ASTR 400B In Class Lab 8: Orbit Integration with Dynamical Friction

April 3rd 2018

We will build on the last assignment and add a deceleration term to the function "M31Accel" to account for the response of M31's dark matter halo owing to the passage of M33.

You will need to create a copy of your Homework 7 solutions, which we will modify in this lab.

1 Steps:

1. Add a new variable to the initializer for the class, self.M33halo, that defines M33's halo mass = 1.96e11.

2. Create a function called "DynamicalFriction" that takes as inputs (Msat,x,y,z, vx,vy,vz,dummy), where "dummy" specifies the component of the acceleration vector (e.g. "x", "y", "z")

   (a) In this function define the coulomb logarithm

   $$\Lambda = \frac{bmax}{bmin} \tag{1}$$

   Where $bmax$ = the current separation between M31 and M33 and

   $$bmin = \frac{GM_{sat}}{V_c^2} \tag{2}$$

   where V_c is the typical speed at that radius (e.g. the circular speed). Let's assume this is flat at $V_c = 200$ km/s in the M31 halo outskirts.

   (b) Return the acceleration term, assuming an isothermal sphere profile for the dark matter halo of M31. Again, this acceleration is a vector and we will do this for a component specified by the input dummy variable. Here is an example for the 'x' direction:

   $$a_{DFx} = -0.428 \frac{GM_{\rm sat} \ln(\Lambda)}{r^2} \frac{\mathbf{v}_x}{v} \tag{3}$$

3. Add DynamicalFriction to the total acceleration returned in "M31Accel". You will need to modify the input values for the function (it'll need the velocity vector).

4. Adjust the inputs for M31Accel when it is called in the "LeapFrog" function (adding vx,vy,vz)

2 Questions

1. How does the analytic orbit of M33 change?
2. What happens when the current separation gets too small ?
3. Is the friction term too strong or not strong enough?
4. Add a "fudge" factor to the DynamicalFriction to change the magnitude of this friction term to better match the simulation data. If you set the fudge = 0 you should return the original solution to Homework7.