

# Cosmic Evidence Investigation

Earth & Space Science · Grades 9–12

Use galaxy spectra, expansion patterns, microwave background measurements, and elemental composition to evaluate explanations for the history of the universe.

**NGSS: HS-ESS1-2.** Construct an explanation of the Big Bang theory using evidence from spectra, galaxy motion, cosmic background radiation, and matter composition.

Name: \_\_\_\_\_

Class / Period: \_\_\_\_\_ Date: \_\_\_\_\_

**Driving Question:** Which independent observations support a hot, expanding universe?

## Evidence Set 1 · Galaxy Redshift

Measure all six galaxies. Record the values shown by the model after each spectrum is matched.

| Galaxy / target | Redshift $z$ | Distance | Recession velocity | Observation |
|-----------------|--------------|----------|--------------------|-------------|
|                 |              |          |                    |             |
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## Evidence Set 1 · Analyze the Galaxies

1. What relationship do you see between galaxy distance and recession velocity?

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2. Why does switching the expansion-model observer matter? What stays true from different viewpoints?

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## Evidence Set 2 · Microwave Background

Scan at least eight directions. Record the model temperature and compare it with the mean.

| Direction | Temperature (K) | Difference from mean |
|-----------|-----------------|----------------------|
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## Evidence Sets 2 and 3 · Patterns

3. Describe the large-scale pattern in the microwave sky. Is the signal concentrated in one direction or present across the sky?

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## Evidence Set 3 · Early Composition

| Sample  | Hydrogen % | Helium % | Trace % | Pattern |
|---------|------------|----------|---------|---------|
| Cloud A |            |          |         |         |
| Cloud B |            |          |         |         |
| Cloud C |            |          |         |         |
| Cloud D |            |          |         |         |

4. What common composition pattern appears across the four separated samples?

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5. Why is it stronger to use several independent types of evidence rather than only the galaxy-redshift pattern?

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# Evaluate Competing Explanations

| Explanation                | Evidence it can account for | Evidence it struggles to explain |
|----------------------------|-----------------------------|----------------------------------|
| Static universe            |                             |                                  |
| Explosion into empty space |                             |                                  |
| Hot, expanding universe    |                             |                                  |

## Evidence Synthesis

6. Choose the explanation best supported by the complete evidence set. Name at least three independent observations that support your choice.

# Claim · Evidence · Reasoning

**Question:** Which model of cosmic history is best supported by the evidence collected in this investigation?

**Claim:** State your answer in one clear sentence.

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**Evidence:** Use at least three specific observations, measurements, or data values from the model.

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**Reasoning:** Explain why your evidence supports the claim using the science ideas from the investigation.

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## Critique the Model

Choose one simplification below and explain how it differs from real astronomical research: clean galaxy trend, exaggerated CMB color differences, rounded composition values, or a 2-D expansion grid.

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