Overview

This application aims to teach planetary physics, including; Gravity, Forces, Circular Orbits, Elliptical Orbits, Planetary Rotation, and Component Forces. The simulation uses real world equations to calculate planetary trajectories, and can show physic overlays to help describe the different aspects that are in play. Click on a topic to find out more...

Gravitational Forces

Each planet in the solar system has a gravitational force due to the other planets in the system. The force between two bodies is given below;

Where , r is the distance between the two bodies, and m is the mass.

F1

F2

m2

m1

r

The force is equal on both bodies, however larger bodies of mass will be affected by it less. e.g. The Sun and the Earth. This is shown in the equation below;

In order for an orbiting body to achieve a circular orbit, it needs to have an equal and opposite force keeping it at the same altitude. If there is no body movement, then the planets will eventually collide. However, an orbit provides a centrifugal acceleration in the opposite direction to the gravitational force.

v

F

F = ma

F

The acceleration of the body is given by the following equation.

Where v is the velocity of the planet and r is the distance from the orbiting body. The force due to acceleration can then be found with the following equations;

Therefore, the velocity that is required to keep the planet in a circular orbit can be shown by making the Force due to gravity equal to the Force due to acceleration. i.e;

Where m1 is the mass of the parent planet.

Elliptical Orbits

All planets follow an elliptical orbit. The planets will be constantly changing velocity, depending on the current distance to the central body. The following equation will outline the different speeds of the body, and the initial required velocity to achieve an elliptical orbit with the desired semi-major axis.

Semi - minor Axis (b)

r

Semi - major Axis (a)

foci

foci

The relationship between the semi-major and semi-minor axis is shown in the following equation;

Where b is the semi-minor-axis, a is the semi-major axis and e is the eccentricity of the ellipse.

Where v is the velocity, G is the gravitational Constant, m is the mass of the body, and a is the length of the semi-major axis.

Orbital Period

Component Forces

Vectors are lines that have both magnitude and direction. To make them easier to understand, they can be shown by component forces. These forces make up the x and y axis of the vector.

𝜽

h

y

x