Qualification Examination—Galactic and Extragalactic Astronomy
May 29, 2008

1. The constituents of the interstellar medium can roughly be classified into (i) cold neutral gas, (ii) warm neutral gas, (iii) warm ionized gas, (iv) hot ionized gas, (v) molecular gas, (vi) dust, (vii) magnetic field, (viii) cosmic rays. Answer as much as you can on their temperature, density, composition, distribution in the Galaxy, and the method you use to detect them. (10 points)

2. Describe and explain (by a simple model) of the following. (10 points)

(a) The Tully-Fisher relation for spiral galaxies.

(b) The fundamental plane of elliptical galaxies.

3.

(a) Define the Local Standard of Rest (LSR). Consider the cylindrical polar coordinate system with the origin at the galactic center. What is the solar motion relative to LSR in this coordinate system. (5 points)

(b) Describe what kind of observations you need to argue the LSR is rotating about the Galactic center. What is the rotation speed of LSR? (5 points)

(c) Describe in detail how you can measure the rotation curve of our Galaxy inside the solar circle by 21 cm observation. (5 points)

(d) Describe how you find the distance of the Galactic center from the Sun. What is that distance? (5 points)

4. Suppose the opacity of visible light is independent of the location in our Galaxy.

(a) Show that the colour excess of a star is proportional to its extinction (e.g., $E_{\mathrm{B-V}} \propto A_{\mathrm{V}}$), and

$$S = \mathrm{U} - \mathrm{B} - \frac{E_{\mathrm{U-B}}}{E_{\mathrm{B-V}}}(\mathrm{B} - \mathrm{V})$$

is an intrinsic property of the star (may serve as a crude identification of spectral type). (5 points)

(b) Given a table of S and the absolute magnitude for stars of different spectral types, describe what observational data you need and how you determine the spectral type of a star and its distance from earth. (5 points)

5. A galaxy was found to be at a distance of 10^9 light years away from the Milky Way according to the Hubble' law. When is the distance referred to? (5 points). Why (5 points)?

6.

(a) What is angular-diameter distance? (5 points)

(b) If a cD galaxy has a diameter of 100 kpc, what is the smallest angular size of this galaxy we can observe in a matter-dminated universe? (5 point)

(c) What is the redshift of the galaxy when it shows the smallest anglular size? (5 points)

7.

(a) Why cannot spiral arms of galaxies be material arms? (5 points)

(b) How do you explain the existance of spiral arms in galaxies? (5 points)

8. Sometimes, astronomers use "dark matter" to explain observational results. Describe at least three different astronomical results that need "dark matter" and explain why they need dark matter. (15 points)