

Gravitational Impact of the Death Star on Endor and Earth-like planets

Simon Tebeck, Pranav Gupta
ASU PHY432 - April 2024

1 Problem

That's no moon. It's a space station. This iconic line from the 4th. episode of the Star Wars Saga introduced the Death Star to the protagonists, an enormous armed space station with a super laser capable of destroying whole planets. But when it can be confused with a moon, how massive is it and how strong is its gravitational impact on other objects? More specifically, if the Death Star is orbiting Endor or let's say Earth, does it have a measurable impact on the planet and the life on it? Does it create dangerous tides or change the gravitational force locally? And what does the sudden destruction of the space station imply physically?

An analysis of these questions mostly focuses on the study of Newton's Law of Gravity

$$F_G = G \frac{M_1 M_2}{r^2} \quad (1)$$

and further explores the three-body problem. However, more objects can be included to increase the challenge of the simulation, for example, the Earth's moon or other battle stations (e.g. Star Killer Base). In addition to that, many of the basic equations of motion will be used, including the ones of circular motion. All this will help find the answers to the question: What gravitational impacts does the Death Star have?

2 Approach

To succeed in this project, firstly a couple of input parameters must be obtained: Quantities like masses, volumes, or distances are needed, and while some of them are specified in fictional literature (see [here](#)), others are drawn from fan analyzes (see [here](#)) or will be estimated based on film footage (see [here](#)). The most important algorithm is the integration algorithm, and because of the conservation of energy, Velocity Verlet will be used mainly. To observe gravitational changes on the surface of planets, forces of many probe masses all around a sphere will be calculated, which also gives information about possible tide changes. Finally, the results should be visualized in an appealing plot, using the 3D functions of matplotlib.

3 Objectives

1. Obtain or produce estimations of significant quantities (masses, volumes, distances)
2. Simulate the orbits of Endor and Earth (with the moon) with and without the Death Star
3. Calculate the impact on the planet's surface (changes of the gravitational force and tides)
4. Find out what the sudden disappearance of the Death Star implies - does it destabilize the orbit of a planet? What happens if the mass falls down on that planet?

5. Visualize the most important results with 3D plots.
6. (Optional) Incorporate additional celestial bodies, such as Earth's Moon or the Star Killer Base, to enhance the complexity and realism of the simulation.
7. (Optional) Develop an interactive web application allowing users to modify parameters and visualize their own scenarios.