

Chapter 18: The Expanding Universe of Student Galaxies

Student Worksheet

Objective:

Gain a solid understanding of how the speed of recession for distant galaxies increases as distance increases. Link this to the concept of the universe lacking a center.

Engage:

Some of the greatest discoveries come from being very, very wrong. Science celebrates the moments where reality is not as we thought. Many a Nobel Prize has been awarded to scientists who unlocked big discoveries on a path with drastically different anticipated results. Can you think of any of these moments in science? What big mistakes or flawed judgments in your own life have led you to uncover some hidden greatness?

Introduction:

In the late 1990s astronomers set out to measure the rate at which the universe was slowing down from the Big Bang. It only seems natural that something expanding from an initial burst of energy must slow down and eventually stop. Even without friction in space, gravity should eventually tug things back in on themselves. Right? Not in this case. The astronomers who set out to measure the deceleration of the universe found that it was not slowing, but speeding up! This observation has led to the field of study called Dark Energy.

Today astronomers see galaxy groups moving away from one another at ever quickening rates. Looking as far away as we can, we see that the calculated speed of recession approaches that of light. Looking at closer galaxy groups, we see that the calculated speed of recession is not as extreme.

This activity aims to clear up any confusion about how some galaxies appear to move faster than others.

Your Task:

Volunteer to participate in the teacher-led demonstration or watch your classmates clarify this concept.

Conclusion:

1. Can this activity achieve the same results for anyone in the line?

2. Which person or persons in the line can see the fastest recession speeds?

3. Relate this to the Doppler shift from the perspective of the central person. Were your classmates redshifting, or blueshifting, or some of each?

4. Would your answer to question 3 above change if it were asked in reference to one of the end people?

5. If the universe is expanding, how is it that we are predicted to collide with the Andromeda galaxy in about 5 billion years?

6. A common thought people have is: *If I see things receding all around me, I must be in the center.* Explain how this is not necessarily the case.

Extend:

- Learn more about Dark Energy. What force does it work against? How are astronomers trying to study it?

- What are some possible shapes of our universe if it is expanding and accelerating?