PHD QUALIFY EXAMINATION —
GALACTIC AND EXTRAGALACTIC ASTROPHYSICS

11th July, 1996

(1) (20 points)

(a) Derive the free-fall time due to self-gravity of a sphere of gas with mass M and initial radius R.

(b) Explain 'Jeans mass', and derive its expression for a collection of gas. Carefully state every assumption you need to make. For a typical interstellar cloud on the galactic disk, $\rho \sim 2 \times 10^{-24}$ g cm^{-3}, $T \sim 100$ K, its Jeans mass is about 10^5–10^6 $M_\odot$, which far exceeds the mass for individual tars ($0 \leq M/M_\odot \leq 60$). Discuss the implication.

(2) (20 points)

The UV photons from a hot star ionize the surrounding hydrogen atoms, forming a spherical H II region called the Strömgren sphere. Assuming the star radiates like a blackbody, write down the expression that equate the size of the Strömgren sphere with the stellar parameters. Show that the transition zone from the H II region to the H I cloud is very sharp. Discuss the effects if the ionizations of helium are also considered.

(3) (20 points)

Fundamental classification of galaxies, such as Hubble Classification, is based on their morphology. However, other physical characteristics, quite unrelated to the original classification criteria, are now proven to have systematic changes along the morphological classification sequence. This proves the value of such classification in our quest to understand galaxies. Describe the details of Hubble classification including the original definition of each sequence. Discuss their characteristic surface brightness and color distribution, stellar/gas/dust contents.

(4) (20 points)

Globular clusters and metal poor stars are known to be important tracers of both chemical and dynamical evolution of our Galaxy. For globular clusters, we try to get good estimates for (1) distance, (2) metal abundance, (3) age, and (4) characteristic core (r_c) and tidal (r_t) radii. For nearby metal poor stars, we measure (5) ultraviolet excess or metallicity, (6) orbital eccentricity, and (7) angular momentum to collect information on old stellar population necessary to understand early stage of our Galaxy evolution. Briefly describe how we obtain estimates of (1) to (7) parameters.

(5) (20 points)

The most fundamental parameter in extragalactic astronomy and observational cosmology is the distance scale to other galaxies. In order to improve both the accuracy and precision, we have developed several independent methods of distance determination. They are largely divided into three groups; primary, secondary and tertiary distance indicators, each of them reaching different depth of the universe. Describe known distance indicators in these three categories.