ATLAS Mission Proposal

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Problem

The ATLAS mission is proposed as a mission of space exploration in the hopes of finding evidence of habitable environments beyond Earth. We believe Titan, Saturn's largest moon, presents us with the unique opportunity of discovering a world outside our own that may sustain life as we know it, or perhaps life in unexpected forms. Our goal will be accomplished through use of the Autonomous Titan Lander and Asynchronous Satellite (ATLAS).

The main problem of interest here is how can we get ATLAS to Titan in an efficient and timely manner? And is it possible to place our satellite in a stable orbit in the Saturn-Titan system? This is going to require a well-developed simulation of the solar system based on Newtonian gravity. From there we will simulate the trajectory of the rocket carrying ATLAS and track it's total flight time and fuel consumption as it utilizes gravitational assists and orbital maneuvers.

Approach

Our course of action is similar to that laid out in `A.8. Dynamics of the solar system` from `assignment_07.pdf`. As suggested in `A.8.` our simulation will make use of the Velocity Verlet algorithm to simulate gravitational interactions. The NASA HORIZONS system will be used to gather the necessary ephemeris data. The trajectory of the spacecraft is to be first modeled as a body under the influence of gravity alone. The sum of forces acting on the object causes some known change in energy. The spacecraft will then be set to reach a given point in Saturn's orbit and the fuel consumption required to get there will be calculated as a function of the energy required to oppose those forces that would cause it to stray from its path.

Objectives

1. Gather necessary equations governing gravitational interactions, orbital mechanics, and powered space flight along with data from NASA HORIZONS.
2. Simulate motion of bodies of interest around the sun, i.e., ignoring sufficiently small or distant objects with negligible effect on the spacecraft.
3. Simulate the motion of the spacecraft on a given trajectory. Parameters at this stage should be allowed to vary in order to minimize time and energy.
4. Bonus: Determine whether a stable Lagrange point exists in the Saturn-Titan system, and if the ATLAS satellite can be placed there.