

Look at the optical images of the four galaxies A, B, C, and D. These galaxies, are all approximately the same actual size. Which galaxy do you think is closest to us? Farthest?

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Closest Farthest

What evidence did you use in these choices?

Label the x-axis of the graph on page 2 with the letter of the galaxies, in order from closest to farthest. Look at the spectra of the four galaxies A, B, C, and D. Determine the wavelength of the red hydrogen line in each spectra.

Galaxy A: \_\_\_\_\_\_\_\_\_\_\_\_\_ nanometers Galaxy B: \_\_\_\_\_\_\_\_\_\_\_\_\_ nanometers

Galaxy C: \_\_\_\_\_\_\_\_\_\_\_\_\_ nanometers Galaxy D: \_\_\_\_\_\_\_\_\_\_\_\_\_ nanometers

The observed redshift is proportional to the speed of the source (for speeds that are not close to the speed of light). For example, for a galaxy moving away from us at 10% of the speed of light, the light will be redshifted by 10%. The hydrogen line that was at 656 nanometers in the laboratory sample of hydrogen gas will be redshifted by about 65 nanometers, and will be observed at 721 nanometers.

By how much has the red hydrogen line been shifted in the spectra of galaxies A, B, C, and D? What fraction of the original wavelength is this? At what fraction of the speed of light is the galaxy moving?

Galaxy A: redshifted \_\_\_\_ nanometers =\_\_\_\_ % Galaxy B redshifted \_\_\_\_ nanometers =\_\_\_\_ %

Galaxy C: redshifted \_\_\_\_ nanometers =\_\_\_\_ % Galaxy D redshifted \_\_\_\_ nanometers =\_\_\_\_ %

Calculate the speed of each galaxy as it is receding from us, using the percentages from your answer above. The speed of light is approximately 300,000 kilometers per second (186,000 miles per second).

Galaxy A: \_\_\_\_ % x 300,000 km/s = \_\_\_\_\_\_\_\_ Galaxy B: \_\_\_\_ % x 300,000 km/s = \_\_\_\_\_\_\_\_ Galaxy C: \_\_\_\_ % x 300,000 km/s = \_\_\_\_\_\_\_\_ Galaxy D: \_\_\_\_ % x 300,000 km/s = \_\_\_\_\_\_\_\_

Summing Up: Doppler Effect for Light

1. The Doppler Effect is not mentioned in this lab, but the term “redshift” is. Describe what a “redshift” is in your own words.
2. How is a redshift related to the Doppler Effect?
3. In fact, a “blueshift” exists too. From your understanding of what a redshift is, describe what you think a blueshift is.
4. When observed from Earth, the light from the Andromeda Galaxy is undergoing a blueshift. Does this mean that the Andromeda Galaxy is coming closer to us or getting farther away? Explain your reasoning in terms of the Doppler Effect.
5. Think about how you described the Doppler Effect in terms of sound. In a similar way, describe the Doppler Effect in terms of light.