Solar System Unit 4: Observables

Computer Modelling

Due: Due: 16:00 Monday, Week 7, Semester 2

Aims

In this fourth unit of the project you will add code to measure key observables from your simulation. They are:

- The total energy and its fractional deviation from a constant value.
- The periapses and apoapses of orbits.
- The periods of orbits.

1 Tasks

1.1 Energy

Your code should already be computing the total energy of the system at each time step. Add code to compute the energy deviation $\Delta E/E_0$ as described in the background information, and print or save it at the end of the simulation.

1.2 Apsides

Add code to your simulation to compute the minimum distance of each body from the sun (perihelion) and the maximum distance (aphelion), and also the minimum and maximum distance of the moon from the earth (perigee and apogee).

1.3 Periods

Add code to your simulation to estimate who long it takes for each body to orbit the sun, and how long it takes for the moon to orbit the Earth.

There are several ways to do this. Ensure that if the method you use fails, e.g. because the planet has only partially completed its orbit, then the method indicates this to the user in some way, for example by returning zero or the special value called `NaN` (short for "Not-a-Number"). You could also try to estimate the period from a partial orbit, but this will always involve assumptions. Check in particular that your method works with Neptune - the wobbles in its orbit can cause some approaches to give the wrong result.

You should check that for a long enough simulation your results are reasonably close to the true values.

Note that it is **not** okay to estimate the period from Kepler's Laws based on the apsides. This defeats the whole point of doing a simulation, and will get no marks.

1.4 Showing results

Your code should print out all the observables you compute in this task. Ideally it should be flexible and work for different input files.

You should check that for a long enough simulation your results are reasonably close to the true values for the periods and apsides.

Optionally, you might want to also save the various observables you computed in this unit to a file, in order to help you later on when writing the report. This is not required, but can be useful to you. If you do this, keep your documentation and help messages up to date.

You can change the command line interface if you wish.

2 Submission

2.1 Submitting

Submit a zip file through Learn as explained in the background briefing. Successful submissions are emailed a receipt.

Always check your code runs one final time before submitting.

2.1.1 What to submit

Ensure you submit at least:

- the main python file.
- the particle3D file.
- any other python files needed to run the code - e.g. a basic functions file if you kept it separate.
- A small readme text file explaining how the user should run the code.

2.2 Marking Scheme

This assignment counts for 10% of your total course mark.

1. Energy deviation calculated correctly **2**
2. Aphelia are calculated reasonably. **3**

3. Moon apogee and perigee are calculated. **2**
4. Periods calculated reasonably. **5**
5. Periods calculation is robust. **3**
6. Moon orbital period around Earth is calculated **3**
7. Code works for different input files **2**

Total: 20 marks.