

FYS3150
Project 3 -

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<https://github.com/kryzar/Perseids.git>

Abstract

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Introduction

Chapter 1

Theory

In a first place, we will begin with an Earth-Sun system with the Earth orbiting around the Sun to test a simple algorithm and then we will add the other planets to have a simulation of the complete Solar System.

1.1 Earth-Sun system

1.1.1 Physical conditions of the system

The only force applied to this system is the gravity. According to the Newton's law, we have

$$F_G = \frac{GM_{\odot}M_{\oplus}}{r^2}$$

with F_G the gravitational force, G the gravitational constant ($G = 6.674 \times 10^{-11} N.m^2.kg^{-2}$), M_{\odot} the mass of the Sun, M_{\oplus} the mass of the Earth and r the distance between the Earth and the Sun.

We will neglect the motion of the Sun here as the mass of the Sun is much larger than the mass of the Earth (more than $300 \times M_{\oplus}$). We want to establish the motion of the Earth around the Sun. Moreover, we will assume that the orbit of the Earth around the Sun is coplanar in the xy -plane.

1.1.2

The Newton's second law of motion is given by $F = M \times a$ with F the force applied to the system, M the mass of the body concerned and a the acceleration. Applied to our case, we have $F_G = M_{\oplus} \times a$ which can be written in two equations :

$$\begin{aligned} F_{G,x} &= M_{\oplus} \frac{d^2x}{dt^2} \\ F_{G,y} &= M_{\oplus} \frac{d^2y}{dt^2} \end{aligned}$$

or

$$\frac{d^2x}{dt^2} = \frac{F_{G,x}}{M_{\oplus}} \quad (1.1)$$

$$\frac{d^2y}{dt^2} = \frac{F_{G,y}}{M_{\oplus}}. \quad (1.2)$$

with $F_{G,x}$ and $F_{G,y}$ the components of the gravitational force.

We will not use the SI units but the Astronomical units (AU) for the distance (with 1AU=average distance Earth-Sun = 1.5×10^8 m) and years for time units.

1.2 Three-body problem

1.3 The complete Solar system

Chapter 2

Implementation

2.1 Earth-Sun system

2.2 Adding one planet

2.3 The complete Solar system

Chapter 3

Results

3.1

3.2

3.3

Conclusion