Particle and Planet Orbits

The aim of this project is to use a particle integrator to investigate particle and planet orbits. It is expected that the project report 1) addresses the underlying principle of symplectic integrators in a brief theoretical discussion, and 2) uses them numerically.

To expand on the use of symplectic integrators, and benefit from higher precision when performing long term orbit integration, the 4th order Candy-Rozmus / Forest-Ruth integrator (see reference material on Absalon under Week 8) could be used.

Several options for long term orbit exploration are available, including

- integration of a specific Solar System setup (Kirkwood gap, giant planets + Pluto, resonances, stability of the giant planets when increasing their mass).
- A Cython version of the particle integration module could be explored for speeding up the computation.
- Stability of the Lagrange points (including a brief discussion of the Lagrange points)
- Investigation of the classical three-body problem

For precision / stability, it will probably be useful to use a constant timestep, dictated by the innermost planet under consideration. An alternative is to use the method developed in exercise 7a with a symmetric timestep. For simplicity, it is useful to have the same timestep for all bodies, to avoid interpolation when computing the mutual gravitational forces.

It is not expected that the report covers all these subjects, so a choice has to be made on exact what to include. The final report is expected to be around 4 pages in length.

References:

- Articles about symplectic methods are available on Absalon (Forest-Ruth-4th-order.pdf and Yoshida-review.pdf)
- Initial conditions for the planets in the Solar System can be found at JPL: https://ssd.jpl.nasa.gov/horizons
- A discussion of the Kirkwood gaps is available on Absalon (nature07778.pdf)
- Overview about the stability of the SS: http://www.scholarpedia.org/article/Stability_of_the_solar_system