Orbital Patterns of Martian Moons

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Abstract

This project's goal was to to create a top-down 2-dimentional model of the positional path of the moons of Mars, Phobos and Deimos. We created a Fortran 90 program to simulate the orbit of the two moons and generate data files for later analysis. The simulation will be provided some initial conditions of a given moon, and simulate the orbit over the course of one orbital period, as defined by NASA [2]

1 Introduction

An object in orbit is a simple kinematics problem illustrated in Fig. 1

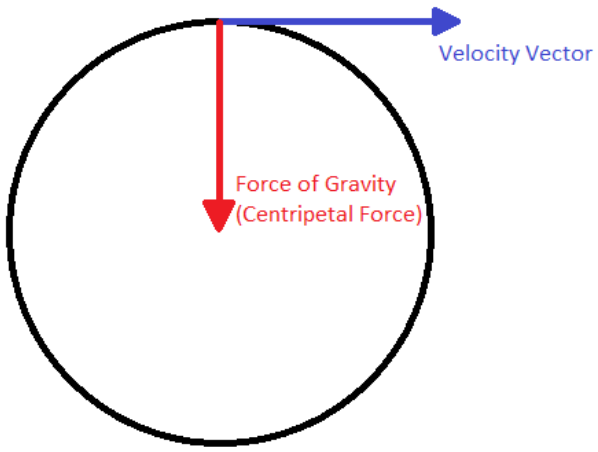

Figure 1: Centripetal force on an object with a velocity vector

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In Fig. 1 there is an object with an intial velocity vector and a centripetal force pulling it towards the center. The black circle represents the objects path over time. In the case of an orbit, the velocity vector is always perpendicular to the centripetal force vector. This is what the program is attempting to simulate, where the orbiting object is each of the Mars' moons, the center object is Mars iteself, and the centripetal force providing the acceleration to change each moon's velocity vector is gravity.

The program will need some initial conditions to be set before simulating the motion of Phobos and Deimos such as the initial position, the initial velocity, moon mass, Mars mass, gravitational constants, as well as time steps and a maximum simulation period. Initial velocity and gravitational constants are calculated by the program based of the properties in Table 1.

Moon Orbit Properties	Phobos	Deimos
Semi-Major Axis (km)	9378	23459
Mass ($10^{15} kg$)	1015	2.4
Orbital Period ($Earth\ days$)	0.31891	1.26244

Table 1: Properties of Phobos and Deimos as described by NASA [2]

The initial $x-y$ position is defined by each moons semi-major axis. The semi-major axis is half the length of the major axis of an ellipse. This is illustrated in Fig. 2 with both Phobos and Deimos labled.

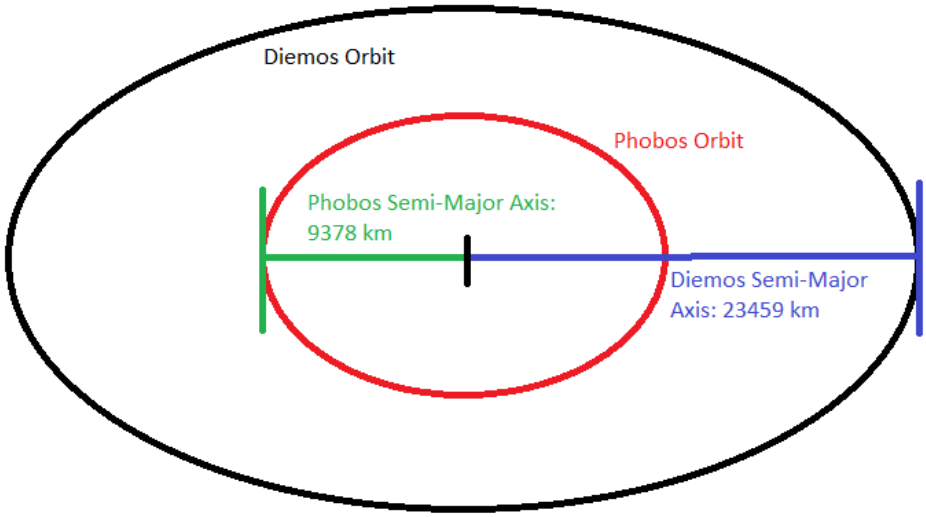

Figure 2: A depiction of the semi-major axis of both Phobos and Demimos

2 Theory

For every equation, you need to explain each variable, for example:

$$F = \frac{mv^2}{r} \ . \tag{1}$$

In Eq. (1), F is the force measured in Newtons, m is the mass in kilograms, v is the velocity measured in meters per second, and r is the radius of the curved path. Equation (1) was obtain from [1].

3 Computational Methods & Techniques

Include snipits of your code, DO NOT INCLUDE YOUR ENTIRE CODE HERE!!!! Write about the methods you used, make sure you ***explain*** the methods!! Don't just say we used "RK4", you need to explain what is RK4.

4 Results

Include ALL results here, including tables of results, plots of results, numerical values, etc... Make sure you include a figure caption for EACH figure. Make sure you include a table caption for each table. For example: In Fig. 3, the orbit is set to 2 full periods...

5 Conclusions

Summarize your results...This should be about a 1 page minimum!!!

References

[1] Douglas C. Giancoli *Physics for Scientists and Engineers*. Pearson Education Inc., Upper Saddle River, New Jersey, 2009.

[2] NASA *Mars Fact Sheet*. NASA, 2016 nssdc.gsfc.nasa.gov/planetary/factsheet/marsfact.html

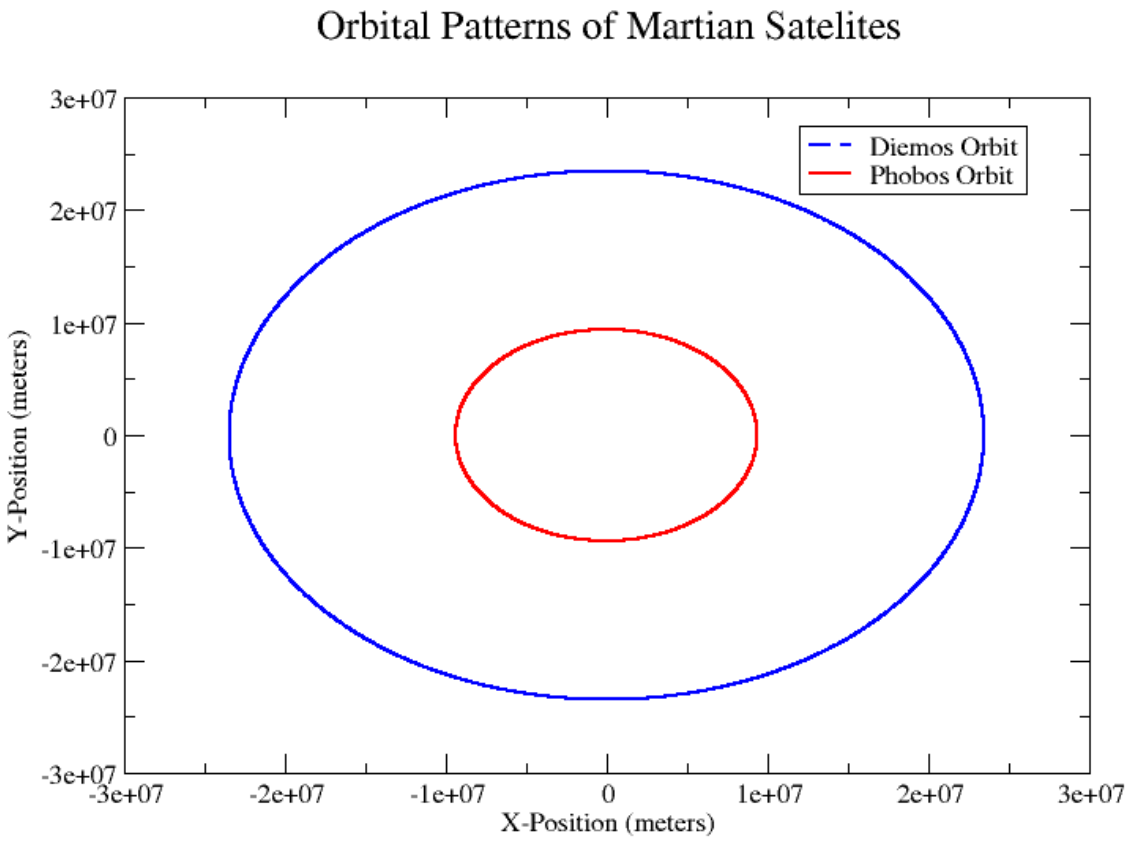

Figure 3: Orbital period in the $x - y$ plane for one full orbit of Phobos and Deimos orbiting Mars.