PHYS358: Session 05

Ordinary Differential Equations (5): Symplectic Integrators

The Kepler problem seems a straight-forward ODE problem. As you saw in the homework, the problem can be easily written in terms of a set of coupled ODEs. For low particle (e.g. planet) numbers, the direct summation is sufficient for calculating the accelerations.

Here, we take a deeper look at the Kepler problem and how to integrate it such that the laws of physics are actually followed.

(a) Earth's Orbit: Please download the class package, and run `kepler.py` with the following parameters:

```
euler 3
rk2 3
rk4 3
rk5 3
```

For each test, check the orbit (it's supposed to be Earth's orbit), and write down the maximum relative change in total energy and angular momentum. You also can try Mercury (1), or any of the other planets (and, no, I'm not going to make a joke about Pluto).

(b) All Planets: Repeat the above, for all planets (`python kepler.py euler all`). Explain the result in the context of your findings in (a) above.

Surely, using a more accurate integrator, you should get better results. Try `python kepler.py rk4 all`, and then repeat for `rk5`. For `rk5`, do you expect the results to be stable if you integrate this for a longer time? Why (not)?