

星系天文物理 資格考 2015

(可用中文作答；題號須標示清楚)

1. Types of galaxies: (30%)

- (a) Describe the main types of galaxies according to the Hubble classification system.
- (b) According to the observations, what type is our Galaxy most likely to be?
- (c) What are the Tully-Fisher law and Faber-Jackson law?

2. Define and explain the following: (30%)

- (a) Relaxation time.
- (b) Jeans length.
- (c) Virial theorem.

3. Consider the loop orbits of stars in weak bars of galaxies with planar non-axisymmetric potentials. Let (R, φ) be polar coordinates in the frame that rotates with the potential, such that the line $\varphi=0$ coincides with the long axis of the potential. Then the first-order term in the equations of motion can be solved as

$$R_1(\varphi_0) = C_1 \cos\left(\frac{\kappa_0 \varphi_0}{\Omega_0 - \Omega_b} + \alpha\right) + C_2 \cos(m\varphi_0)$$

where the numeric subscripts denote the order, C_1 and α are arbitrary constants, Ω_b is the pattern speed, and

$$\kappa_0^2 = \left(R \frac{d\Omega^2}{dR} + 4\Omega^2 \right)_{R_0}, \quad C_2 = \frac{-1}{\kappa_0^2 - m^2(\Omega_0 - \Omega_b)^2} \left[\frac{d\Phi_b}{dR} + \frac{2\Omega\Phi_b}{R(\Omega - \Omega_b)} \right]_{R_0}.$$

Use this first-order solution of $R_1(\varphi_0)$ to explain **all** possible **resonances**. (20%)

4. Consider the Plummer model, a simple spherical model for a collisionless system:

$$\Phi(r) = \frac{-GM}{\sqrt{r^2 + b^2}}$$

where r is the distance to the center, b is the Plummer scale length, and M is the total mass of the system. (20%)

- (a) Derive the density $\rho(r)$ of the system as a function of r .
- (b) Derive the total gravitational potential energy W of the system.