Jett Tinik

Prof. Lu

PEP 336

22 March 2022

Lab 1 Report

"I pledge my honor that I have abided by the Stevens Honor System" - Jett Tinik

1. This lab aims to calculate the kinetic/potential energy of a specific binary star system. In this case, we are looking at the stars Sirius A and Sirius B. After entering the parameters of the mass of the parent star, semi-major axis, and orbital eccentricity, we are able to obtain data at specific timestamps. With this data, we can plot the relationship between reduced mass vs the parent star during the orbit.
    a. This lab will help increase my understanding of data engineering
    b. This lab will help increase my understanding of binary star systems and how they orbit

Trial Run of the Code

```
                         Elliptical Orbit Data

                         Mstar =     40.000 Msun
                         a     =    777.000 AU
                         P     =   3424.279 yr
                         e     =      0.529


        t (yr)          r (AU)           theta (deg)          x (AU)            y (AU)
        ------          ------           -----------          ------            ------
         0.000         365.967                 0.000         365.967             0.000
        22.789         367.582                 9.140         362.915            58.388
        45.578         372.360                18.125         353.883           115.840
        68.367         380.110                26.816         339.232           171.480
        91.156         390.544                35.104         319.508           224.586
       113.944         403.311                42.915         295.373           274.618
       136.733         418.042                50.212         267.527           321.229
       159.522         434.370                56.986         236.661           364.237
       182.311         451.960                63.252         203.410           403.599
       205.100         470.513                69.036         168.338           439.369
       227.889         489.773                74.373         131.929           471.670
       250.678         509.525                79.301          94.591           500.667
       273.467         529.590                83.858          56.661           526.550
       296.256         549.822                88.081          18.415           549.513
       319.045         570.103                92.003         -19.924           569.755
       341.833         590.338                95.655         -58.175           587.465
       364.622         610.450                99.066         -96.194           602.823
       387.411         630.378               102.260        -133.864           616.000
       410.200         650.072               105.260        -171.094           627.153
       432.989         669.496               108.083        -207.812           636.427
```

2.

Here is the output data formulated into my Notepad

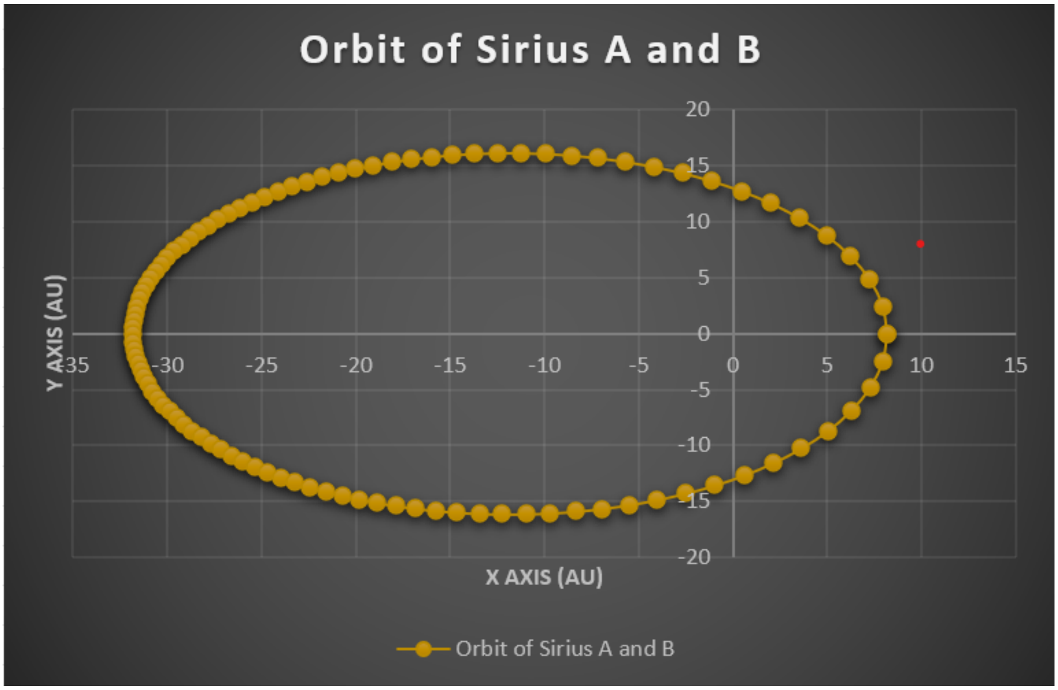
```
Elliptical Orbit Data

Mstar =      3.100 Msun
a     =     20.000 AU
P     =     50.796 yr
e     =      0.592
```

t (yr)	r (AU)	theta (deg)	x (AU)	y (AU)
0.000	8.160	0.000	8.160	0.000
0.508	8.299	17.262	7.925	2.463
1.016	8.697	33.491	7.253	4.799
1.524	9.304	47.979	6.228	6.912
2.032	10.059	60.502	4.953	8.755
2.540	10.907	71.178	3.519	10.324
3.048	11.809	80.265	1.997	11.639
3.556	12.733	88.043	0.435	12.726
4.064	13.662	94.761	-1.134	13.615
4.572	14.582	100.624	-2.688	14.332
5.080	15.486	105.793	-4.215	14.901
5.588	16.368	110.396	-5.704	15.341
6.096	17.225	114.533	-7.152	15.670
6.604	18.055	118.281	-8.554	15.900
7.111	18.858	121.704	-9.910	16.044
7.619	19.632	124.850	-11.218	16.111
8.127	20.378	127.762	-12.479	16.111
8.635	21.097	130.470	-13.693	16.049
9.143	21.788	133.002	-14.860	15.934
9.651	22.451	135.381	-15.981	15.769
10.159	23.088	137.626	-17.057	15.561
10.667	23.699	139.752	-18.089	15.312
11.175	24.284	141.773	-19.077	15.026

Here is the command line interface

```
jettenemos@DESKTOP-D0HCLB3:/mnt/c/users/jtini/462Project1$ ./a.out
Enter file nameOfficialRun
     Orbit computes the orbit of a small mass about a much larger mass.

               Details of the code are described in:
               An Introduction to Modern Astrophysics
               Bradley W. Carroll and Dale A. Ostlie
                       Addison Wesley
                       copyright 2007


 Enter the mass of the parent star (in solar masses):  3.1
 Enter the semimajor axis of the orbit (in AU):        20
 Enter the orbital eccentricity:                       0.592

 The period of this orbit is 50.796 yr


Please enter the number of time steps to be calculated and the
frequency with which you want time steps printed.

Note that taking too large a time step during the calculation
will produce inaccurate results.

Enter the number of time steps desired for the calculation: 1000


How often do you want time steps to be printed?
             1 = every time step
             2 = every second time step
             3 = every third time step
                         etc.

Frequency: 10
testing
```

Here is the X and Y coordinate plot of the binary orbit



3.

Here is a screenshot of the equations for KE and PE that I added to the code provided

```
do {
  // Calculate the distance from the principal focus using Eq. (2.3); Kepler's
  // First Law.
  r = a * (1 - e * e) / (1 + e * cos(theta));

  double PE = 0;
  double KE = 0;
  double x = r * cos(theta);
  double y = r * sin(theta);
  double deltat = t - tprev;

  if (t == 0) {
    KE = 0;
    PE = -G * Mstar * mustar / r;
    cout << "testing" << endl;
  }
  else{
  PE = -G * Mstar * mustar / r;

  double dfdx = x - prevx;
  double dfdy = y - prevy;
  double deltat = t-tprev;
  double velo = sqrt(pow((dfdx / deltat), 2) + pow((dfdy / deltat), 2));

  KE = (0.5) * mustar * pow(velo, 2);
  cout << KE << endl;
  tprev = t;
  }
```

Here is the graph of Kinetic Energy and Potential Energy along the orbit path