

Name: \_\_\_\_\_ Period: \_\_\_\_\_ EN \_\_\_\_\_

## Evidence for Expanding Universe Lab

### STUDENT WORKSHEET Calculating and Graphing Galactic Speed

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?

\_\_\_\_\_ 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 = \_\_\_\_\_

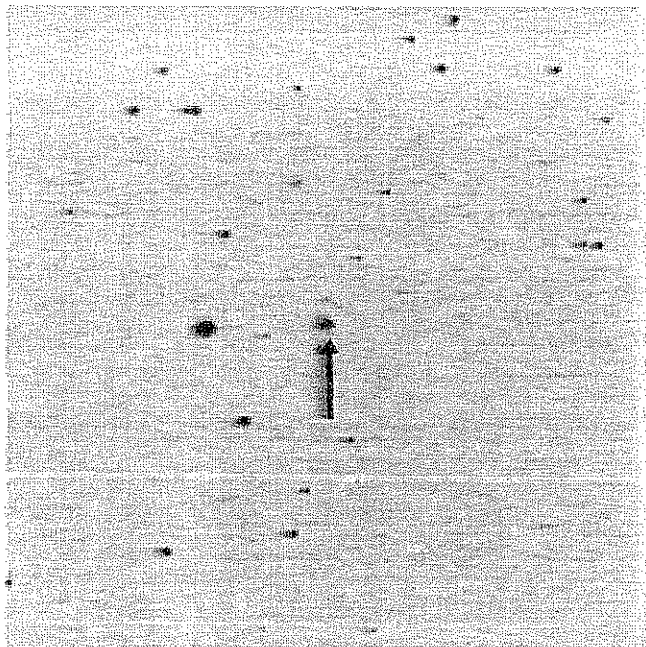
Galaxy B: \_\_\_\_\_ % x 300,000 km/s = \_\_\_\_\_

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

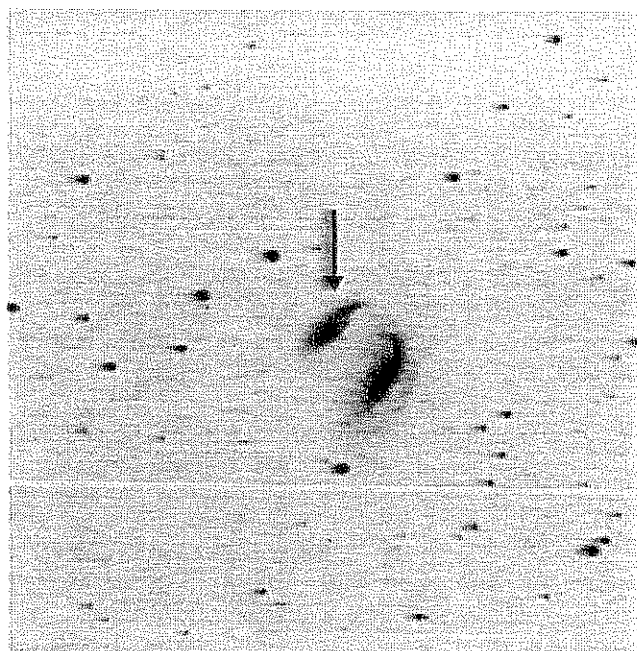
Galaxy D: \_\_\_\_\_ % x 300,000 km/s = \_\_\_\_\_

# STUDENT WORKSHEET Images of Four Galaxies

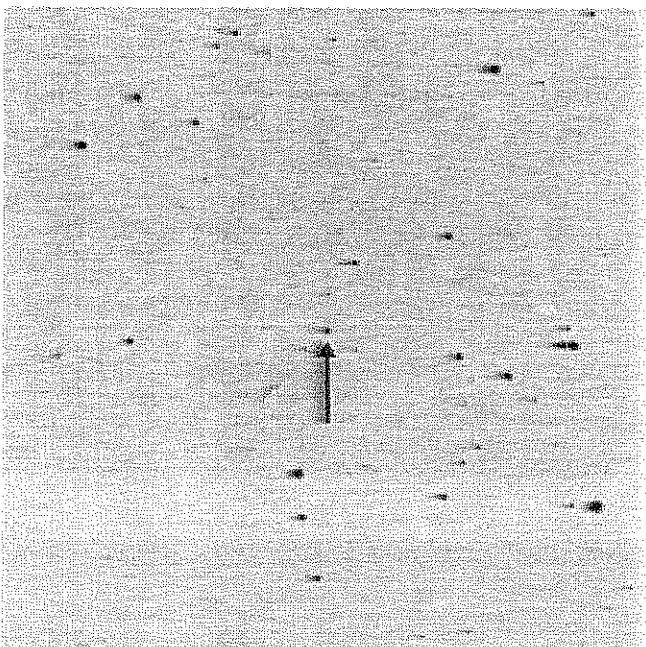
Galaxy A



Galaxy B



Galaxy C



Galaxy D

