PHYS4061 Computational Physics 2024-2025
Homework 03

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This is a small report to explain the difference in energy conservation between the two chosen integration methods:

- Euler Method
- Leapfrog Method

Here is the energy plot over time for different integration methods under the same initial conditions:

Euler Method

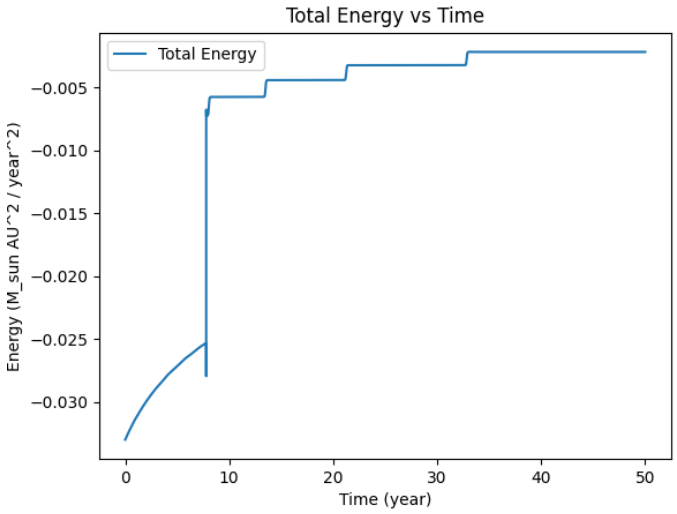

Figure 1: Euler Method

Leapfrog Method

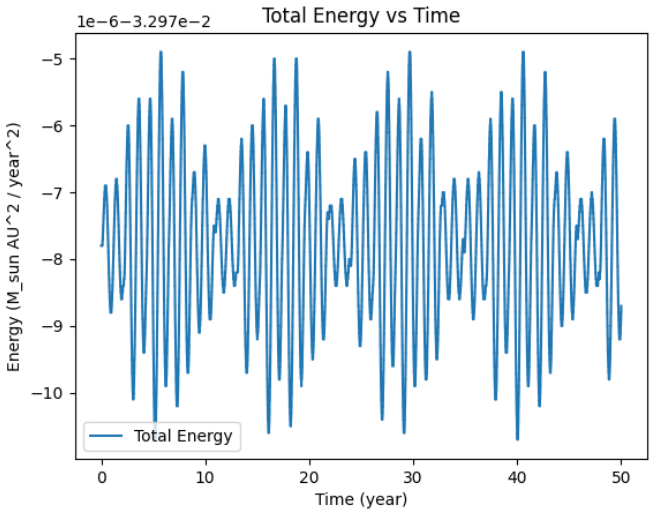

Figure 2: Leapfrog Method

By observation, the energy in the Euler method increases over time, while the energy in the leapfrog method fluctuates over time with bounded amplitude. This shows the Euler method fails to conserve energy and the leapfrog method has a better ability to simulate a conserving system.

The local truncation of error for the Euler and Leapfrog method is $O(h^2)$ and $O(h^3)$, but a higher error order does not imply a better ability to conserve energy. It is because the Leapfrog integrator is a "symplectic" integrator due to its symmetric pattern in its algorithmic structure, which makes it good for conserving systems.

For more details, please check the code attached.