Astr 323: The Midterm Exam

Extragalactic Astronomy and Cosmology
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MY NAME IS (print please!): ———————————————-

1. The Properties of Normal Galaxies (1000 points, 100 per each question)

The intensity of a galaxy's light, $I(R)$ as a function of distance from its center, R, can be parametrized as

$$I(R) = I_o \exp\left(-(R/L)^{1/n}\right), \quad (1)$$

where I_o is the central intensity, L is the scale length, and n is the Sersic index.

a) How does the Sersic index relate to galaxy type?

b) What does Freeman's Law have to do with this equation?

c) How is the galaxy color correlated with galaxy type?

d) How is the galaxy color correlated with galaxy luminosity?

e) How can we distinguish between star-forming and AGN emission in the spectra of emission line galaxies?

f) What kind of stars are spiral arms made of, and what are the two basic theories of spiral arm formation?

g) Describe the light profiles from the central parts of elliptical galaxies.

h) How do we know that there is dark matter in spiral galaxies?

i) Write down the Schechter function and sketch its graph.

j) How does the galaxy luminosity function depend on galaxy type?

2. Dark Matter from Dynamical Measurements (500 points)

a) Describe a typical rotation curve of spiral galaxies.

b) Describe the two basic properties of dark matter and explain why rotation curves of spiral galaxies imply its existence.

c) Write down the Tully-Fisher relation and define the quantities.

d) Write down the Faber-Jackson relation and define the quantities.

e) State the virial theorem, and describe in words why it is so important in astronomy.

3. Quasars and Active Galactic Nuclei (500 points)

a) What is a quasar/AGN and why is this a very important astrophysical phenomenon?

b) Sketch a typical quasar spectral energy distribution (SED) from X-rays to radio, label the most prominent features, and compare to a stellar SED.

c) Why do *observed* SEDs of quasars vary a lot, although the physical mechanism responsible for their emission is the same?

d) Describe (or sketch) the quasar number density distribution as a function of redshift.

e) Explain the essentials of the Unified AGN Model (what is it, what observations motivate it, what and how it "unifies")?

4. Star formation (500 points)

a) You observe two nearby spiral galaxies. Both are blue in optical, but only one is bright in UV. What can you deduce about their star formation histories?

b) You measure the spectrum of a galaxy and note that it has absorption line features similar to a K-giant star. Why does that imply that the galaxy formed most of its stars more than 10 Gyr ago?

c) What are the three major phases of gas in spiral galaxies? Rank them in order of increasing pressure.

d) From observations of stars in a far away spiral galaxy, astronomers have deduced that stars in its halo are very metal-poor, while stars in its disk have high metallicity. Using this information, place these two components in order of decreasing formation epoch (i.e. the younger component listed first).

e) Justify why you could use the metallicity to derive the particular order you chose in part (d).

5. Miscellanea (500 points)

a) What is the main reason that spiral galaxies are flattened (i.e. not spherical)?

b) Using your knowledge of astronomy, or just by plain guessing, answer **all** five of these correctly and earn whopping 100 points (no partial credit for fewer than five correct answers):

YES **NO** Edge-on spiral galaxies are ideal for measuring rotation curves.

YES **NO** When large galaxies merge together, the remnant might eventually look like an elliptical galaxy.

YES **NO** The rotation curves of spiral galaxies can only be measured in the radio.

YES **NO** The ELS (Eggen, Lynden-Bell and Sandage) model for galaxy formation successfully predicted the Butcher-Oemler effect.

YES **NO** High angular momentum regions of the early universe are likely to form spiral galaxies.

c) Qualitatively describe the stellar distribution in the Milky Way (hint: how do the three main components look like)?

d) Describe the stellar kinematics in the Milky Way (hint: what are the two components that greatly differ from each other)?

e) Describe the distribution of stellar metallicity in the Milky Way (hint: what are the two components that greatly differ from each other)?