

## Galaxy Questions

1. What is a galaxy and how is it different from a globular cluster?
2. What are the basic constituents of a galaxy? How do we know?
3. What are the properties (i.e., shape, location, gas content, etc.) of the smallest galaxies?
4. What are the properties (i.e., shape, location, gas content, etc.) of the largest galaxies?
5. How do you characterize a distribution of stars? (some answers...)
  - (a) surface brightness profile
  - (b) velocity
  - (c) velocity dispersion
  - (d) luminosity function
6. How do you measure the stellar luminosity function?
7. How do you ensure the completeness of the faintest stars? (ans. proper motion surveys)
8. Is the luminosity function intrinsic to a stellar population?
9. What are the units of an initial mass function?
10. What is the S-Z effect?
  - (a) Draw a diagram and sketch spectra.
  - (b) What do I see if I observe at 50 MHz towards the cloud versus in other directions?
  - (c) What is the cross-over frequency on the plot (where the up-scattered and unscattered spectra have the exact same intensity?) (ans: Leo says 212 GHz, C-P says 217 GHz)
  - (d) Is the excess or deficit easier to detect? Why?
  - (e) How does the magnitude of the effect depend on distance to the cloud?
  - (f) Through what radiative process does the cluster gas emit? At what temperature is the gas?
  - (g) How does this emission depend on the size and density of the cloud?

- (h) How does the amount of S-Z absorption depend on the size and density of the cloud?
  - (i) What can we use the S-Z effect to measure? What cosmological parameters?
  - (j) What is the ratio of mass in cluster gas to mass in galaxies?
11. Consider a differentially rotating disk galaxy. We observe a two-dimensional velocity field.
- (a) Draw the isovelocity contours.
  - (b) What is the rotation curve that produces this?
  - (c) What does this imply about the density profile as a function of radius in the two regions?
  - (d) How does this compare with the luminosity profile of the galaxy?
  - (e) What mass components make up the galaxy?
  - (f) If you see closed loops in the spider diagram, what does that mean?
  - (g) How do things change for a warped galaxy?
  - (h) How is the circular velocity related to the gravitational potential?
  - (i) How do we infer the presence of dark matter?
12. Can we measure rotation curves for ellipticals?
13. How do we determine the dark matter content of ellipticals?
14. What is the IMF? Where/how is the IMF measured?
- (a) What observational evidence tells us that the IMF is similar at different locations?
  - (b) What observations would you make to establish the IMF? Give an example of what system you would observe.
  - (c) How do you establish cluster membership?
  - (d) How do you measure stellar masses?
  - (e) If you were to use the Pleiades, the mass function would extend only to B stars. So how do you get the 0-star mass spectrum?
  - (f) What is the normalization of the IMF?
  - (g) How would you get the IMF for low mass stars?
  - (h) When Salpeter first measured IMFs in 1956, there were not many parallax measurements available. How did he proceed?

- (i) Imagine a galaxy with interstellar pressure that is very different from that in the solar neighborhood, e.g. the center of the MW. Would the IMF be different?
  - (j) Why can't a single power law describe the entire population?
  - (k) What is the main sequence lifetime of a G star? (List some other lifetimes, too.)
15. Write down (or derive) the Jeans mass.
  16. Does the Jeans instability require a collisional or collisionless system?
  17. Imagine a star cluster with  $10^3$  stars and a galaxy with  $10^3$  galaxies. How do the relation times compare?
  18. What is the criterion for a relaxed system?
  19. What is the interaction rate for both systems?
  20. What is the crossing time for a self-gravitating system?
  21. What is the tidal radius for a globular cluster? Describe physically what the tidal radius is.
  22. If you measure the actual radii of globular clusters and compare with the computed tidal radii, is  $R_{tidal}$  greater than  $R_{GC}$ , similar, or smaller? Why? (Hint: What types of orbits to globular cluster have?)
  23. Find the general expression and simplify for a flat rotation curve.
  24. Make a graph of acceleration of a star in a disk galaxy as a function of  $z$  inside a stellar scale height. Hint: If you are within a scale height does the exponential term matter?
  25. How much dust is in the Galactic bulge compared with locally? In what wavelengths can we observe it?
  26. How large is the Galactic bulge, and would it look the same in all directions?
  27. Would it be easier to tell if the Galaxy is barred? What other large scale structure of the Galaxy would you learn?
  28. How do we measure the distance to the GC?
  29. How can we get distances in the IR? What lines are seen in the IR? What's the most robust molecular line?

30. What could one measure regarding globular clusters?
31. Could you measure the mass of the Galaxy?
32. How can we tell if star formation (in a dwarf spheroidal, for example) has been continuous or in bursts?
33. What's the Local Group? How do we know where the LG ends spatially?
34. What is generally true of galaxies not in the LG?
35. How does one measure masses in Galaxies? (Also write down the relevant Kepler law.)
36. How does one determine the thickness of a disk?
37. What determines height of stars in a disk?
38. What is the Local Standard of Rest?
39. What are the Oort constants?
40. How do we measure the angular speed of the Sun?
41. How is neutral gas in the Galaxy measured?
42. What is the dust mass to gas mass ratio in the Galaxy?
43. How is determining the rotational properties of other galaxies different from measuring the rotational properties of our own Galaxy?
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