Mid-term

Short Answers- 2.5 points each 25 total points

1) Give 2 reasons for how we know that galaxies are much more massive than the mass of stars they contain

2) Why are spiral galaxies bluer than elliptical galaxies

3) How does the proportion of Elliptical and Spiral Galaxies depend on the density of the environment

4) What are the spectral signatures of ionized gas in a galaxy

5) Which galaxies are most dark matter dominated

6) What is the closed box approximation to metal creation and what are its problems

7) What is the observational data which suggests an accretion origin for at least part of the mass of the Milky Way

8) In spirals what is reason that the relative amount of energy radiated in the optical and IR is similar.

9) In galaxy formation what is a fundamental difference between the properties of baryons and dark matter?

10) Why do galaxies have a very different appearance in the UV, IR and x-ray.

Amswer 4 out of 6

Question 1 15 points

Give 4 physical differences between spirals and elliptical galaxies and how they control 2 of the observables (e.g luminosity, color, size, surface brightness, internal structure, etc) .

Question 2 25 points each section 5 points

a)What is the relation between spectral types of stars and their luminosities. How does the luminosity of the star relate to its mass and lifetime (either give a functional form, or describe the relation).

b) Please draw either the H-R diagram or the color magnitude diagram for a simple stellar population (SSP) at t=0 and indicate how it changes with time.

c) What is the physical process that controls the energy generation of stars on the main sequence and what is the reason for stars to move off the main sequence.

d) Estimate the lifetime of a $10M_{\odot}$ star compared to the sun- using your knowledge of the lifetime of the sun on the main sequence what is the lifetime of the $10M_{\odot}$ star. What is the lifetime of a $0.1M_{\odot}$ star (2.5 pts each)

e) What is the effect on galaxy spectra of 1) aging of a SSP 2) continuous star formation and aging (2.5 pts each)

Question 3 15 pts
a)Describe the effects of dust on the electromagnetic radiation received from galaxies. b) Define extinction and reddening and explain how the radiation from a star would be affected by Av=1.

Question 4 – Oort constants and galactic rotation: 25 pts
Assume A=15 km/sec and B=-15 km/sec at the position of the sun
a) If what does this mean for the rotation curve.
b) Calculate the local rotation curve (see equation sheet)
c) Calculate the distance to the galactic center
d) What the is period of the suns orbit and the time for one orbit. How many trips around has the sun made in the lifetime of the Milky Way (assume 10Gyrs).

Question 5 Initial Mass function 25 points
a) What is the most often used form of the IMF and what problem does that form have. What modification does this form need to prevent this problem.
b) Using a simple power law IMF $N(M)=A\ M_{\odot}^{-2}$ from 0.1 to 100 and a total mass of $7x10^{4}M_{\odot}$ what is the value of A. What is the total number of stars.
c) For this simple form what is the relative mass between 0.1-1 and 10-100 $M_{\odot}$ how does this compare to the form you used in part (a)?

Question 6 25 pts
Use the virial theorem to calculate the how fast a star must move to escape the galaxy for a) a point-like potential with a mass of $10^{11}M$
b) singular isothermal sphere potential of the same total mass and radius 10kpc.
Question 7 What is meant by the relaxation timescale of a stellar system? How does it vary with stellar density? Compare the relaxation timescale of a typical elliptical galaxy with the age of the Universe (order-of-magnitude estimate is suffcient here). What does your answer imply?

Equations: ϕ is the potential

For motion perpendicular to the disk $\sigma_h^2 \sim 2\pi G \Sigma_0 z_0$

Scale s lengths $\rho(r) = \rho(0)\exp(-R/R_0)$

Oort constants $A = 1/2[V_c/R - dV_c/dR]$ evaluated at R_0

$B = 1/2[V_c/R + dV_c/dR]$ evaluated at R_0 V_c is the value of the rotation curve

$L(\text{star}) \sim L_{sun}[M/M_{sun})^{3.5}$

$T_{\text{main sequence}} \sim 10^{10} (L//L_{sun})^{-5/7} \sim 10^{10}$ yrs$(M//M_{sun})^{-5/2}$

Escape velocity $v^2_{escape} = -2\phi$

Virial theorem " $2T + U = 0$; T= Kinetic energy U= potential energy

$U = m\phi(r)$

Singular isothermal sphere $\phi(r) = 4\pi\rho(r)Ga^2\ln(r/a)$ where a is the radius of the sphere and $\rho(r) = \rho(0)(r/a)^{-2}$