# PHSX 331 Homework 3 - Kepler's Equation

## Due September 19th 5:00 p.m.

One of the oldest unsolved problems in physics is solving Kepler's Equation,

$$\frac{2\pi}{P}(t - T) = u - e\sin(u) \tag{1}$$

Where $P$ is the period of the orbit, $T$ is the time of pericenter passage (think of this as a $t_0$ it's the reference time that the orbiting object passes pericenter), $e$ is the eccentricity of the orbit, and $u$ is the eccentric anomaly. In a perfect world we would be able to invert this equation and have a function of $u(t) = ...$ then we could have an analytic equation for the motion of planets around the sun. , but no one in the last 300 years has been able to figure out how to do that. But they never had computers! The over all goal of this homework is to plot $u(t)$ for the Earth in 2018.

In a normal two body system $T$ is a constant, but because there are things like other planets and the moon, Earth doesn't have the same time of pericenter passage each year, but we're going to ignore that.

- For 2018 the Time of Perihelion was January 3, 5:35 a.m. So that will be our $T$. The period is 365.25 days. Our eccentricity is 0.0167. If we want to solve for $u(t)$ then we need to solve for $u$ over a range of times. For each time $t$ solve for $u$ using bisect.py. This should result in an array of $u$ values for each time. $u = [u(0), u(t_1), u(t_2), ...]$

  Set up an array of time values starting at 0 seconds, and ending at one year, with 30 day steps between each element.

  Do this again but with one day steps between each element.

- Make a single plot for both sets of $u(t)$ with the 30 day steps, and with the 1 day steps. As always make sure your graph is appropriately labeled. What do you notice about the two graphs?