Pre-Proposal : Kepler's Laws

Jake Ribich

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1 Introduction and Background

Throughout the early years of astronomy, it was believed and accepted that the earth was located at the center of the universe. Based partially in science and partially in religion, this claim went virtually unquestioned for hundreds of years. However, in 1543 Nicolaus Copernicus published the extremely contraversial idea that this claim was actually false. He proposed the idea of heliocentricity, or the notion that the universe was centered around the sun, not around the earth. Between the years of 1609 and 1619, Johannes Kepler published a work which would strongly support this idea of heliocentricity. The work contained what would later be called Kepler's Laws of Planetary Motion, and went on to explain and describe the motions of the heavenly bodies. My goal with this project is to model these three laws, illustrating the motions of the planets while also mathematically proving them. All three laws will be dependent on the law of universal gravitation, which Newton defined as:

$$F = G\frac{Mm}{r^2}$$

Using this equation to determine the effects that each planetary body has on the other, their respective motions can not only be calculated, but easily illustrated.

2 Kepler's First Law

A planet revoves around the sun in an elliptical orbit with the sun at one focus.

2.1 Execution

This model will be relatively simple in the sense that only two objects need to be created. Three examples will be illustrated, each using the same sun but with varying sizes of planets. VPython will allow for the easy creation of each of the celestial bodies. After bestowing the size, position, and physical features if each object the universal law of gravitation will be used to determine the forces that are exerted. Updating each objects momentum by applying this force at varies points in time, the movement of the planets and sun will be accuratey illustrated to scale.

3 Kepler's Second Law

The line joining the sun to a planet sweeps out equal areas in equal times.

3.1 Execution

For the most part, the coding from the first law models can just be recycled. Thus will still provide an accruate illustration of the movements of the sun and planets. I plan to take advantage of the make trail function in order to show the amount of area covered over acertain period of time. This will be done by creating a line to connect the two objects, and creating the trail on this line. Another addition to the first law's code would be a display or print feature that will show the current area that has been covered. This will be added to counter the fact that estimating the area of a non-regular shape can be hard to do by merely looking at it.

4 Kepler's Third Law

The square of the period of revolution of a planet is proportional to the cube of the length of the major axis of its orbit.

4.1 Execution

There are currently two possbile options in order to model the third and final law. The first option involes recycling the same code from the first law once again. In this case, the same visual representations will be used, however, a print function would be added in order to display both the length of the major axis as well as the period of the orbit. The other option that I am considering, would allow the user to input the length of the major axis. The program would then use this input in its calculations of the period of revolution, and adapt the visual representation in order to accurately mdel the result.