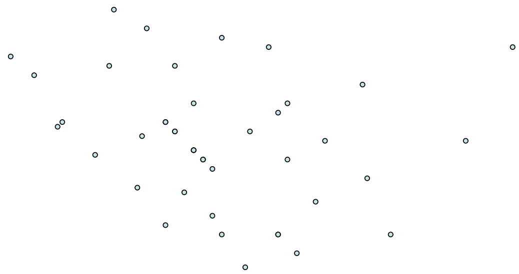
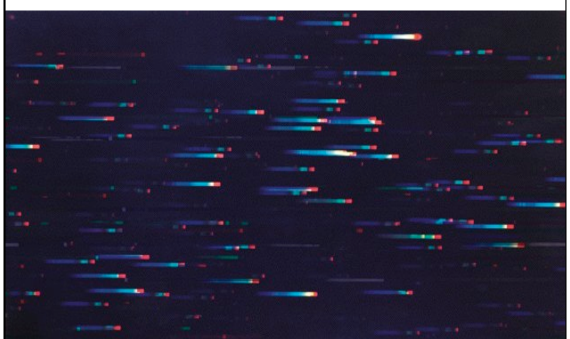
Photographs of a Star Cluster



Spectra of a Star Cluster



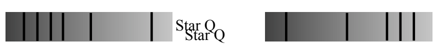
What can we learn directly by analyzing the spectrum of a star?

- A star's chemical composition
  - dips in the spectral curve of lines in the absorption spectrum
- A star's temperature
  - peak wavelength of the spectral curve

In-class Activity: Analyzing Spectra

- Work with a partner!
- Read the instructions and questions carefully.
- Discuss the concepts and your answers with one another. Take time to understand it now!!!!
- Come to a consensus answer you both agree on.
- If you get stuck or are not sure of your answer, ask another group.
- If you get really stuck or don't understand what the question is asking, ask me.

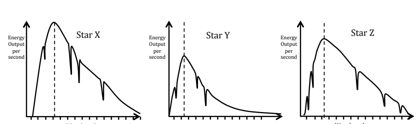
Consider the dark line absorption spectra shown below for Star Q and Star T. What can you determine about the color of the two stars? [*Assume that the left end of each spectrum corresponds to shorter wavelengths and that the right end of each spectrum corresponds with longer wavelengths.*]



A. Star Q would appear red and Star T would appear blue.
B. Star Q would appear blue and Star T would appear red.
C. Both stars would appear the same color.
D. The color of the stars cannot be determined from this information.

The three spectral curves shown in the graphs below illustrate the energy output versus wavelength for three unknown stars X, Y, and Z. These three plots have the same scales and ranges in wavelength and energy output. Which star has the highest temperature?

A. X
B. Y
C. Z
D. Same



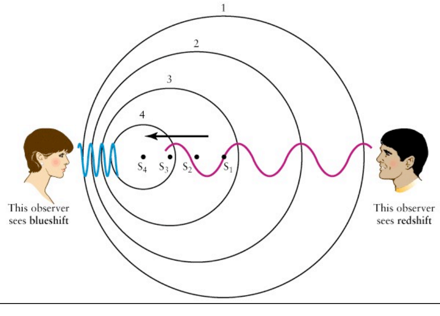
- Imagine you are observing two stars. One star is hot and small and the other star is cooler and larger. Which star is more luminous?

A. The hotter star
B. The larger star
C. The have the same luminosity
D. There is insufficient information to answer this question

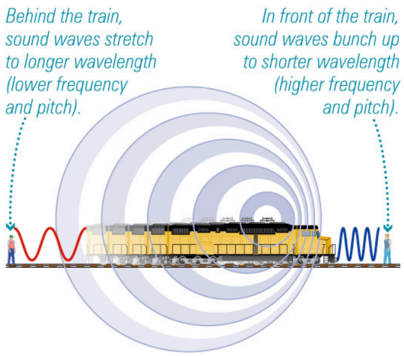
The Doppler Effect

- Definition: "The change in wavelength of radiation (light) due to the relative motion between the source and the observer along the line of sight."

Astronomers use Doppler Effect to learn about the *radial* (along the line of sight) motions of stars, and other astronomical objects.



train moving to right

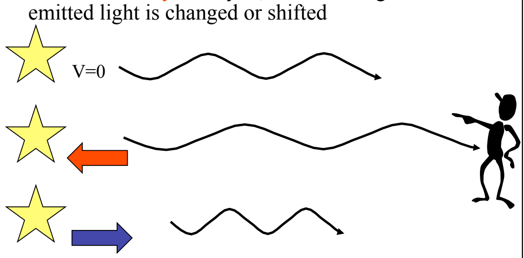


The Doppler Effect

- Definition: "**The change in wavelength of radiation (light) due to the relative motion between the source and the observer** along the line of sight."

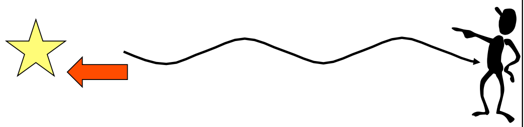
Doppler Effect

- When something which is giving off light moves towards or away from you, the wavelength of the emitted light is changed or shifted



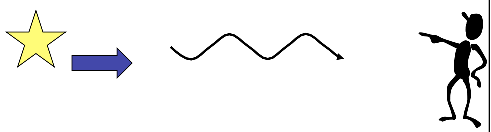
Doppler Effect

- When the source of light is moving away from the observer the wavelength of the emitted light will appear to increase. We call this a "redshift".



Doppler Effect

- When the source of light is moving towards the observer the wavelength of the emitted light will appear to decrease. We call this a "blueshift".

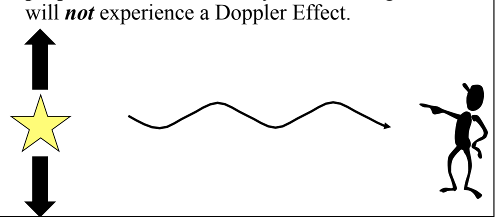


The Doppler Effect

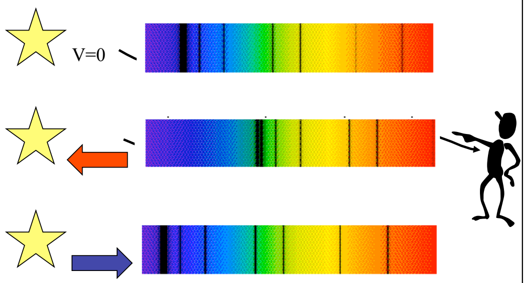
- Definition: "The change in wavelength of radiation due to relative motion between the source and the observer **along the line of sight**."

Doppler Effect

- "Along the line of sight" means the Doppler Effect happens only if the object which is emitting light is ***moving towards you or away from you***.
  - An object moving "**side to side**" or **perpendicular**, relative to your line of sight, will ***not*** experience a Doppler Effect.



Astronomy Application



Doppler Shifts

- **Redshift (to longer wavelengths)**: The source is moving ***away from*** the observer
- **Blueshift (to shorter wavelengths)**: The source is moving ***towards*** the observer

$$\frac{\Delta\lambda}{\lambda_0} = \frac{v}{c}$$

$\Delta\lambda$ = wavelength shift
λ_o = wavelength if source is not moving
v = velocity of source
c = speed of light

Doppler Broadening

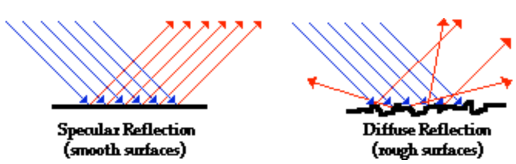
- The spectral line appear wider for a rotating star
- The faster the object is rotating, the broader in wavelength the spectral lines become

What can we learn directly by analyzing the spectrum of a star?

- A star's chemical composition
  - dips in the spectral curve of lines in the absorption spectrum
- A star's temperature
  - peak wavelength of the spectral curve
- A star's motion and rotation rate
  - Doppler effect

What can we learn from reflected/scattered light?

- chemical composition of a planet's surface



In-class Activity: Doppler Shift

- Work with a partner!
- Read the instructions and questions carefully.
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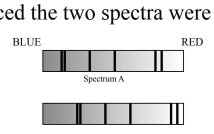
The Doppler Effect causes light from a source moving away to:

A. be shifted to shorter wavelengths.
B. be shifted to longer wavelengths.
C. changes in velocity.
D. Both a and c above
E. Both b and c above

You observe two spectra (shown below) that are redshifted relative to that of a stationary source of light. Which of the following statements best describes how the sources of light that produced the two spectra were moving?



1. Source A is moving faster than source B.
2. Source B is moving faster than source A.
3. Both sources are moving with the same speed.
4. It is impossible to tell from looking at these spectra.

A bright star is moving toward Earth. If you were to look at the spectrum of this star, what would it look like?

1. an absorption spectrum that is redshifted relative to an unmoving star
2. an emission spectrum that is redshifted relative to an unmoving star
3. a continuous spectrum that is blueshifted relative to an unmoving star
4. an absorption spectrum that is blueshifted relative to an unmoving star
5. a continuous spectrum that is redshifted relative to an unmoving star