Astro 381 (Gravitational Dynamics) : Homework 4

Assigned on Tu Apr. 26, 2010. Due in class on Tu May 4, 2010

The questions with notation "GD" are in the **second edition (2008; Princeton University Press)** of the textbook "Galactic Dynamics" (GD) by J. Binney & S. Tremaine. In case you have the first edition of the book, a copy of the questions will be handed in class. The number of points for each question is indicated in brackets. and the total score is 100 points.

1. GD, problem 7.4 [**15 pts**]

2. GD, problem 7.13 [**20 pts**]

3. GD, problem 7.16 [**25 pts**]

4. You will find a text file at http://www.as.utexas.edu/∼sj/a381c-sp10/vrot.txt) on the class website. It shows the rotation curve (rotation velocity V in km/s plotted versus radius R in kpc) of a weakly barred spiral galaxy, which is at a distance of 20 Mpc.

a) Assume for simplicity that V is equal to the circular speed $V_{\rm c}$ (i.e, do not correct for non-circular streaming motions). Derive and plot the angular frequency Ω (defined as $V_{\rm c}/R$), the epicyclic frequency κ, (Ω - $\kappa/4$), and (Ω - $\kappa/2$) as a function of radius R. [**20 pts**].

b) Structural decomposition of a near-infrared image of this galaxy shows that it hosts a weak bar at a radius of 35 arcseconds. Bars are expected to end between the 4:1 ultraharmonic resonance (UHR) and the corotation resonance (CR) due to the presence of chaotic orbits near the CR. Estimate lower and upper limits on the bar pattern speed $\Omega_{\rm p}$ in km per second per kpc. [**10 pts**].

c) *HST* images of this galaxy shows a nuclear ring of intense star formation. Explain the possible origin of such a ring. Estimate the radius near which you would expect the ring to lie, assuming that the bar pattern speed is equal to the lower limit you calculated in (b). [**5 + 5 = 10 pts**].