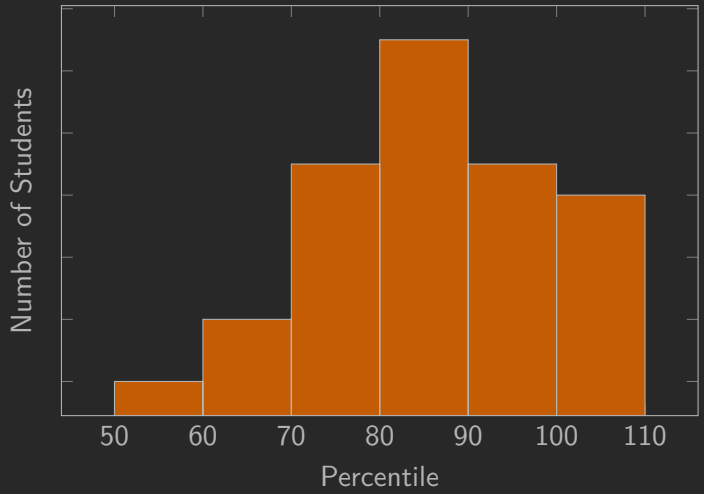
Announcements

- Webwork due on Friday
- Graded Test 3 coming back to you now!
- Updated grade reports were issued, though participation is lagged a bit
- Polling: `rembold-class.ddns.net`

Test Summary!



- High: 110%
- Mean: 85%
- Median: 84%

Test Coverage

- We'll quickly go over the test.
- If you have concerns over your score, or find I made a mistake, please swing by my office and we can chat and fix things

Warm Up Question

Suppose you were to take a spectra of a star and learn that it has a much greater fraction of heavy elements in it compared to our Sun. What would you conclude about when that star formed?

A. It formed early in the formation of the galaxy, before our Sun
B. It formed around the same time as our Sun
C. It formed much later that our Sun
D. That couldn't happen! Check your equipment!

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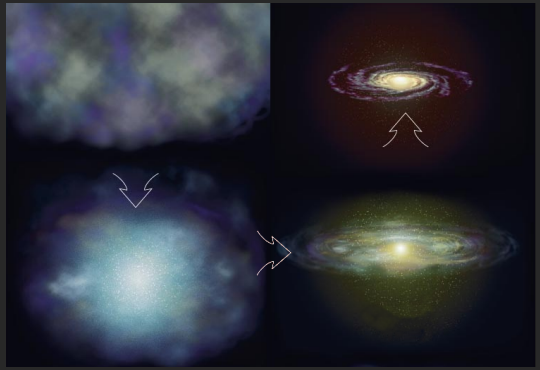
I can see your Halo

- Stars in the Halo are old!
  - A smaller fraction of heavy elements than the Sun
  - Largely low-mass, red stars
- Stars in the disk are relatively young
  - A greater or equal fraction of heavy elements to the Sun
  - Lots of high and low mass stars, both blue and red
- Stars in the Halo must have formed early in the Milky Way's history
  - When fewer heavy elements existed
  - No ISM (gas) in the halo
  - Star formation in halo stopped long ago when the gas got flattened into the disk

Galaxy Formation

- Any theory of galactic formation needs to predict these differences between halo and disk stars
- Going theory is that of a giant protogalactic cloud that collapses
  - Halo stars form as it collapses
  - Get left behind as angular momentum flattens the collapsing cloud



Problems with Proto-Galactic clouds

- Stars and star clusters should be forming the whole way through the stars collapse
- So halo stars far from the center would be older than halo stars nearer to the center
  - Would imply that far away halo stars should have the least heavy elements
- But in truth ALL halo stars have the same elemental composition
- Suggests a collision between multiple protogalactic clouds

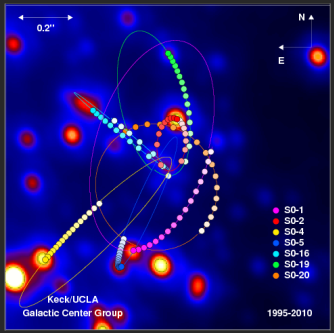
Galaxy Collisions

- Galaxies tend to cluster in groups
- Means collisions are a real possibility
- Milky Way has already consumed two galaxies in the past
- Will collide with the Andromeda galaxy in about 5 billion years

The Beast at the Center

- We can see into the core with radio, infrared, and X-ray telescopes
- Near the center, we see a radio source named Sagittarius A*
- Lots of stars VERY close with orbits that suggest Sgr A* has a huge mass

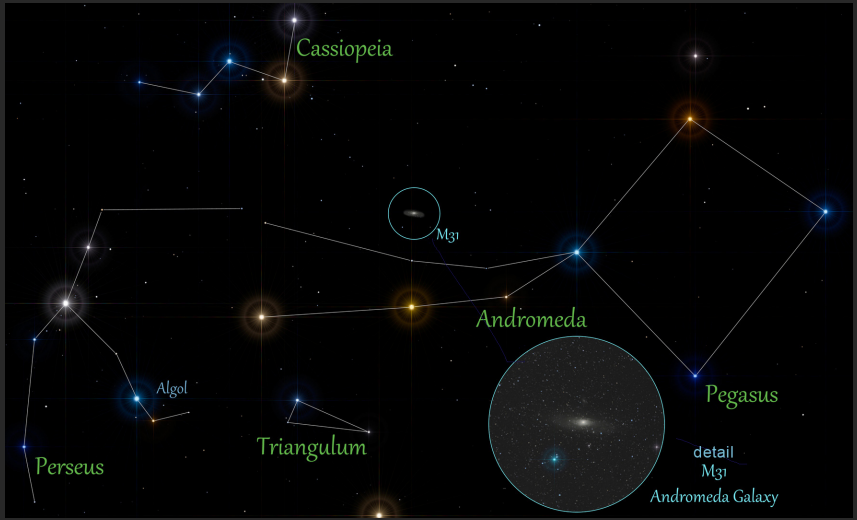
- Almost certainly a black hole
  - Yet odd in that it is not a strong x-ray source
  - Occasional bright x-ray bursts
  - Clumps of infalling material instead of a smooth stream?



Our Neighbors: The Magellanic Clouds

- Large and Small (160,000 and 200,000 light-years away)
- Irregular Dwarf Galaxies
- Both orbit the Milky Way
- Only visible from the Southern Hemisphere :(

Our Neighbors: The Andromeda Galaxy



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