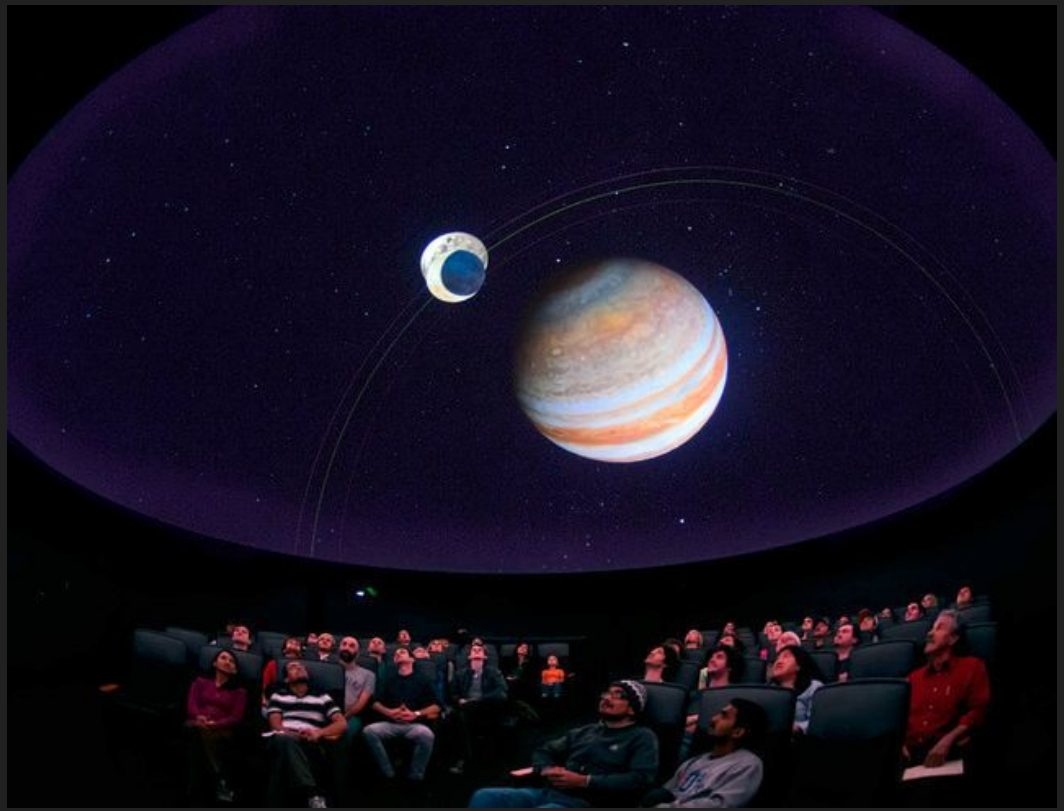
The Great Debate

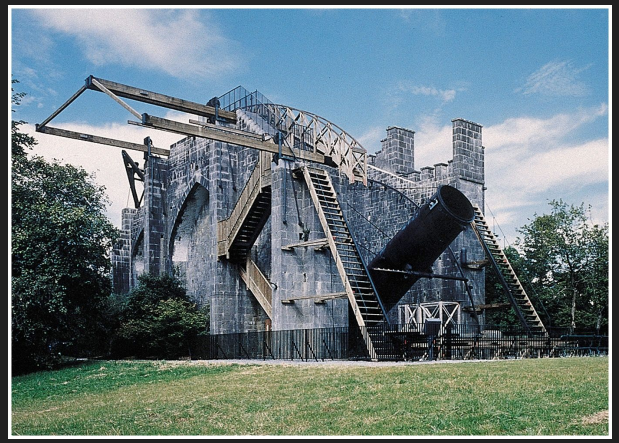
Meet in Planetarium Friday

University of Wyoming
College of Engineering and Physical Sciences
Physics and Astronomy



Spiral Nebulae

- Dim diffuse “nebulae” with spiral structure
- First noted in the mid-1800s by William Parsons aka Lord Rosse



Parsons’ 1.8m telescope “Leviathan”

Parsons’ sketch of M51

HST image of M51

Spiral Nebulae

M31—The Andromeda Galaxy

Spiral Nebulae

M101—The Pinwheel Galaxy

Spiral Nebulae

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M81 (left) and
M82(right)—Bode's galaxy

The Great Debate

- What are Spiral Nebulae? How far away are they?
- Kant: Our Galaxy is an “island universe” and other spiral nebulae are the same as our Galaxy and very far away.
- Herschel: Our Galaxy is the whole universe and other spiral nebulae are in our Galaxy and nearby.

The Great Debate

- 26 April, 1920: Harlow Shapley and Heber Curtis, two famous astronomers of the day, met at the Smithsonian Museum of Natural History to discuss the size and scale of the universe
- Shapley is absolutely convinced that the Milky Way, our Galaxy, is all that there is
  - He knows the RR Lyrae stars in globular clusters proves the Galaxy is ~100,000 light years across (correct) and for Andromeda, the largest spiral nebula in the sky, would have to be ridiculously far away.
- Curtis thinks that spiral nebulae are other, distinct galaxies, or “island universes”
  - He’s counted many novae going off in the Andromeda spiral nebula. Why would a tiny structure in our galaxy have so many novae?

Poll everywhere

1. If Andromeda subtends 0.05 radians, and it were to have the same diameter as our Galaxy (L = 100,000 ly), how far away would Shapley have calculated Andromeda to be?

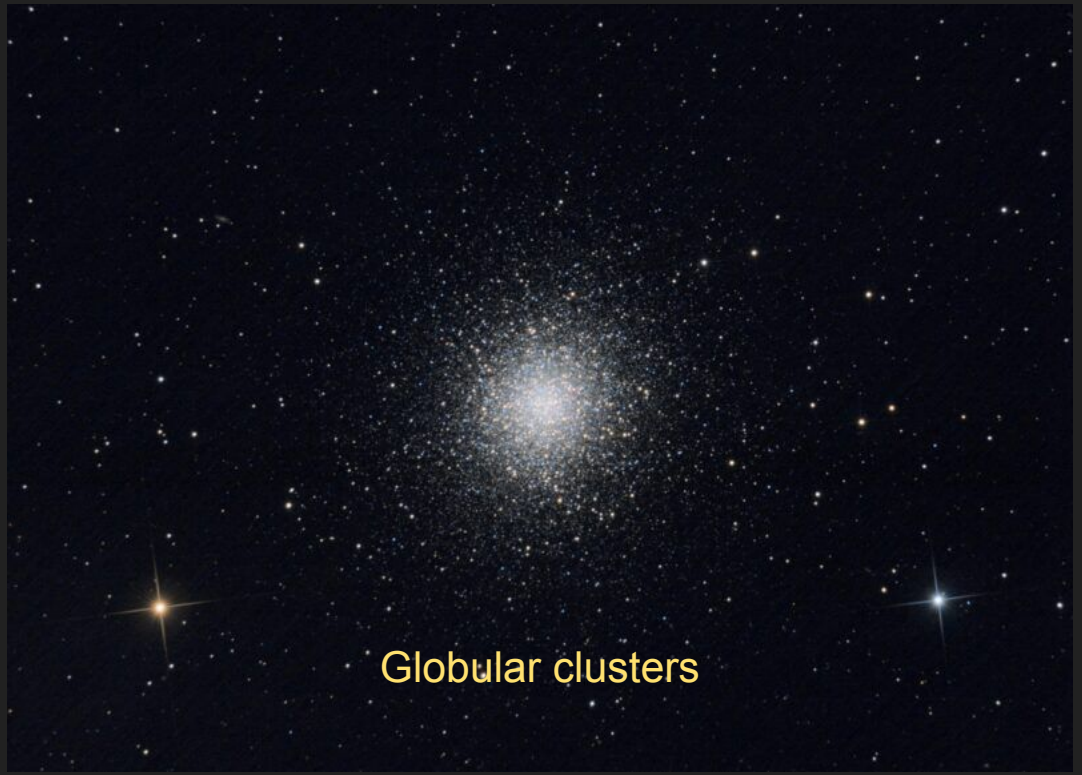
When poll is active respond at **PollEv.com/nikhilpatten355**

Send **nikhilpatten355** to **22333**

The Great Debate

- Today the Great Debate seems trivial, of course galaxies are very far away
- Think how difficult the problem being discussed actually was
- We see weird spiral things in the sky, but we also see lots of weird things in the sky

The Great Debate



The Great Debate

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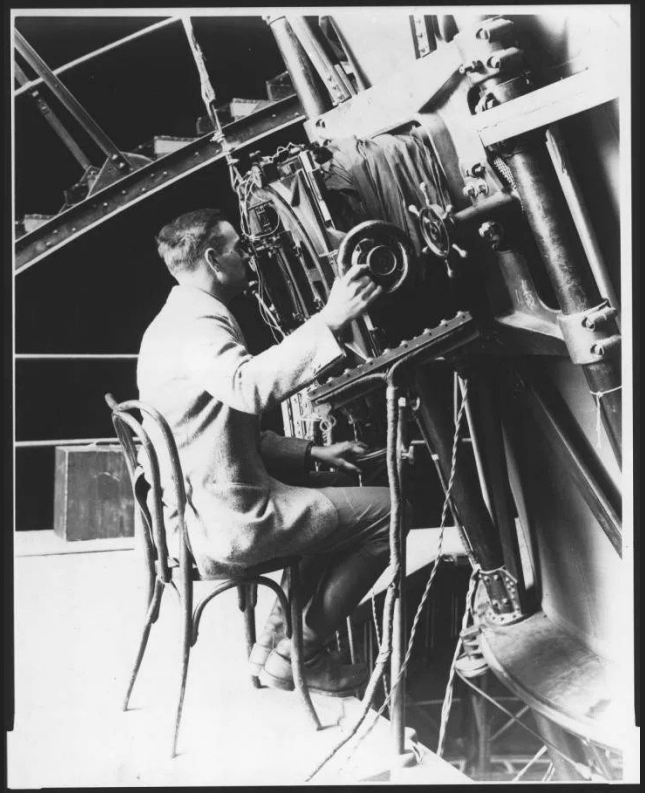
Giant molecular clouds

The Great Debate

- Today the Great Debate seems trivial, of course galaxies are very far away
- Think how difficult the problem being discussed actually was
- We see weird spiral things in the sky, but we also see lots of weird things in the sky
  - Why are spiral nebulae any different?
- How might one prove that these spiral nebulae are either close to us (within our Galaxy) or far away (outside our Galaxy)?

The Great Debate

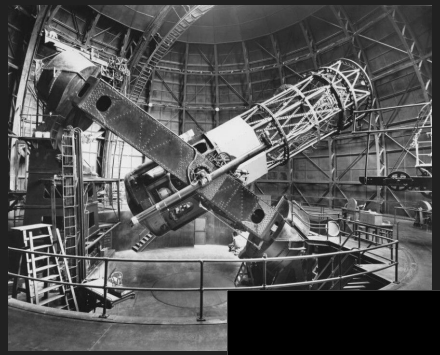


Edwin Hubble

- One of the most important observational astronomers of the 1900s
- Demonstrated spiral nebulae were outside our Milky Way, the expansion of the Universe, classified galaxies
- Namesake for the famous space telescope

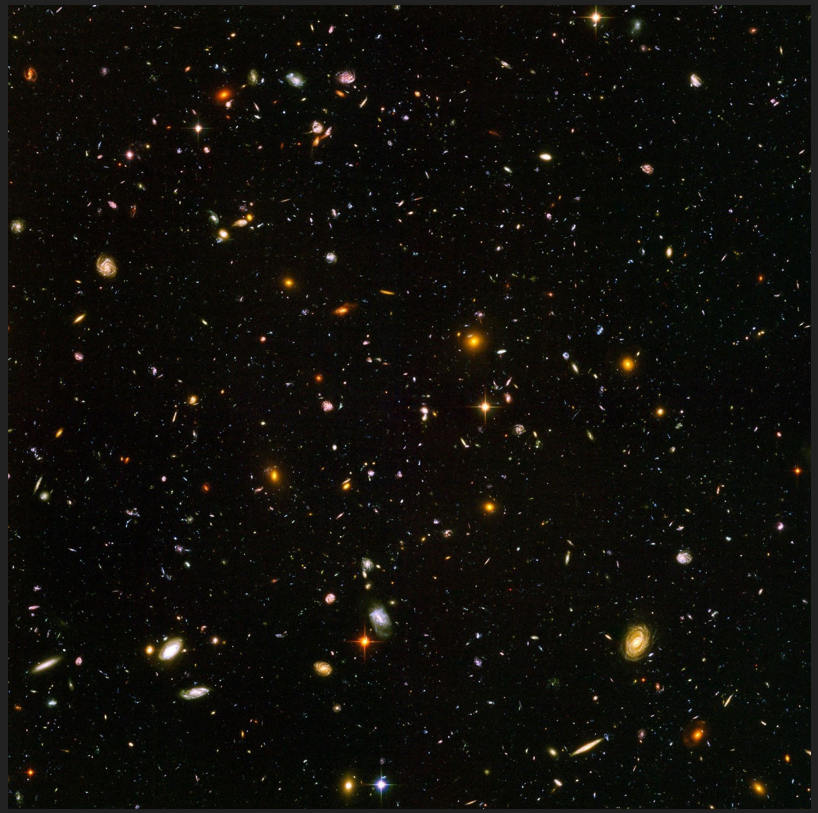
Edwin Hubble

- Hubble resolved the Andromeda “nebula” into individual stars from his Mt. Wilson observatory
- After resolving stars, Hubble searched for Cepheid Variables (stars that have a pulsation-absolute magnitude relation)
- Found M31 was ~300,000 pc away (modern estimate is ~770,000 pc)
- Two types of Cepheids lead to discrepancy
- Andromeda is an “island universe” like our own Galaxy



Galaxies

- The cosmic engines that turn gas and dust into stars and planets, they recycle the fast from dead/dying stars to form new stars
- In between galaxies, no star formation occurs—essentially nothing happens in intergalactic space
- Galaxies can be classified by morphology (shape and size)



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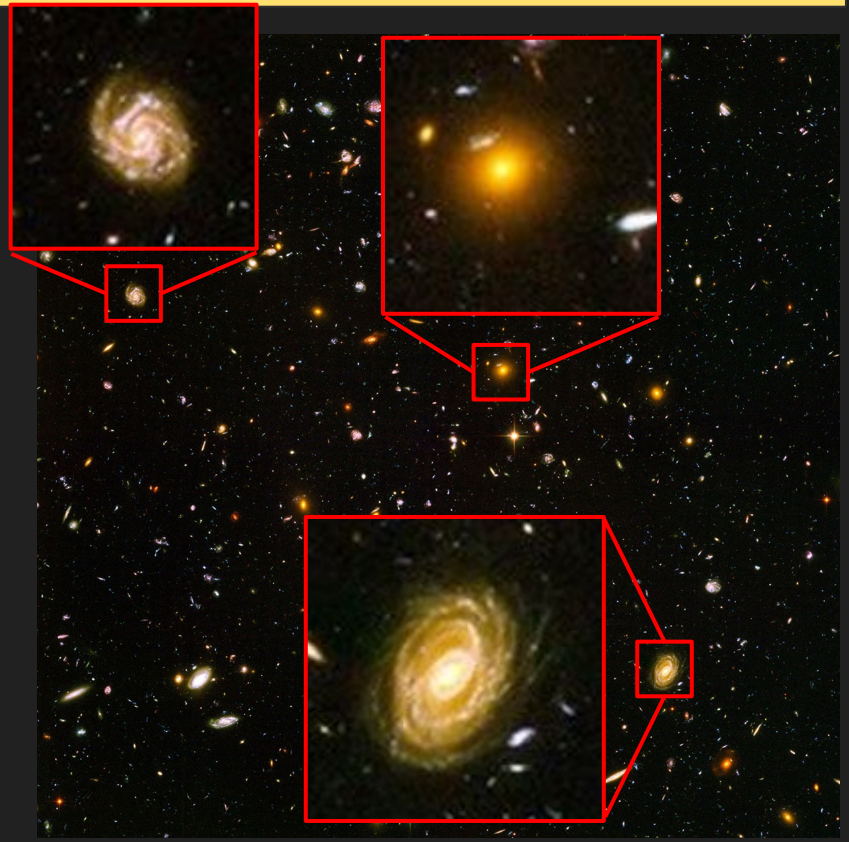

Classes of Galaxies

- Spirals (S)
  - Structure: Disk, halo, bulge
  - Medium to large galaxies
  - The disk contains young, blue stars while the bulge and halo contain older red stars
- Ellipticals (E)
  - Pure bulge, no disk
  - Large range of sizes
  - All older red/yellow stars
- Irregulars (Ir)
  - Irregular
  - Typically smaller that content mostly young, blue stars

Galaxy Types: Overview

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	Spirals	Ellipticals	Irregulars
Mass (M_{sun})	10^9 – 10^{12}	10^5 – 10^{13}	10^8 – 10^{10}
Luminosity (L_{sun})	10^8 – 10^{10}	10^5 – 10^{11}	10^7 – 10^9
Diameter (kpc)	5 - 200	1 - 200	1 - 10
Color	**Disk:** Blue-to- white **Halo/ Bulge:** Red-to-yellow	Reddish-yellow	Bluish-white

Announcements

- Meet in planetarium on Friday
- Homework 8 assigned today

Next time

- Galaxy evolution