jupiter has its own little “planetary” system (satellites)**
- **Sunspots**



Isaac Newton
(1642-1727)

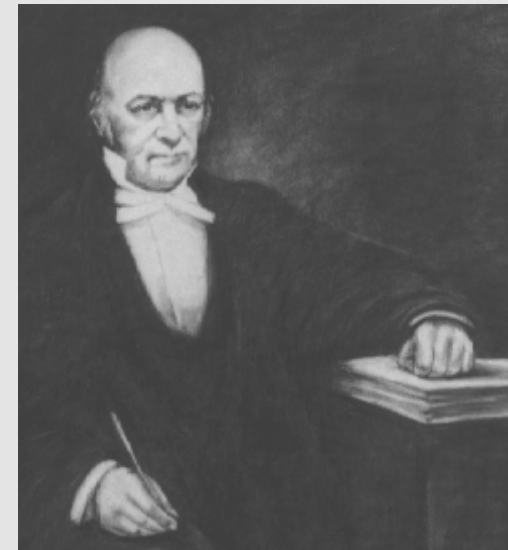
- **The concept of a central force**
- **Laws of Motion**
- **Inverse square law for gravity**



Leonhard Euler
(1707-1783)



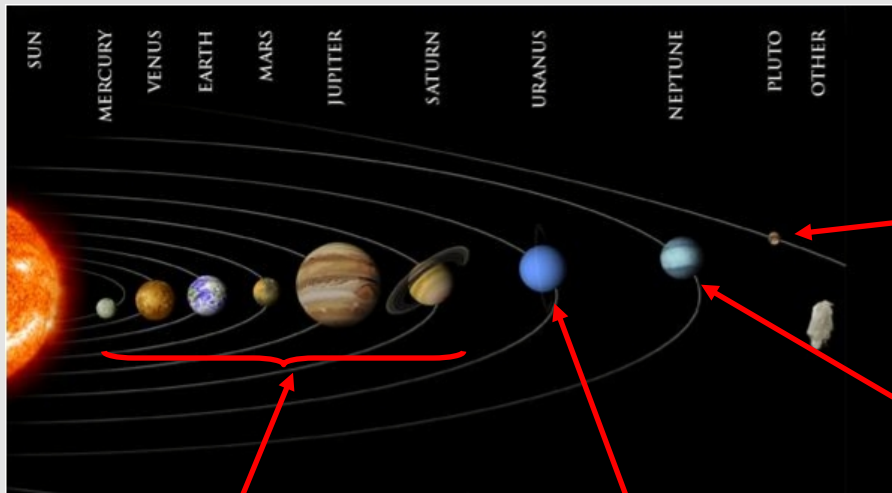
Joseph Louis Lagrange
(1736-1827)



William Rowan Hamilton
(1805-1865)



The predictive power of a theory



**Visible by eye
Known to the ancients**

**Chance discovery
with telescope (1781)**

**Predicted by theory
in 1843**

**Found by chance (1930)
while looking for planet X**



In this class we will cover the works of:

Isaac Newton
(1642-1727)

+

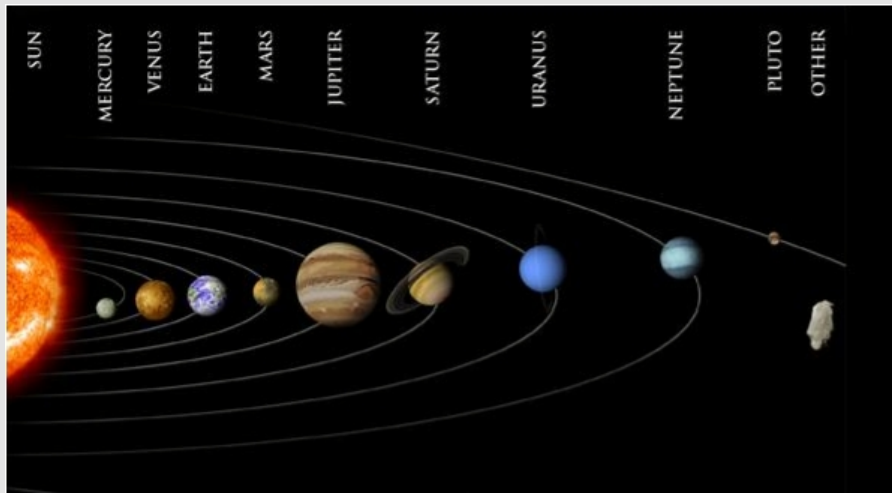
Leonhard Euler
(1707-1783)

Joseph Louis Lagrange
(1736-1827)

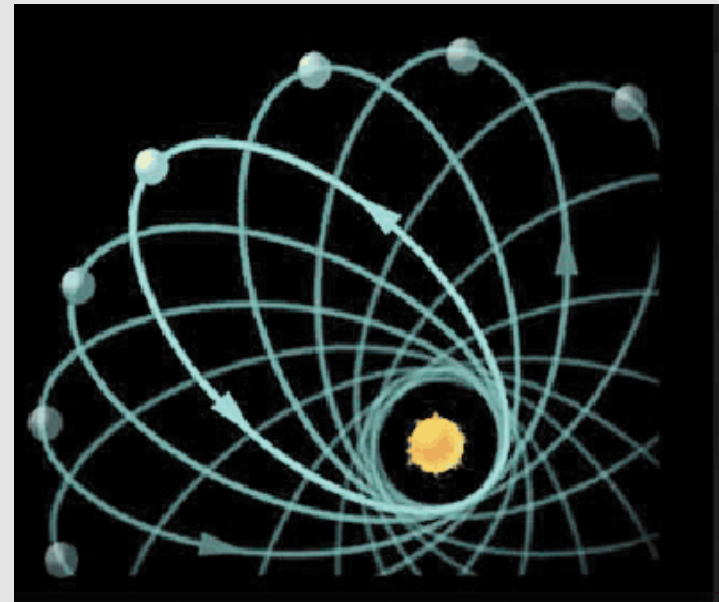
Sir William Rowan Hamilton
(1805-1865)



But one problem remained:



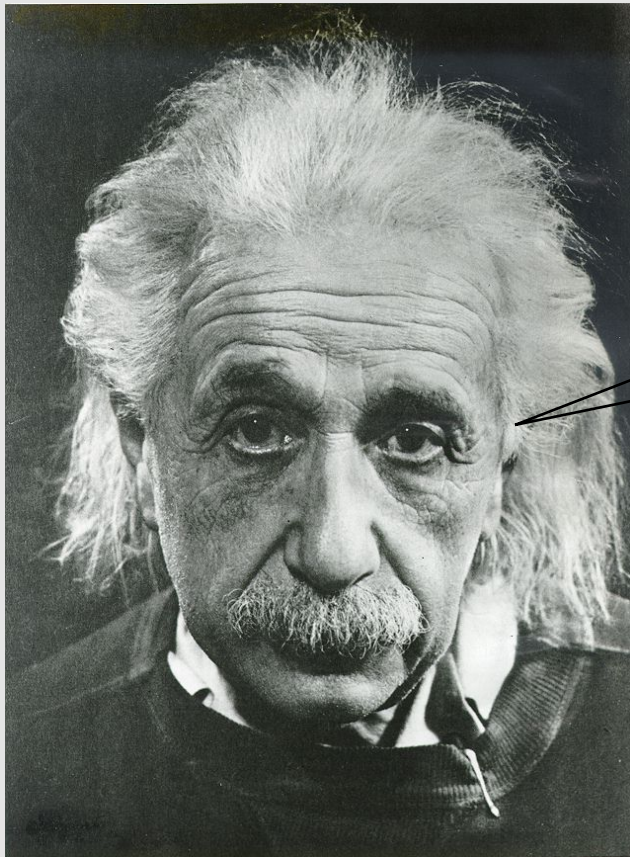
Mercury's orbit precesses...



A new inner planet?



Maybe not!



Albert Einstein
(1879-1955)

No such thing as central forces, inverse square laws, etc. Planetary motions are due to the curvature of the spacetime.

Laws of Physics are different

- **at high speeds**
- **around strong gravitational fields**



And things get even more complicated:

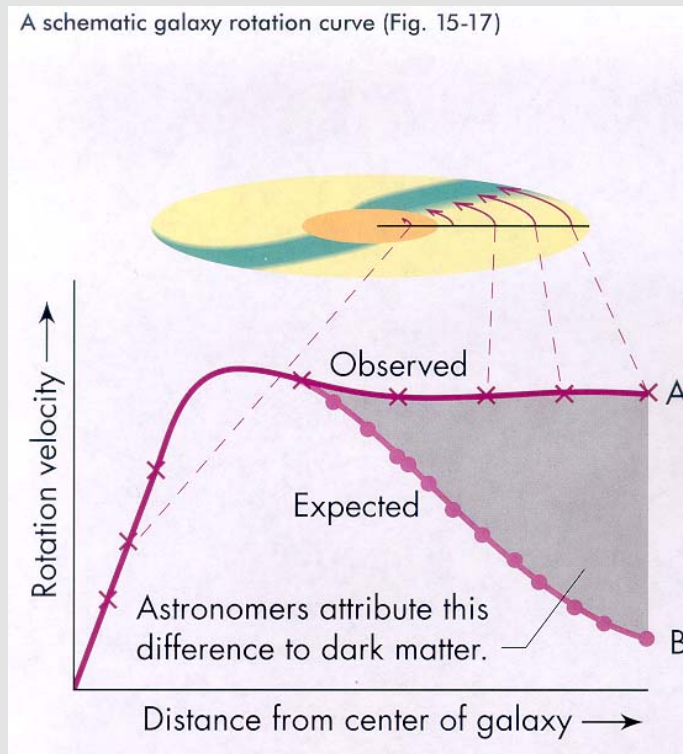
You cannot tell the position and the velocity of an object with infinite accuracy at the same time





What will the future bring?

- **Connection between relativistic gravity and quantum physics**
- **Behavior of gravity in very weak gravitational fields**



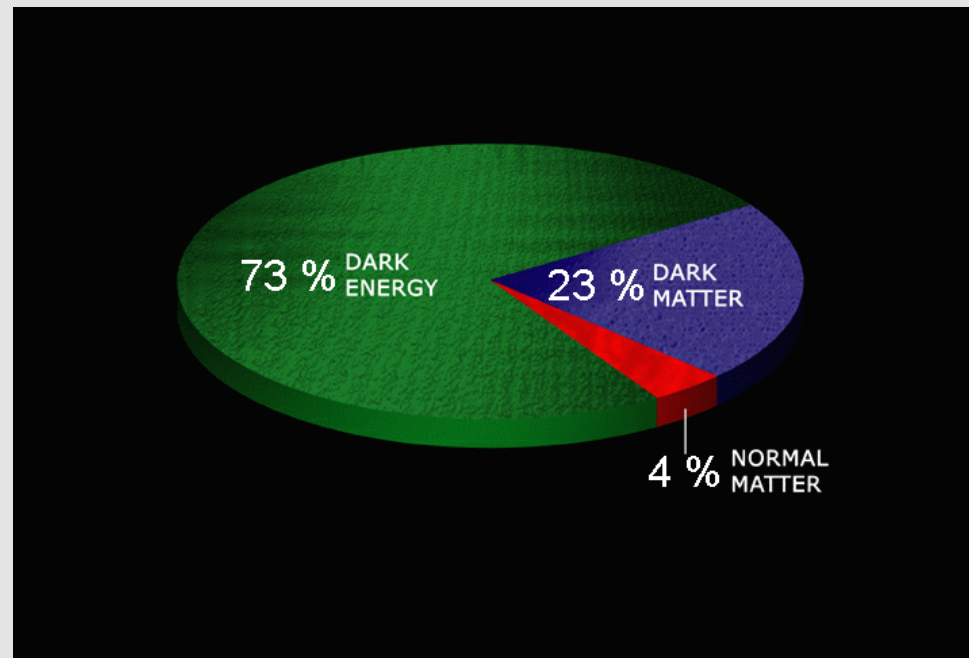
Dark Matter: Evidence for

- **Unknown form of matter?**
- **New law of gravity?**



What will the future bring?

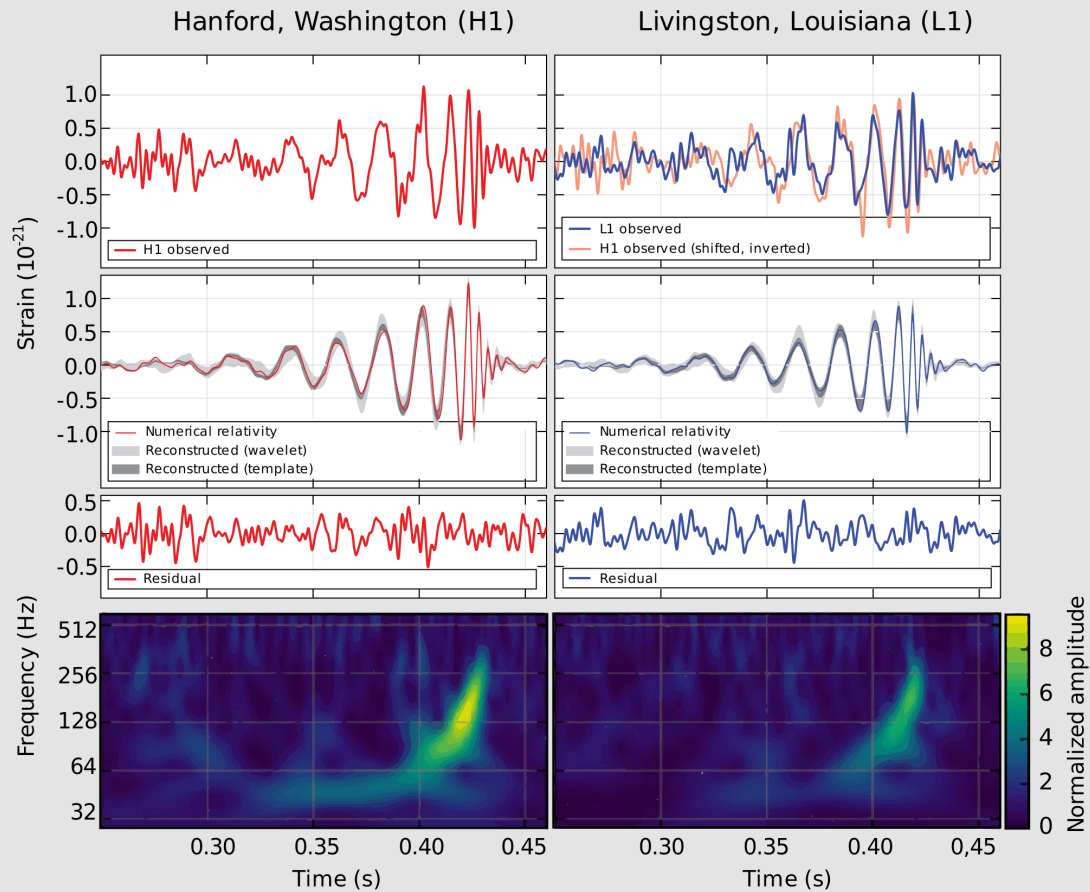
- **Connection between relativistic gravity and quantum physics**
- **Behavior of gravity in very weak gravitational fields**





What will the future bring?

➤ First Detection of Gravitational Waves with LIGO





What will the future bring?

- **First Image of a Black Hole with the Event Horizon Telescope**

