Lab1 Qeustion 1 (c)

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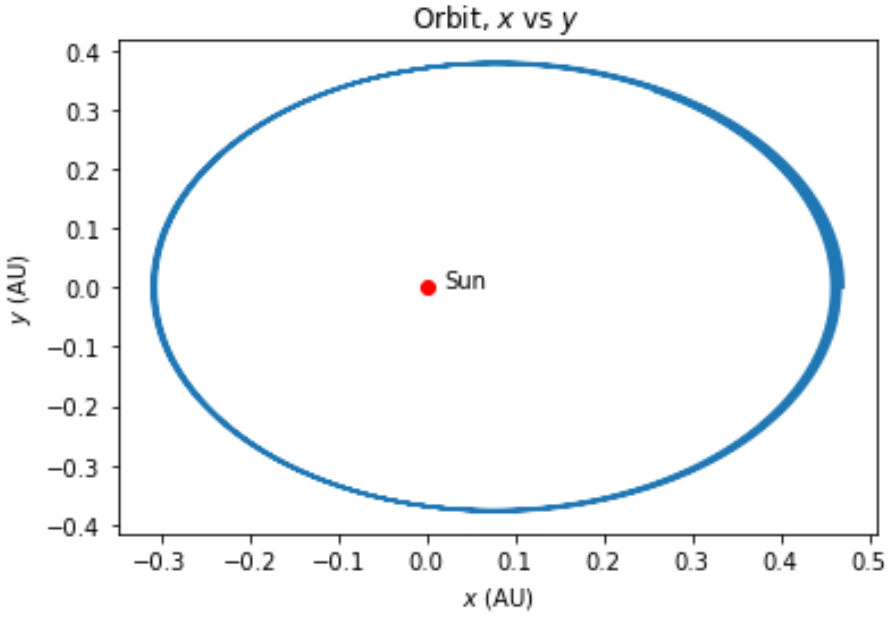
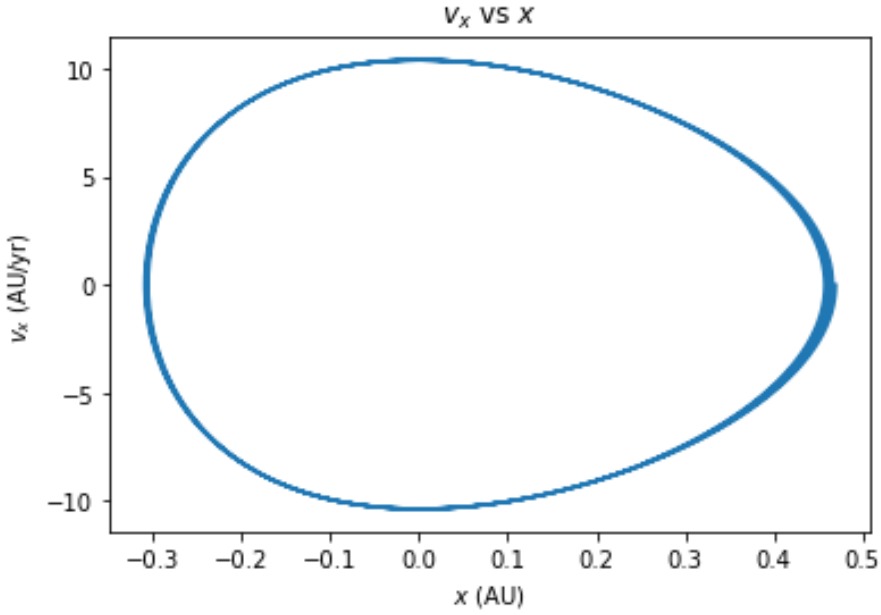
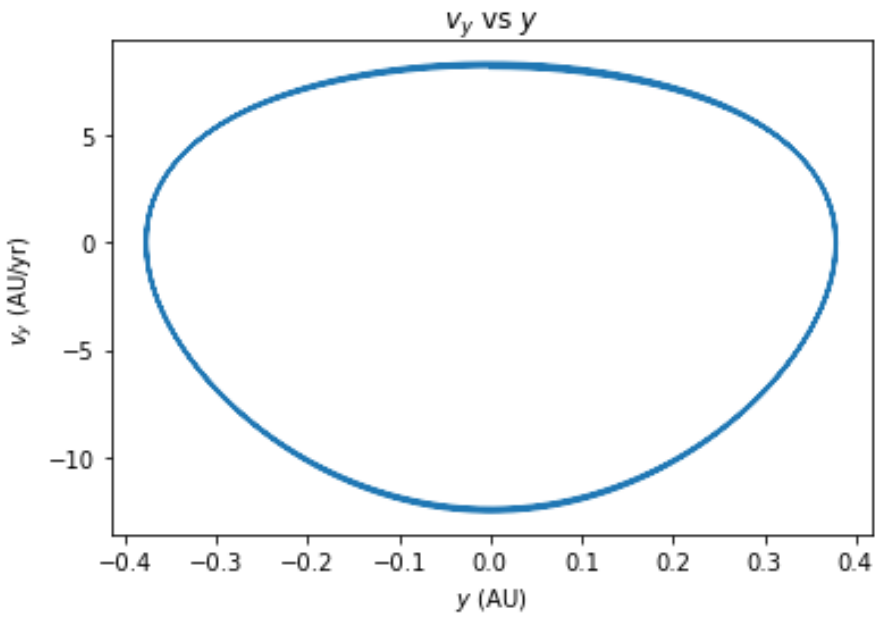
1 Plots


Orbit, x vs y
Sun
y (AU)
x (AU)
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
−0.3
−0.2
−0.1
0.0
0.1
0.2
0.3
0.4
0.5


v_x vs x
v_x (AU/yr)
x (AU)
10
5
0
−5
−10
−0.3
−0.2
−0.1
0.0
0.1
0.2
0.3
0.4
0.5



2 Explanation

2.1 Function

The function itself is basically the same as the pseudo code I showed in Q1(b). The differences are I imported the `Scipy` constant package in the header:

```
import scipy.constants as spc
```

and so I changed the gravitational constant `G` into `spc.G`.
I also defined the mass of sun `M_s` in the beginning of the function:

```
M_s = 2*(10**30)
```

2.2 Plot and Simulation

Since all the given values are in AU and year, I converted them into SI units:

```
x_0 = 0.47 * spc.au
y_0 = 0
vx_0 = 0
vy_0 = 8.17 * spc.au / 31622400
dt = 31622400 * 0.0001
t = 31622400
```

After the simulation is done, I converted the results back to AU and year for plotting convenience:

```
x = [i / spc.au for i in result[0]]
y = [i / spc.au for i in result[1]]
vx = [i * 31622400 / spc.au for i in result[2]]
vy = [i * 31622400 / spc.au for i in result[3]]
```

and plot them all.

3 Angular momentum

Please note, all the calculations are rounded to 2 significant digits.
At the beginning:

$$|v_0| = v_y = 8.17\ \text{AU/yr}$$

$$r_0 = x = 0.47\ \text{AU}$$

So

$$L_0 = mvr = m \cdot 3.84\ \text{AU}^2/\text{yr}$$

At the end of simulation, we obtain the value by:

```
x_f = x[int(t/dt)-1]
y_f = y[int(t/dt)-1]
vx_f = vx[int(t/dt)-1]
vy_f = vy[int(t/dt)-1]
print(x_f, y_f, vx_f, vy_f)
```

So

$$x_f = 0.26\ \text{AU} \qquad y_f = 0.33\ \text{AU}$$

$$v_{xf} = -8.19\ \text{AU/yr} \qquad v_{yf} = 4.38\ \text{AU/y}$$

$$r_f = \sqrt{{x_f}^2 + {y_f}^2} = 0.42\ \text{AU}$$

$$|v_f| = \sqrt{{v_{xf}}^2 + {v_{yf}}^2} = 9.29\ \text{AU/y}$$

and

$$L_f = mvr = m \cdot 3.90\ \text{AU}^2/\text{yr}$$

We can tell that the angular momentum is differed due to the error of simulation.