Physics 131: Survey of the Universe
Spring 2004
Prof. Michael S. Vogeley
Homework assignment 7

Due at the beginning of class, 12:30 p.m. Thursday, May 27. Please write your work and answers on a separate sheet of paper, with your name at the top and all pages stapled together.

1. Estimating the Mass of a Galaxy

We can use the circular velocity of gas, stars, or any other object around the center of a galaxy to estimate the mass required to gravitationally bind those objects to the galaxy and hold them in orbit. Suppose we observe a small satellilte galaxy (like one of the Magellanic Clouds) orbiting a larger galaxy (like the Milky Way) on a roughly circular orbit with $r = 50\mathrm{kpc}$. The circular velocity of the small galaxy is $v = 200\mathrm{km/s}$. Estimate the mass of the larger galaxy, in units of solar masses. (Hint: First get an answer in kilograms, then convert to solar masses. Be careful to use consistent units: mass in kg, distance in m, time in s.)

2. How Do You Find "Dark" Matter?

Describe the evidence for the presence of large amounts of dark matter – material which is gravitating but neither emits nor absorbs light – in the halos of galaxies. Your answer should include reference to an equation that relates the mass of a galaxy to observable properties of the galaxy.

3. Galaxy Properties

Fill in the blanks. On your answer sheet, write out each sentence and underline the missing word or words that you filled in.

(a) We live in a [type of galaxy] galaxy.

(b) The Sun is [distance in kiloparsecs] from the center of the Milky Way.

(c) Most of the gas and dust in a galaxy is in the [part of a galaxy].

(d) New stars form in the [part of a galaxy].

(e) Older stars inhabit the [part of a galaxy] and [another part of a galaxy].

(f) Stars in the [part of a galaxy] are on circular orbits.

(g) Stars in the [part of a galaxy] are on random orbits.

(h) Star formation has mostly ceased in [type of galaxy] galaxies.

(i) The Magellanic Clouds are [type of galaxy] galaxies.

(j) Bright O and B stars would be found in the [part of a galaxy]

4. Size and Time Scales

(a) How long will the Sun burn on the Main Sequence?

(b) How many years does it take light from the Galactic Center to reach us?

(c) The nearest large galaxy, Andromeda, lies at a distance of 700kpc. How many years does it take light from Andromeda to reach us?

(d) The Coma Cluster of galaxies lies at a distance of roughly 70 Mpc (that's Megaparsecs). How many years does it take light from the Coma Cluster to reach Earth?

(e) Use your answers to parts a, b, c, and d to answer the following question: Have any of those objects changed substantially while its light travelled toward us? (Hint: compare the light travel times to the main sequence lifetime of the Sun.)

5. Distance Measurement with Standard Candles

(a) What is a "standard candle" in Astronomy?

(b) Suppose that we observe two stars that are known to have the same luminosity. If star A appears brighter than star B by a factor of 25, what is the ratio of distances to the stars d_B/d_A?

(c) What observable properties of a Cepheid variable star do you need to measure to estimate its distance?