Week 5 Notes
Astro 2 (Discussion Section 101)

Department of Physics: University of California, Santa Barbara

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Administrative Tasks

Midterm 1 Your first exam is Thursday. It will be all free-response questions with both conceptual and computational questions.

Homework and Solutions I hope to have HW 2 back to you by tomorrow's class, though I may not. Note that solutions to the first three homework should be posted online for your studying needs. Also feel free to talk to me in office hours if you have concerns about your grades. I do make mistakes and am happy to fix them if you bring them to my attention.

Midterm Review

Basic Galactic Concepts

Be familiar with the process through which we came to understand the nature of galaxies (from the spiral nebulae to our current understanding) and how the problem was eventually solved by Hubble's discovery of the expanding universe. Also recall the basic equations relating apparent magnitude, absolute magnitude, brightness, luminosity, and distance:

$$b = \frac{L}{4\pi d^2}$$
$$m_2 - m_1 = 2.5 \log\left(\frac{b_1}{b_2}\right)$$
$$m - M = 5 \log \frac{d}{1 \text{ pc}} - 5$$

and know how to use these to ascertain information from an object in conjunction with other laws (like Kepler's third law or Hubble's Law). Last week's example problem is a good example to look at for review.

Classes of Galaxies

Be familiar with the different types of galaxies, how they're classified, and how we measure them. As a refresher, the main classes are spiral, elliptic, lenticular (sort of), and irregular. Be familiar with how Hubble's "tuning fork" diagram to compare galactic morphologies. Understand what spectra, lensing, and other means of detection can tell us about a galaxy.

Structure of Galaxies

Understand the two main means of support for galaxies, rotational support and pressure support, and what equations govern these two forms of support:

$$M(R) = \frac{v^2 R}{G}$$
$$M = \frac{k\sigma^2 R}{G}$$

Standard Candles

Understand the idea of what a standard candle is, what properties are desirable in a standard candle, and how we use them in Astronomy to determine distances to objects.

Hubble's Law and Redshift

Understand how we came to see that the universe is expanding and what implications it had on the "spiral nebula" debate. Know what is meant by the phrase "Hubble flow" and be familiar with the idea of an object's redshift, given by

$$z \equiv \frac{\lambda - \lambda_0}{\lambda_0} = \frac{\Delta\lambda}{\lambda_0}$$

Be familiar with how to interpret and use Hubble's Law:

$$v = H_0 d$$

as well as how to derive the age of the universe from this constant. Finally, also note the relationship between redshift and recessional velocity

$$v_{\text{slow}} = zc$$
$$v_{\text{fast}} = \frac{(z+1)^2 - 1}{(z+1)^2 + 1}\, c$$

and know when to use each form ($z < 0.1$ for slow solution, otherwise use the fast one).

Galactic Mergers

Know about the basic ideas behind galactic mergers, like tidal tails, the starburst effect, and how galactic mergers can affect morphology.

Dark Matter

Be able to explain why the idea of dark matter even came to be, as well as present alternate theories that solve the problem. Be able to remember other candidates for dark matter that have proven unsuccessful (hot baryonic matter, MACHOs, etc.). Also understand both weak lensing and strong lensing and what information each process gives astronomers. Finally, understand the leading model of dark matter: WIMPs.

Active Galactic Nuclei

Understand current models of Pulsars and related phenomena as well as the unified theory of AGN, which states that many of these phenomena are more or less the same, but we are observing them from different perspectives.

Sample Problems

Sample Problem 2 (U 24.33)

When the results from the Hipparcos mission were related, with new and improved measurements of the parallaxes of *nearby* stars within 500 pc, astronomers had to revise the distances to many *remote* galaxies millions of parsecs away. Explain why.

Solution Recall the idea of the distance ladder. Each method of distance determination is calibrated by the previous "rung" on the ladder. Since parallax gives us accurate distances for nearby objects, this would enhance the accuracies of spectroscopic parallax measurements, which would in turn revise our measurements of Cepheid variables, etc.

Sample Problem 3 (U 25.36)

Observations of a certain galaxy show that stars at a distance of 16 pc from the center of the galaxy orbit the center at a speed of 200 km/s. Use Newton's form of Kepler's third law to determine the mass of the central black hole.

Solution We cannot necessarily find what the mass of the black hole is, since all matter within the star's orbit contribute to the gravitational pull. Thus, we find the total mass within the orbit and assume that most of the mass comes from the black hole. The relevant form of Kepler's law in this situation is given by

$$M(R) = \frac{v^2 R}{G}$$

Now the problem has been reduced to plugging in variables and getting them in the correct variables.

$$\begin{aligned} M(16\text{ pc}) &= \frac{(200\text{ km/s})^2\,(16\text{ pc})}{6.67\times10^{-11}\text{ m}^3/\text{kg/s}^2} \\ &= \frac{\left(200\text{ km/s}\times\frac{1{,}000\text{ m}}{\text{km}}\right)^2\left(16\text{ pc}\times\frac{3.086\times10^{16}\text{ m}}{\text{pc}}\right)}{6.67\times10^{-11}\text{ m}^3/\text{kg/s}^2} \\ &= \frac{4\times10^{10}\cdot4.94\times10^{17}}{6.67\times10^{-11}}\text{ kg} \\ &= 2.96\times10^{38}\text{ kg} \\ &= 1.5\times10^{8}\text{ M}_\odot \end{aligned}$$

While the answer in kg is right, such large masses are typically expressed in terms of solar masses.

Other Questions