PHY 407 Lab 1

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1 Question 4 Pseudocode

- DEFINE gravitational constant in units of AU, Msun and years ($39.5\,AU^3 M_{sun}^{-1} yr^{-1}$).
- DEFINE initial time, final time and timestep (t_i, t_f, Δt).
- CREATE sampled array of time based on the above criteria.
- SET dependent variable arrays (x,y position and velocity as well as total separation r) to be arrays of zeros as long as the sampled array of time.
- SET initial positions and velocities in x and y.
- FOR values in time array:
  - CALCULATE updated velocities ($v_{x,i+1}$,$v_{y,i+1}$) with $v_{k,i+1} = -\frac{GM_{sun}k}{r^3} \cdot \Delta t + v_{k,i}$.
  - CALCULATE updated positions (x_{i+1}, y_{i+1}) with $k_{i+1} = v_{k,i+1} \cdot \Delta t + k_i$.
  - CALCULATE updated separation (r_{i+1}) with $r_{i+1} = (x_{i+1}^2 + y_{i+1}^2)^{1/2}$.
- PLOT y vs x, v_x vs t and v_y vs t.

2 Question 5 Plots

Plots produced with code written in lab1q5.py follow below.

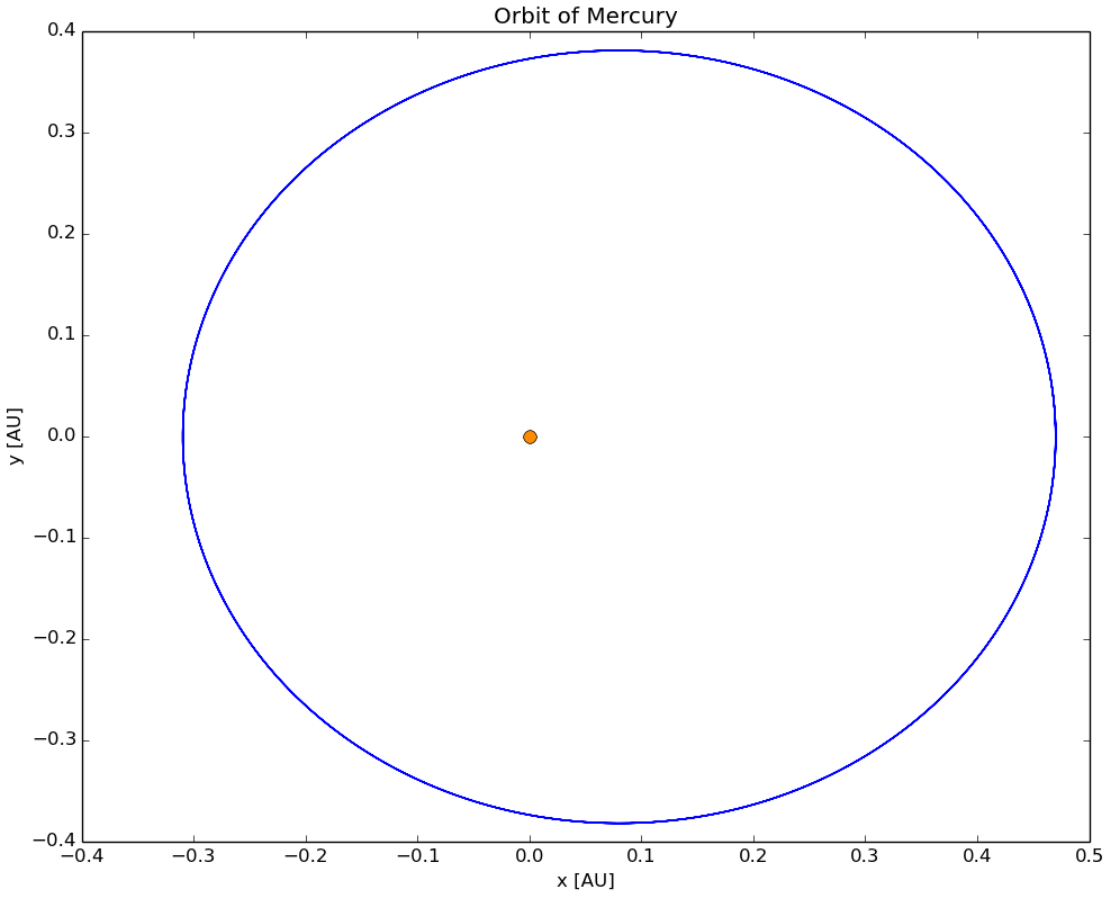

Figure 1: Orbital position of Mercury over the course of one Earth year. The yellow dot marks the Sun's position.

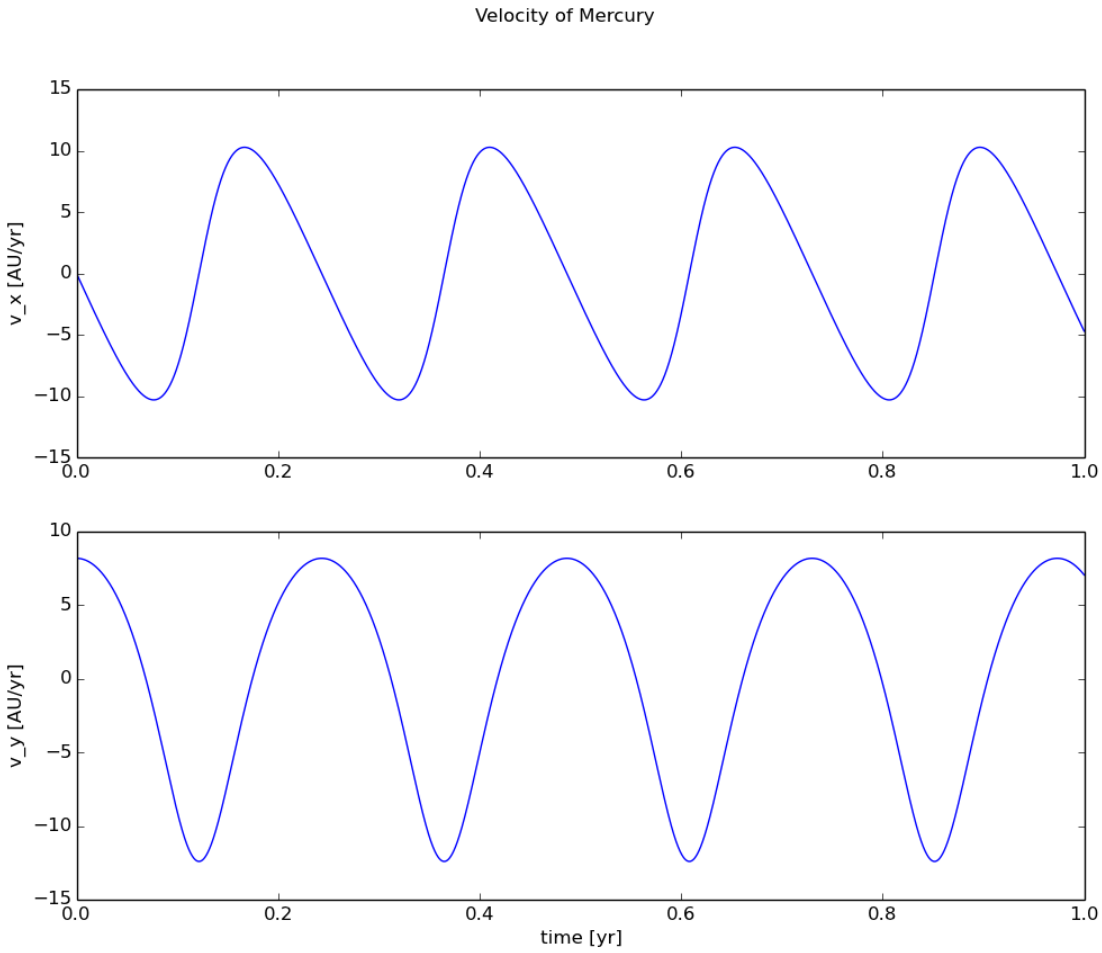

Figure 2: Velocity of Mercury in each dimension over the course of one Earth year.

3 Question 6 Plot

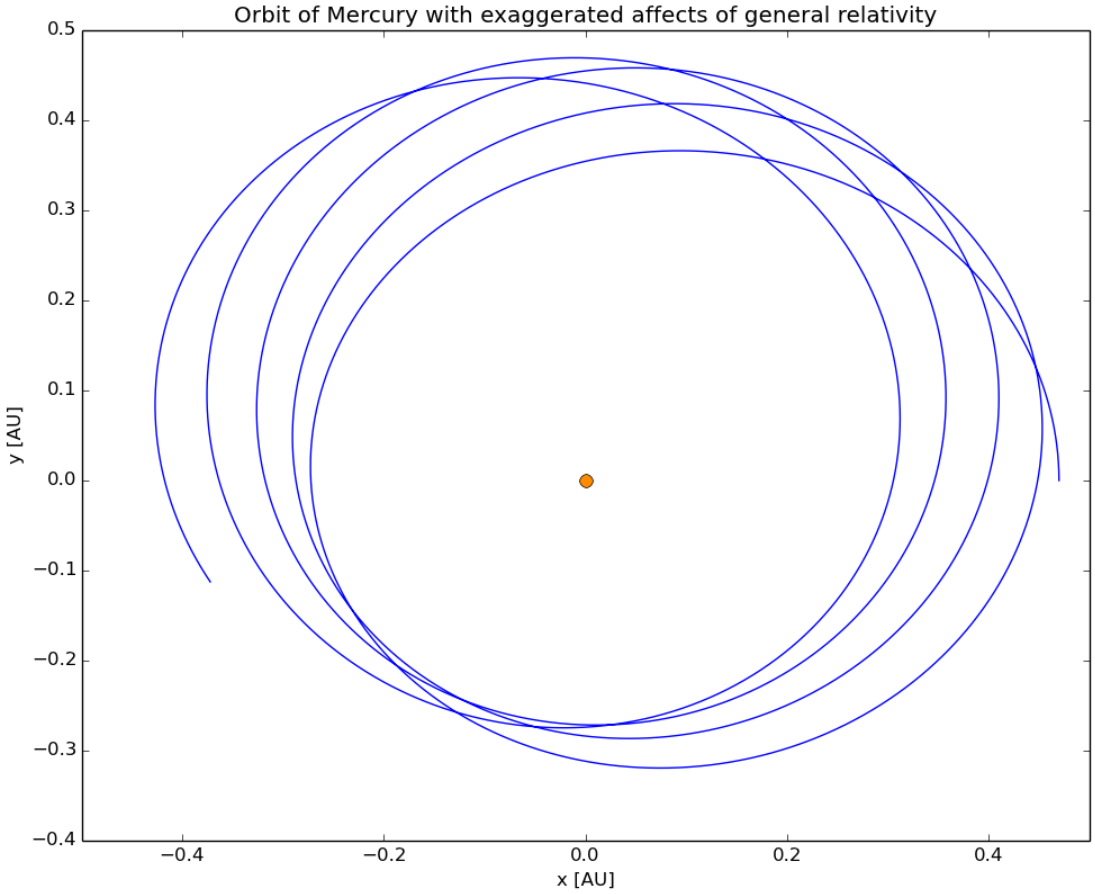

Figure 3: Orbital position of Mercury over the course of one Earth year with exaggerated affects of general relativity ($\alpha = 0.01\,AU^2$). The yellow dot marks the Sun's position.

4 Question 7 Plot

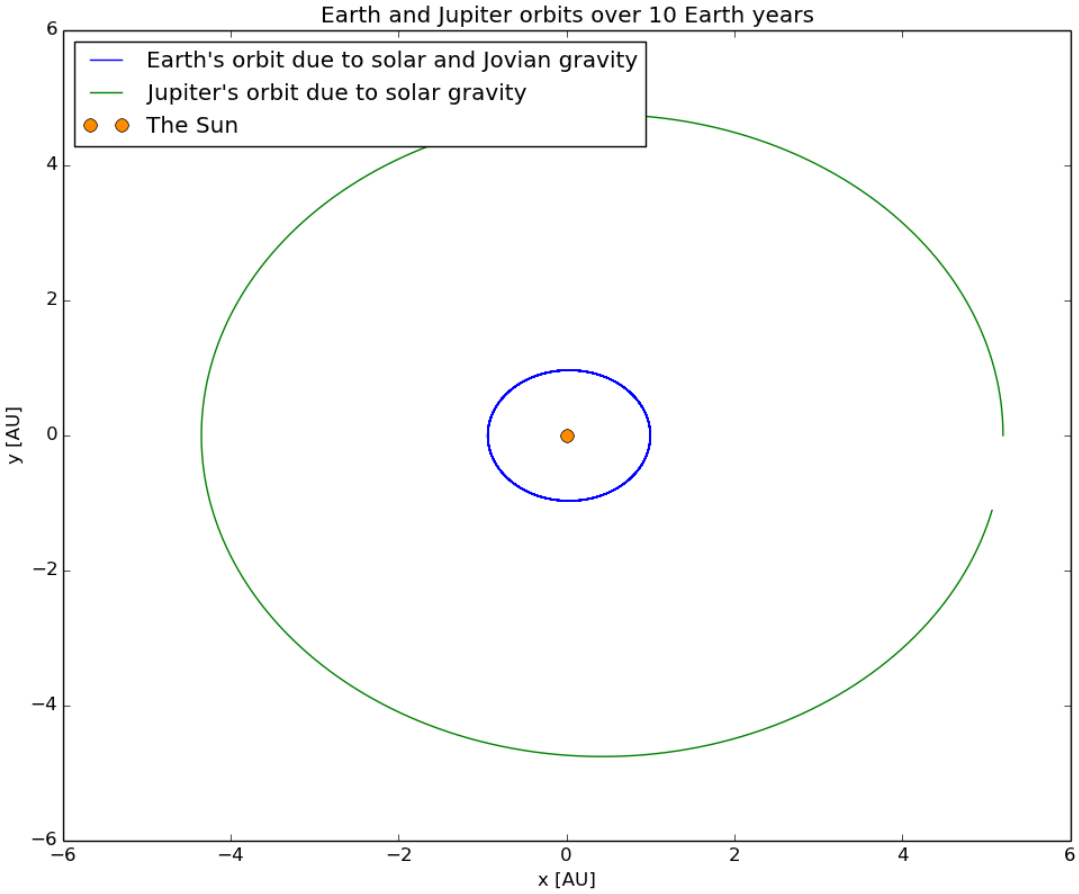

Figure 4: Orbital position of the Earth and Jupiter over the course of 10 Earth years, with the mass of Jupiter as $M_{jup} = 1 \times 10^{-3}\, M_{sun}$.

5 Question 8 Plot

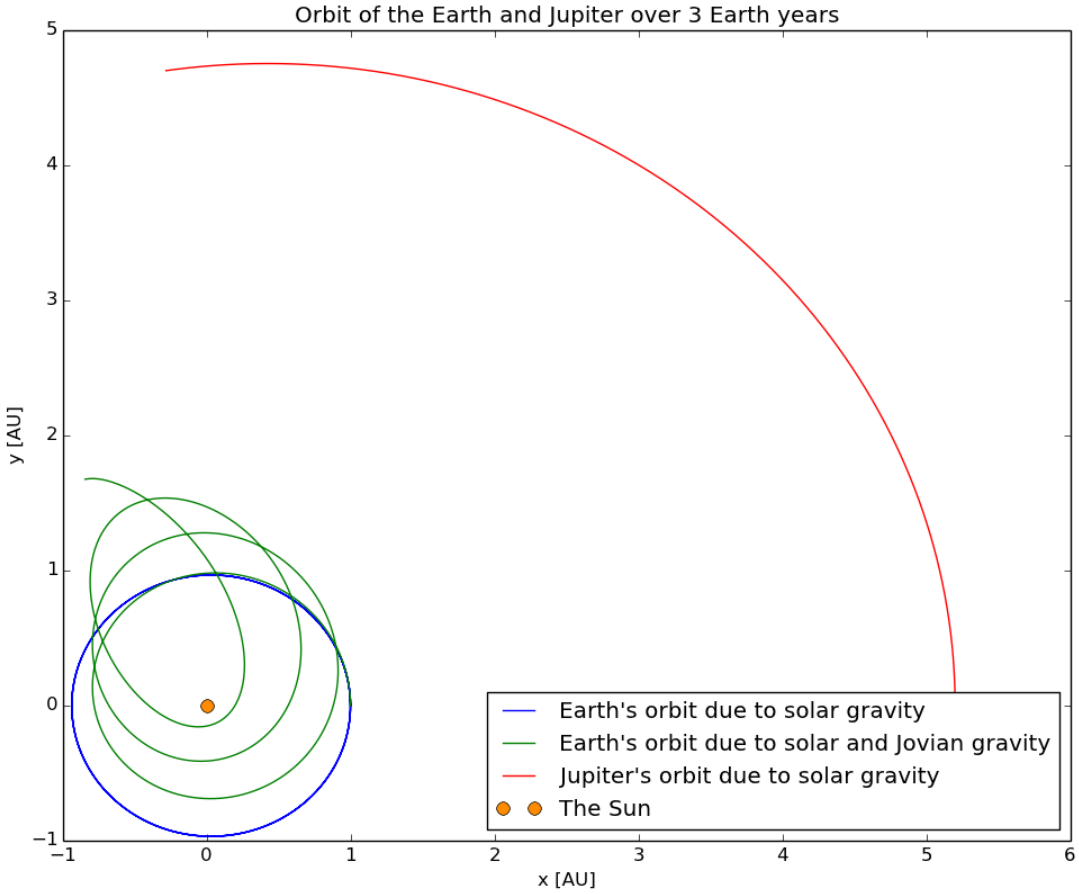

Figure 5: Orbital position of the Earth and Jupiter over the course of 3 Earth years, with the mass of Jupiter as $M_{jup} = 1\,M_{sun}$.