

Retrograde Motion

Relative to the stars, the Moon and Sun always move **prograde**, from West to East.

But, the planets *usually* move prograde, but have periods of reverse, **retrograde** motion.

Ptolemy's **geocentric** (Earth-centered) system explained retrograde motion with **epicycles** – complex, nested circular orbits.

Kepler's **heliocentric** (Sun-centered) system explained retrograde motion with **elliptical orbits**.

Kepler's Laws (1600)

Three laws that describe the planets' motions, even if they don't explain why.

1. Each planet moves in an ellipse, with sun at one focus
2. Line between sun and planet sweeps out equal area in equal time
3. $A^3 = P^2$, where A = distance (AU), P = orbital period (years)

Newton's Laws (1700)

Three laws that explained **why** the planets move like they do, and formed the basis of the science of **Physics**.

1. A body at rest stays at rest, and a body in motion moves at a constant speed in a straight line unless a force acts upon it.
2. A force acting on a body causes it to accelerate in the direction of the force and inversely proportional to the mass of the body.
3. For every force on a body, there is an equal and opposite force acting on another body

Galileo's Alleged Use for the Telescope

”Most Serene Prince. Galileo Galilei most humbly prostrates himself before Your Highness, watching carefully, and with all spirit of willingness, not only to satisfy what concerns the reading of mathematics in the study of Padua, but to write of having decided to present to Your Highness a telescope (“Occhiale”) that will be a great help in maritime and land enterprises. I assure you I shall keep this new invention a great secret and show it only to Your Highness. The telescope was made for the most accurate study of distances. This telescope has the advantage of discovering the ships of the enemy two hours before they can be seen with the natural vision and to distinguish the number and quality of the ships and to judge their strength and be ready to chase them, to fight them, or to flee from them; or, in the open country to see all details and to distinguish every movement and preparation.”

— Galileo to Prince of Venice Mar 1610

Is the Earth *Really* Round?

In groups of 3-4, **come up with an experiment** that could determine whether the Earth is **round** or **flat**. You can use any technology you like, but can't leave the Earth's surface to actually look at it. You can use the stars, the Sun, mountains, logic, boats – anything you like.

Think about what **Columbus, Aristarchus, Galileo, etc.** might have been thinking. Can you do better than them?