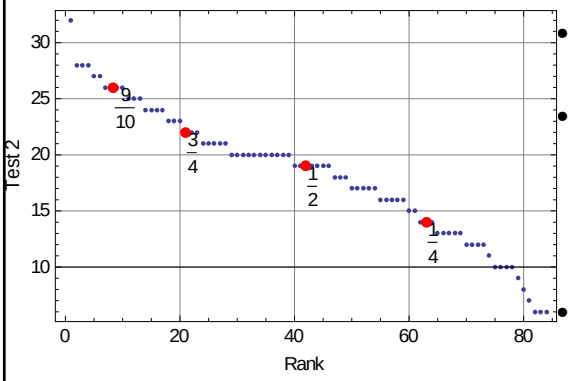
About the Big Bang—2 Nov

- Outline
  - Test 2
  - How to improve
  - Objectives: To answer and give evidence for these questions.
    - Galaxies move away from us in all directions. Are we at the center of the Big Bang?
    - Why are galaxies moving? Why is the universe expanding?
    - Why are most galaxies moving away from us? Why are some galaxies moving toward us?
    - Is Hubble's Constant a constant? You will answer in Hwk8.
    - Is everything expanding? Figure this out yourself.
- Open house at the MSU Observatory, Fri & Sat, 9:00-11:00

Test 2: Average: 19/31 (61%)

Test 1: Average: 60%



- Q 1d was not covered by 10/19.
  - Grade was computed out of 31 points, not 34.
- Answers: Link AT2 on syllabus on angel
- Grade is on angel
  - Report>Report Setting
  - Choose "Grades"
  - Overall % (Course grade)
    - Eg., 90% (4.0)
- Course grade
  - Average is 2.9
- 50% of grade is in the future.

How to improve

- Homework
  - Did I do the homework or copy it from on-line?
  - What did I learn?
  - What key ideas did I need?
  - Look at the homework answers.
- Classes
  - What are the key ideas?
  - Am I able to write the main ideas in a few sentences?
- Clickers
  - Am I relying on my buddy to do the work?
  - If so, I need to write down the reasoning after class.

How to do poorly

- The goal of homework, clicker, and pre-class questions is to help learn. In addition they count as part of the overall grade.
- How to do poorly
  - Separation between 3.0 and 3.5 is 5%.
  - I won't do the homework
    - Homework counts 23%.
    - I give up 5 grades. 4.0→3.5 →3.0 →2.5 → 2.0→1.5.
  - I won't do the pre-class questions
    - Pre-class questions count for 5%.
    - I give up 1 grade. 4.0→3.5
  - I'll miss half the classes (clicker questions).
    - Clickers count for 10%.
    - I give up 1 grade. 4.0 →3.5

Are we at the center of the Big Bang?

- Galaxies move away from us in all directions. (H's Law says so.) Therefore we are at the center of the Big Bang.

1. Can an astronomer on some planet in Hoag's Galaxy make the same statement? (Recall our demo from Fri.) Is Hoag's Galaxy at the center of the Big Bang?
   A. Yes & yes
   B. YN
   C. NY
   D. NN

- Every point is at the center of the BB. This is a special property of Hubble's Law

Why do galaxies move?

- Why does a baseball move? Two ways to ask the same question:

1. A baseball is 1 inch from a fan's hands in right field. Miguel Cabrera is trotting toward 1st base. Why did the baseball move from 2in to 1in from the fan's hands?
2. Coma is 100Mpc from us, and it is moving at 6000km/s. Why did Coma go from 50Mpc to 100Mpc?

- What main idea enables you to answer these?

Why do galaxies move?

1. Coma is 100Mpc from us, and it is moving at 6000km/s. Why did Coma go from 50Mpc to 100Mpc?

- The main idea:
  - Newton's 1st Law: Natural motion is motion in the same direction at the same speed.
  - Coma was moving at 6000km/s. It will keep moving at the same speed all by itself. (We must look for the cause only if it slows down or speeds up.)

Why do galaxies move?

- The Big Bang set the material in motion.
  - At some early time proto-Coma was 1cm from us and moving at 6000km/s. Proto-Hoag's Galaxy was 3cm from us and moving at 18,000km/s. (We will find out later if the speeds slowed or increased.)
  - Later, we will discuss early universe.

Who obeys Hubble's Law?

1. Who obeys Hubble's Law? P: Milky Way Galaxy and Hoag's Galaxy. Q: Earth & sun. Hint: think about why galaxies move.
   A. Yes for both cases P & Q
   B. Y for P. N for Q.
   C. N for P. Y for Q.
   D. N for both
- What is different about the two cases that makes one obey and the other violate Hubble's Law?

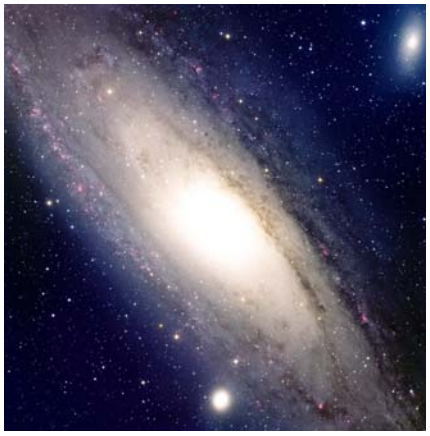
Why do most galaxies move away, but a few move toward us?

- Andromeda & two companions are moving toward us at 200km/s. The distance is 0.7Mpc.
- According to H's Law, what should the speed of Andromeda be? (H=64km/s/Mpc)

  v = H D = 64km/s/Mpc 0.7Mpc

  = 45km/s

1. What is very strange about Andromeda's motion?
   A. It is going too fast.
   B. It is going in the wrong direction.
- Why does A not obey H's Law?



Andromeda M31, M32, & M33
www.noao.edu/image_gallery/images/d6/m31y.jpg

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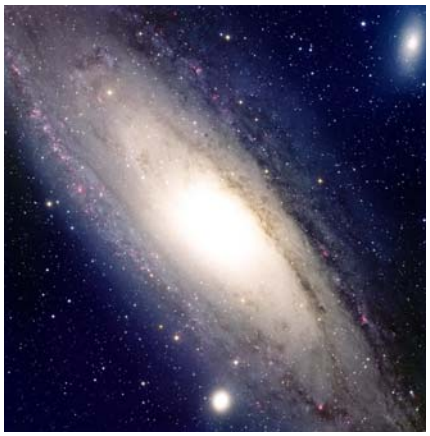
1. What is very strange about Andromeda's motion?
   A. It is going too fast.
   B. It is going in the wrong direction.

- Why does A not obey H's Law?

1. Assume early in the history of the universe, A did obey Hubble's Law. What caused it to change direction and move toward us?



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