Astronomy 100
Tuesday, Thursday 2:30 - 3:45 pm

Tom Burbine
tburbine@mtholyoke.edu

www.xanga.com/astronomy100
OWL assignment (Due Next Thursday)

- There is an OWL assignment due on Thursday, April 28 at 11:59 pm.
- There are 15 questions and a perfect score will give you 2 homework points.
Homework Assignment (Due by May 3)

• Make up a test question for next test
• Multiple Choice
• A-E possible answers
• 1 point for handing it in
• 1 point for me using it on test
• The question needs to be on material that will be on the 4th exam
Homework Assignment
(Due by May 5)

• I have placed 40 terms on the website
• You get 0.1 of a HW point for each of these you define and hand in to me
• Definitions need to be hand-written or hand-typed
• A lot of these definitions will be on next test
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Astronomy Help Desk

• There is an Astronomy Help Desk in Hasbrouck 205.
• It is open Monday through Thursday from 7-9 pm.
Distances

- Distances are hard to measure in space
- Apparent brightness = Luminosity
  \[4\pi \times (\text{distance})^2\]
White Dwarf Supernova

- White Dwarf Supernova are believed to be due to a white dwarf star that gains enough mass from a binary companion that it goes over the 1.4 solar mass limit
White Dwarf Supernova

• This causes the interior temperature to increase due to the increased gravity
• Carbon fusion ignites throughout the star
• The White Dwarf explodes
Because

• These white dwarf supernova are all formed from white dwarfs of similar masses
• Have similar maximum luminosities and similar lightcurves
You can

- Use the white dwarf supernova as a standard candle since you can determine its luminosity
The graph shows the evolution of luminosity (in solar units) over time (in days) for two types of supernovae:

- Red line: massive star supernova
- Blue line: white dwarf supernova
Tully-Fisher Relation

- The luminosity and rotation speed of a spiral galaxy depend on its mass
- Luminosity depends on the number of stars, which is function of mass of galaxy
So

- If we measure the rotation speed of a galaxy
- We can determine the galaxy’s luminosity
- Use to determine distance since we can measure apparent brightness
Measure rotation rate.

Plot rotation rate on horizontal axis.

Determine luminosity from rotation rate.

Line represents observed Tully-Fisher relation.

Luminosity ($L_{\odot}$)

Rotation rate (km/s)
Importance of Hubble’s Constant

- Remember: $v = \frac{d}{t}$
- $d = vt$
- $d = \frac{v}{H_0}$
- so $t = \frac{1}{H_0}$
- so if you know Hubble’s constant, you can determine the age of the universe
$1/\text{Hubble’s Constant}$

- Will equal the age if
- The expansion rate has not changed
Calculation

• Hubble’s Constant = 71 km/s

\[ \frac{\text{Mpc}}{1 \text{ Mpc}} = 1000000 \text{ parsecs} = 3260000 \text{ lightyears} \]

\[ 1 \text{ Mpc} = 3.08 \times 10^{19} \text{ km} \]

Hubble’s Constant = \( 2.305 \times 10^{-18} \text{ s}^{-1} \)

\[ 1/\text{Hubble’s Constant} = 4.34 \times 10^{17} \text{ s} \]

\[ 1/\text{Hubble’s Constant} = \sim 14 \text{ billion years} \]
Distant galaxies appear redshifted

- Since galaxies are moving away from us, they appear redshifted
- Wavelengths of features move to longer wavelengths
Galactic Formation
How did Galaxies form

• Usually assume two things:
  • Hydrogen and Helium filled all of space pretty uniformly at the beginning of the Universe
  • The Uniformity was not perfect and certain regions were denser than others
Next

• The denser regions slowed their expansion and caused the material to contract into protogalactic clouds
• Thought that stars in the spheroidal part formed first
Next

- Collisions among gas particles tend to average out their random motions.
- Acquire orbits in the same direction and same plane.
Next

- Star formation occurs in the disk
- But not in the halo due to lack of gas
Why do galaxies differ?

- Maybe due to spin of the protogalactic cloud
- It was spinning fast to begin with, you get Spiral
- It was spinning slow to begin with, you get Elliptical
Or

- Elliptical galaxies may arise from denser protogalactic clouds
- These would cool fast
- Gas would form stars before they could settle into disk
Galaxies Collide

• Collisions happen over hundreds of millions of years
• Probably occurred more frequent when the universe was smaller and galaxies were closer together
Collisions

• If two spiral galaxies collide
• They may form elliptical galaxies
• Large fraction of gas sinks to the center of the collision
• Disks are torn apart
• Star orbits are randomized
It appears

• That the Milky Way Galaxy and the Andromeda Galaxy will collide in about 5 billion years
Show Movies
Cartwheel Galaxy
150,000 light years across
Starburst Galaxies

• Producing stars at \(~100\) per year
• Milky Way Galaxy produces \(~1\) new star per year
Arp 220
High Rate of Star Formation

- They would consume all their interstellar gas in a few hundred million years
- High rate of star formation means very high supernova rate
Produces

- Galactic Wind is hot gas that erupts into interstellar space
- Gas has temperatures of 10-100 million Kelvin
M82 visible
M82
X-ray
Questions