PHYS358: Session 01, Group B

Ordinary Differential Equations I

The Kepler problem does not need much explanation. You probably met it in P401 in its specific form of a two-body problem. Here, we'll generalize it to an arbitrary number of bodies, eventually investigating the stability of the Solar system.

Derive the set of coupled ODEs describing the planar motions of planets around a central star (i.e., we assume that the motions are in a two-dimensional plane). Each body feels the gravitational forces of all other bodies.

1. Assuming $1 \ldots n$ bodies, with e.g. $n = 9$, write down the gravitational force of bodies $j \neq i$ acting on body i.
2. Derive the ODEs from the force equation.
3. If you double the number of bodies, by what factor will the computation time increase?
4. Sketch the time evolution of the total energy (kinetic and potential) of the system, and the evolution of the total angular momentum.