

Institute of Astronomy, National Central University

PHD QUALIFYING EXAMINATION — GALACTIC AND EXTRAGALACTIC ASTROPHYSICS

31st May, 2002

(1) (20 points)

The Solar Radius is about 7.0×10^{10} cm and $1 \text{ pc} = 3.086 \times 10^{18}$ cm

- (a) (10 points) In the Milky Way, please calculate and thus prove that a star would have a possible collision with another star for about every 10^{19} years.
- (b) (10 points) Similarly, please calculate the time interval of a possible collision between two stars in a globular cluster.

(2) (20 points)

On the Galactic plane, the line-of-sight velocity of a material is:

$$v_{\text{los}}(l, R) = [\Omega(R) - \Omega(R_0)]R_0 \sin l,$$

where R_0 is the Galactocentric distance of the Sun, Ω is the angular velocity.

- (a) (5 points) Express Galactic longitude l as a function of the Galactocentric polar coordinates, (R, ϕ)
- (b) (7 points) Assume a flat rotation curve for the Galaxy, after using the result in (a) to express $v_{\text{los}}(R, \phi)$, please calculate dv_{los}/dR and $dv_{\text{los}}/d\phi$.
- (c) (8 points) Assume that the rotation velocity on the Galactic plane: $v_c = AR^5 \ln(R)$, where A is a constant, after using the result in (a) to express $v_{\text{los}}(R, \phi)$, please calculate dv_{los}/dR and $dv_{\text{los}}/d\phi$.

(3) (20 points)

If you are observing a system, which could be a cluster of galaxies, a galaxy or a stellar cluster.

- (a) (6 points) Please describe the details of all necessary processes to determine its distance.
- (b) (7 points) Please describe the details of all necessary processes to determine (or understand) its mass-to-light ratio.
- (c) (7 points) Please describe the details of all necessary processes to determine (or understand) its density profile.

(4) (20 points)

What is the apparent angular size of a galaxy cluster with a diameter $D = 1$ Mpc at red-shift $z = 1$? Assume a matter-dominated flat universe.

(5) (10 points)

An AGN has a luminosity of 10^{45} erg/sec; what is the minimum mass of the central black hole in the AGN if the luminosity is caused by spherical accretion?

(6) (10 points)

Explain the Gunn-Peterson effect (test) and the Sunyaev-Zel'dovich effect, and discuss their importance.