Lecture 7 : The Realm of the Galaxies

The 'Great Debate' (of Astronomy) also called the 'ShapleyCurtis Debate', over the scale of the universe took place on 26 April 1920 at the Smithsonian Museum of Natural History. Two lectures were delivered by Harlow Shapley (Mount Wilson Solar Observatory) and Heber D. Curtis (Lick Observatory) followed by a joint discussion as part of the annual meeting of National Academy of Sciences of the USA.

This Debate grew out of the papers published by Shapley and by Curtis in the May 1921 issue of the Bulletin of the National Research Council. Shapley argued that the universe was comprised of a single galaxy, while Curtis held that it contained many galaxies. Curtis thought that the spiral nebulae were galaxies external to our own, while Shapley disagreed, holding instead that they were clusters made up mostly of gas. On this point, Curtis turned out to be correct, as subsequent data bore out. But Shapley was correct in arguing that our galaxy was larger than previously thought, and for showing that our Sun was not at the center of its galaxy.

Besides this hotly debated question concerning , and whether there are other galaxies besides our Milky Way Galaxy, another important question concerned the different stellar populations in our Galaxy, and the spatial distribution of stars. This lecture explains the various momentous discoveries that answered these questions.

For the curious -

The Shapley - Curtis Debate in 1920
https://apod.nasa.gov/diamond_jubilee/debate20.html

For the advanced -

D. Mihalas & J. Binney, 1981, **Galactic astronomy. Structure and kinematics**, W H Freeman & Co.

J. Binney & M. Merrifield, 1998, **Galactic Astronomy**, Princeton University Press

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Astronomy & Astrophysics : An Introductory Survey

A lecture series by Prof. G. Srinivasan

A 'Golden Jubilee Celebration' Event of the Astronomical Society of India

Lecture 7 : The Realm of the Galaxies

[Supplementary Material : Dr. Sushan Konar]

Suggested Problems

1. Scientists are still not certain about the cause of the extinction of dinosaurs. Let us, for a moment assume (completely wrongly, of course!) that a time machine can be made and scientists can go back to that era to investigate the cause of dinosaur extinction. If those scientists looked up at the sky, would they find anything different? Justify your answer.

2. (a) What is the most distant object in the sky that the human eye can see without optical instruments? Justify your answer.

   (b) A Cepheid variable in a nearby galaxy looks 10 6 times fainter than an identical Cepheid (in the milky way) 1000 parsecs away. how far away is the nearby galaxy?

3. A star of mass $1\mathrm{M}_\odot$, located at a distance of 25 kpc from the centre of the galaxy has an orbital period (around the centre) of 10^9 years. Calculate the number of stars in this galaxy. Assume the galaxy to be equivalent to an infinitely thin disk with a uniform stellar surface density and all the stars to be of equal mass. Also assume that the orbit of the above-mentioned star to be at the edge of the galactic disk.

4. Our Galaxy ($M \sim 7 \times 10^{11}\mathrm{M}_\odot$) and the Andromeda galaxy ($M \sim 10^{12}\mathrm{M}_\odot$) are separated by 690 kpc and are in circular orbits about the common center of mass (which theyâĂŹre not), what would be our distance to that center of mass? What would our orbital period be?

5. Quasars are thought to be the nuclei of active galaxies that radiate enormous amounts of energy. If the luminosity of a quasar happens to be 10^{48} erg/s, find the rate at which the mass of this quasar being reduced to supply this energy? Convert the answer to solar mass per year.

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