Problem Set #5

Astro 2: Spring 2012

Due: May 8, 2012 (in class)

Problem 1

Explain the MACHO microlensing project. Summarize the result of that project: How much of the dark halo of the Milky Way is thought to be due to MACHOs? What is the estimated mass of these bodies? Explain qualitatively how this estimate is made.

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Problem 2

Give at least two pieces of evidence for dark matter in:

(a) Spiral galaxies

(b) Elliptical galaxies

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Problem 3

Henrietta Leavitt discovered that the Cepheid variable stars in the Small Magellanic Cloud, and found that there is a correlation between period of variation of light output and apparent brightness. In other words, she supplied a table of the APPARENT brightness of the Cepheids in the Small Magellanic Cloud, and their periods of variation. This paved the way for the use of Cepheid variables as distance indicators.

Suppose you find a Cepheid variable in another galaxy, and measure its brightness and period. Can you get that galaxys distance from this information alone, or was an additional crucial piece of information needed? Explain.

This question does not appear to be directly answered anywhere in the text. Instead, consult the following:
http://imagine.gsfc.nasa.gov/docs/science/mysteries_l1/cepheid.html

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Problem 4

Counting the number of celestial objects (stars, galaxies, or whatever) at each apparent brightness (flux) provides useful information about:

- the size of the Milky Way Galaxy
- the spatial distribution of galaxies, quasars, and gamma-ray bursts
- the evolution of those objects
- the curvature of space

For objects distributed uniformly in ordinary 3D 'flat' space, show that the number N of objects with flux F_0 or greater follows the relationship $N \propto F_0^{-3/2}$. Hint: Consider the inverse square law and the volume of a sphere.

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Problem 5

Explain the 'winding dilemma' for spiral galaxies. How was it resolved? The spiral arms have bright blue regions, dust lanes, and red gas clouds around star-forming nebulae. Why is that? None of these attributes are seen in the regions between the arms.

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Problem 6

Explain the concepts of 'Population I' and 'Population II.' Do these terms apply to elliptical galaxies, spiral galaxies, neither, or both?

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Problem 7

Consider the square column of air in Earth's atmosphere above a 1 square meter patch of surface. The mass of this square column of air is 1.03×10^4 kg. Use this fact, the radius of the earth, the gravitational constant G, and the air pressure at sea level, to estimate the mass of the Earth. (Answer: 6.0×10^{24} kg)

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