1 Results

1.1 Euler and Verlet without oo

In order to make sure that our algorithm is running correctly, we will start solving the differential equation using both Euler's and Verlet's method without using object oriented(oo) code. The algorithms used to calculate the two are located in the following folders ((Euler) and (Verlet))

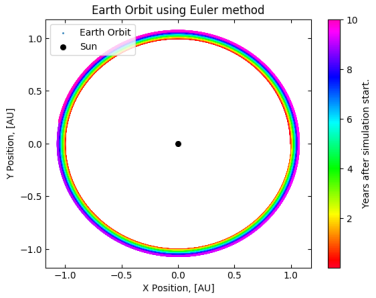

Figure 1: Earth orbit around the Sun using Eulers method

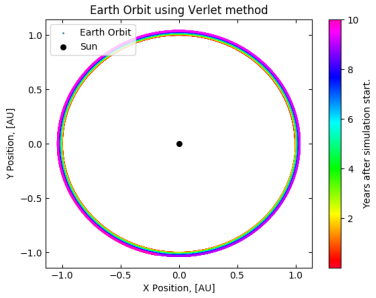

Figure 2: Earth orbit around the Sun using Verlet's method

1.2 Testing

1.2.1 Stability with varying timestep

In the figures below we plotted Earths orbit over a thousand years with different timesteps.

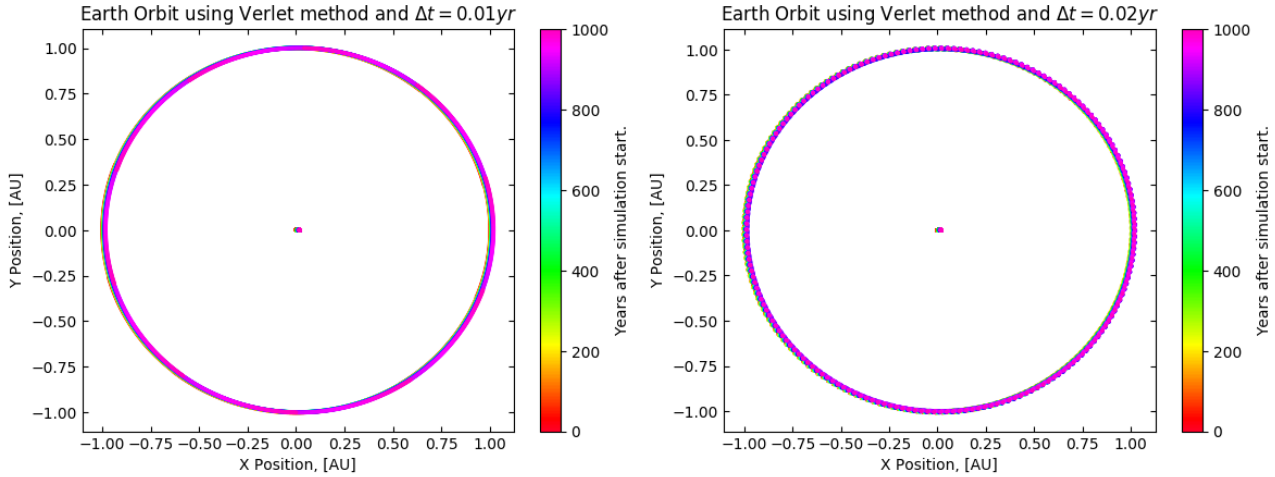

Figure 3: Earth orbit with time steps $\Delta t = 0.01$years and 0.02years respectively

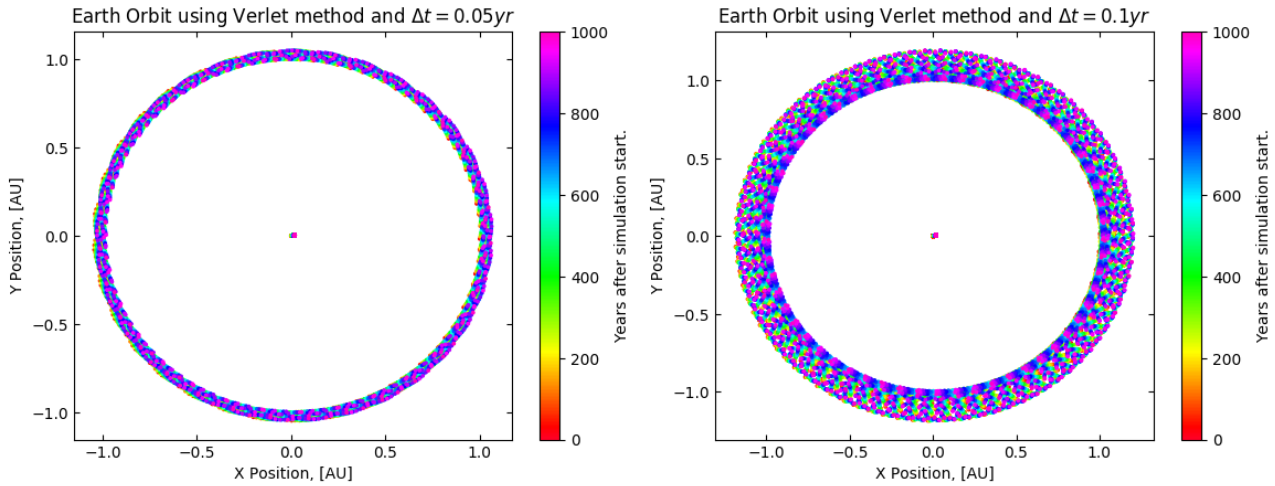

Figure 4: Earth orbit with time steps $\Delta t = 0.05$year and 0.1year respectively

1.2.2 Energy and angular momentum conservation

In the figures below, kinetic energy and potential energy is plotted as a function of time in the system. We chose to simulate over a thousand years with a timestep of $\Delta t = 0.01$, as this gives the most stable results.

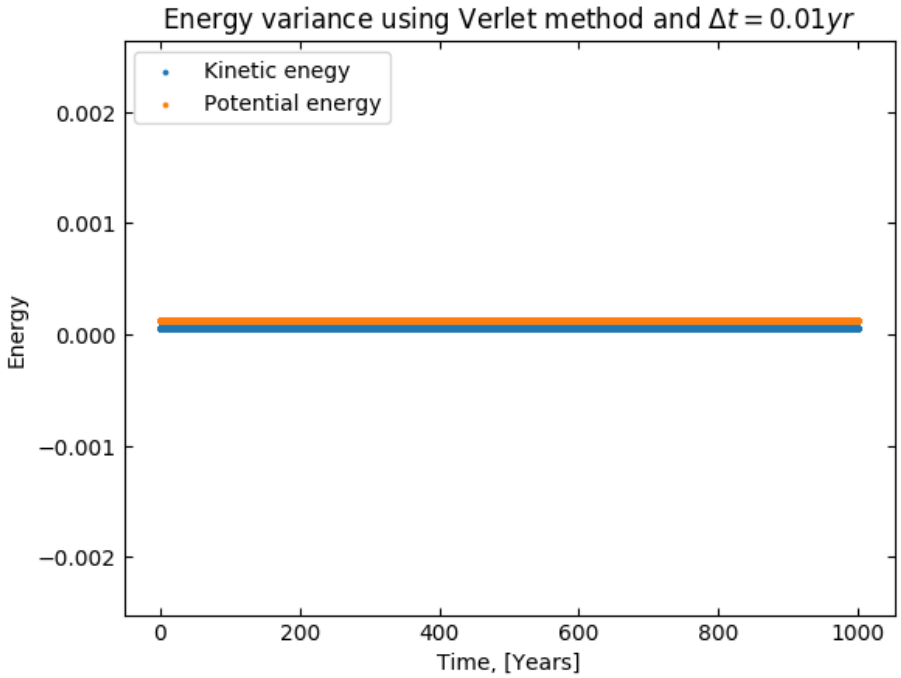

Figure 5: Kinetic and Potential energy with timestep $\Delta t = 0.01$year.

1.2.3 Verlet vs. Euler

Table 1: Comparison of flops and time for the Verlet and Euler method for 100000 iterations over a period of 10 years

	Flops	**Timing**
Euler's method:	10N	2580 ms
Verlet's method:	6N	2875 ms

1.3 Escape velocity

By trail and error the escape velocity of planet Earth is: From section **??** using equation **??** to calculate the theoretical value

$$v_{esc-theoretical} = \sqrt{\frac{2 \cdot 4\pi^2 \cdot 1}{1}} = 2.83\pi$$

We also looked at what happens when changing the exponent of the denominator the force of gravity from 2 towards 3 with initial velocity $v_{initial,x} = 2.2\pi$. This is shown in the following plots.

Figure 6: Escape velocity of planet Earth

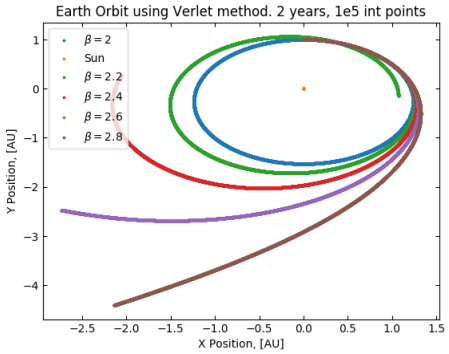

Figure 7: Escape velocity with increasing exponent of denominator

1.4 Three-body problem- Sun, Earth and Jupiter.

Stability Verlet solver with increased mass:
Sammenlign resultetene med de tidligere.