Astronomy 330 / Galaxies

Problem Set 3

Due: Problems 1-3, Wednesday 20 October 2010
Problems 4-5, Friday 22 October 2010

Problem 1. A galaxy forms, starting at $t = t_{form}$, out of matter initially at rest and dispersed over very large separations, $r_{form} \rightarrow \infty$. At t_{form}, the matter begins to collapse into a bound structure in dynamical equilibrium with total mass M_g and circular speed v_c. The galaxy virializes on a time-scale comparable to a few × t_{dyn}. *In terms of these parameters:* **(a)** What is the total energy, kinetic energy, and potential energy of the system before collapse occurs? **(b)** What is the total energy, kinetic energy, and potential energy of the system after it virializes? How do you account for differences in the total energy? **(c)** Estimate the characteristic size of the galaxy, and state what assumptions you have made to form this estimate. **(d)** Convert any total energy differences you find into the equivalent mass of H (in units of M_g) that can be ionized and heated to 10^6 deg (K) assuming all of the "missing energy" goes into this heating (hint: take a look at Problem 7.2 in S&G). Also compute the numerical fraction of M_g for v_c =200 km s^{-1}. Adopt v_c =200 km s^{-1} for the next three questions: **(e)** Assuming the material out of which the galaxy forms is representative of the universe on average (see the lectures), what fraction of the galaxy's baryons does your answer in (d) represent? **(f)** Assuming the galaxy is depleted of a fraction of its baryons, such that its baryon mass-fraction is 10% today, what is the temperature of the expelled gas? **(g)** What might these calculations tell us about the origin of the WHIM in the cosmic web and the fraction of the total baryons in it?

Problem 2. Do Chris Mihos' galaxy rotation curve lab. It can be found by going to burro.astr.cwru.edu/JavaLab/index.html. Go to "RotCurve" and follow the instructions on the "lab" page. You'll need to turn in your chi-squared fits, halo size, halo central density, and disk mass-to-light ratio. Given your fit, what would you expect the circular velocity of a companion to UGC 128 at a distance of 90 kpc to be? Now look at your fit for NGC 2403. Assume you can view the galaxy face-on. What would you expect the vertical (z) stellar velocity dispersion to be at 2 disk scale lengths? How does this compare to the vertical velocity dispersion of stars in the solar neighborhood?

Problem 3. Do Chris Mihos' surface-of-a-section (SOS) lab (same url).

Problem 4. (a) Do Problem 3.12 and 3.13 in Sparke & Gallagher. For 3.12, what is the maximum velocity you expect any one star to have? Explain your answer.

Problem 5. Do Problems 3.24 and 3.25 in Sparke & Gallagher

Reminder: in-class mid-term coming up on 27 Oct.