Messages in Starlight

Use spectral lines to investigate matter and cosmic history.

PHY.4.10 "Enrichment: Research the ways absorption and emission spectra are used to study astronomy and the formation of the universe."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline how dark and bright lines form, circle what their patterns reveal about matter, and number two statements that connect spectra to the history of the universe.

Reading Light from Space

1. At an observatory, a telescope splits light from a star into its colors. The spread is called a spectrum. At certain wavelengths, thin dark lines interrupt the light. Atoms in cooler gas between the star's bright surface and the telescope absorb light at particular wavelengths, leaving an absorption spectrum. Each element has a distinctive pattern of lines, measured in a laboratory. When astronomers match several dark lines to that pattern, they can identify elements in the gas, even though they cannot collect a sample. A single dark line is less convincing because different elements can have lines near the same wavelength.

2. A cloud where stars are forming provides a different signal. Energetic light from young stars excites atoms in the thin gas. As those atoms release energy, the gas sends out bright lines at specific wavelengths, an emission spectrum. Astronomers match groups of bright lines to laboratory patterns to find which elements are present, such as hydrogen and oxygen. They also compare the strengths of certain lines to estimate conditions in the cloud, although brightness alone cannot give an exact amount of an element. Emission lines let astronomers examine star-forming gas that might be too faint to study by its continuous light.

3. Now consider a distant galaxy. Its spectrum may contain dark and bright line patterns, but they appear at longer wavelengths than laboratory patterns. This redshift shows that the galaxy is receding; across many distant galaxies, the trend supports an expanding universe. Light takes time to travel, so distant galaxies are observed as they were further in the past. Astronomers compare their spectral lines to trace changes in gas across cosmic history. Hydrogen and helium formed in large amounts early in the universe, while stars later produced many heavier elements. Comparing element patterns across time can test this history, but spectra cannot explain it alone.

2 ANSWER WITH EVIDENCE

Use the passage

1. An astronomer sees several dark lines in a star's spectrum. How can those lines help identify gas along the light's path?

2. How can bright lines help astronomers study a cloud where stars are forming?

3. A distant galaxy's line pattern appears at longer wavelengths than the laboratory pattern. What does this tell astronomers, and how does studying many such galaxies extend that finding?

4. How could comparing spectral lines from galaxies seen at different times help test an idea about the universe's chemical history?

3 YOUR TURN

Your own words

A newly found galaxy has a glowing gas cloud and a bright star cluster. Write a five- to six-sentence observing plan that uses both absorption and emission spectra, explains how you would check for redshift, and names one limit on what your evidence could prove about cosmic history.

ANSWER KEY

Messages in Starlight

HIGH SCHOOL · PHY.4.10

PART 1 · READ AND MARK

Underline how dark and bright lines form, circle what their patterns reveal about matter, and number two statements that connect spectra to the history of the universe. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	An astronomer sees several dark lines in a star's spectrum. How can those lines help identify gas along the light's path?	**The astronomer matches the pattern of dark absorption lines to an element's laboratory pattern. Several matching lines provide stronger evidence than one.**
2	How can bright lines help astronomers study a cloud where stars are forming?	**Bright emission lines reveal elements in the gas when their pattern matches laboratory measurements. Line strengths can also help estimate conditions in the cloud.**
3	A distant galaxy's line pattern appears at longer wavelengths than the laboratory pattern. What does this tell astronomers, and how does studying many such galaxies extend that finding?	**The redshift indicates that the galaxy is receding. A trend of redshifts across many distant galaxies supports an expanding universe.**
4	How could comparing spectral lines from galaxies seen at different times help test an idea about the universe's chemical history?	**Because distant light shows an earlier time, astronomers can compare element patterns across cosmic history. Those comparisons can test the idea that stars produced many heavier elements after hydrogen and helium formed early on.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would collect a spectrum of the star cluster and look for dark absorption lines. I would match several of those lines to laboratory patterns to identify gas along the light's path. I would also collect light from the glowing cloud and match its bright emission lines to identify elements in its gas. To check for redshift, I would compare the wavelengths of whole line patterns with laboratory measurements. A shift toward longer wavelengths would show that the galaxy is receding. These measurements could contribute to a study of cosmic history, but one galaxy's spectrum could not establish how element abundances changed throughout the universe.

Accept equivalent explanations that use line patterns, rather than a single line, to identify elements. For the observing plan, accept other valid limits, such as the inability to determine exact element amounts from line brightness alone.