Gravity, Two-Body Problem

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ABSTRACT:

The two-body problem was first formulated by Kepler while studying astronomy. This app simulates the simple case of a two-body problem assuming the masses to be point masses and observed from the center of mass frame. Here in this app, we look at the motion of the two point-masses from the barycenter as origin and apply this simulation in the following cases:

I. To understand the dynamics of a two-body problem
II. Verify the Kepler's third law
III. Simulate the Earth-Sun system as a two-body problem

The simplest way to solve this problem is by using reduced mass method and converting it into central force problem. The trajectory of the bodies depends on initial conditions such as mass of the bodies, distance between them, initial velocities. The trajectory is simplified to the conical equation given by:

$$r(\theta) = \frac{p}{1 + e\cos\theta}$$

Where:

$r(\theta)$ is the radial distance between the two bodies

p is the semi-latus rectum,

e is the eccentricity of the conic orbit

We will illustrate different orbits (elliptical, circular, and hyperbolic) for different initial values of motion. The Kepler's third law of periods can also be verified to see the dependence of time period and semi-major axis. At the end, we will simulate the Earth-Sun system as a two-body problem with real measured values and compare our results with observations.

KEYWORDS:

Kepler's problem, Centre-of-mass, Barycentre, Angular momentum, Reduced mass, Orbit, Trajectory, Eccentricity, Orbital period