

Solutions: Doppler Effect

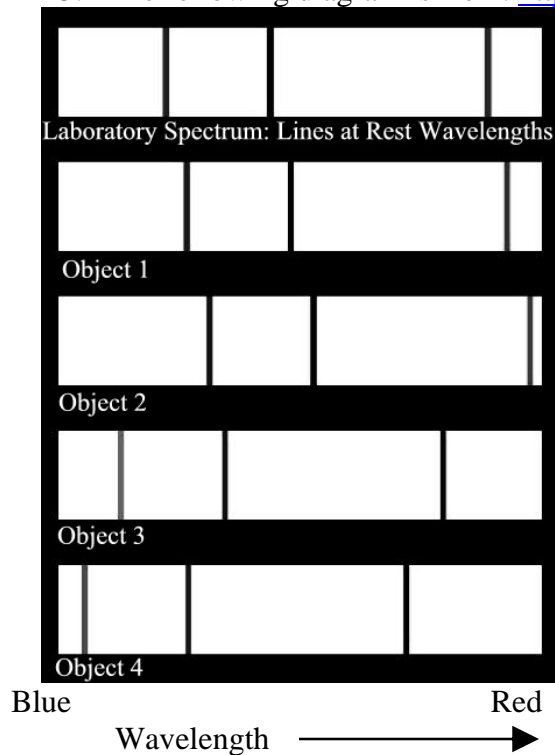
Doppler Basics:

- Go to: <http://www.fearofphysics.com/Sound/dopwhy2.html>
1. Watch the waves reaching your ear if:
 - the source moves *towards* your ear at 100 meters / second
 - the source moves *away* from your ear at 100 meters / second
 - a. In which case is the frequency of sound higher?
The frequency of sound is higher when the source moves towards you
 - b. In which case is the wavelength of the sound waves longest?
The wavelength of sound is longest when the source moves away from you
 - c. If these were light waves, in which case would the light reaching your eye be redder?
For a source moving away from you
 - d. If these were light waves, in which case would the light reaching your eye be bluer?
Light reaching your eye would be bluer for the source moving towards you
 2. Watch the waves reaching your ear if:
 - the source moves *away from* your ear at 100 meters / second
 - the source moves *away from* your ear at 200 meters / second
 - a. In which case is the frequency of sound higher?
For the source moving away from you more slowly
 - b. In which case is the wavelength of the sound waves longest?
For the source moving away from you the fastest

Doppler Shifting of Spectral Lines:

- Go to:
http://www.classzone.com/books/earth_science/terc/content/visualizations/es2802/es2802page01.cfm?chapter_no=visualization
3. Adjust the motion of the star (both towards and away) and its speed relative to the Earth.
 - a. Describe what happens to the spectrum of the star if it is moving towards Earth. What if it is moving away from Earth?
If the star is moving towards Earth, the spectrum is shifted to the blue. If the star is moving away from Earth, the spectrum is shifted to the red.
 - b. Describe what happens to the shift in the spectrum of the star if the star moves more quickly.
The shift is bigger if the star moves more quickly towards / away from Earth.
 4. Go to: http://www.pbs.org/wgbh/nova/universe/moving_nf_04.html
 - a. Order the spectra, starting with the one that is moving the fastest toward us and ending with the one that is moving the fastest away from us. What sequence do you come up with?
a,d,c,b

5. The following diagram is from: http://woodahl.physics.iupui.edu/05-22_anno.jpg



- Which objects are moving towards Earth? Objects 3 & 4 (blue shift)
- Which object is moving towards Earth fastest? Object 4 (bigger shift)
- Which objects are moving away from Earth? Objects 1 & 2 (red shift)
- Which object is moving away from Earth fastest? Object 2 (bigger shift)

Astronomical Applications:

- Go to: <http://www.astronomy.ohio-state.edu/~pogge/Ast162/Movies/specbin.html>
- From your examination of the movie and what you've learned so far:
 - Which star is moving faster in its orbit: "A" or "B"? **B**
 - Which star's absorption lines show the largest Doppler shifts: "A" or "B"?
Explain why.
Star B's lines show the biggest shift, because Star B is moving the fastest
 - How is star "B" moving relative to Earth when its lines are shifted the most to the blue?
At that time, Star B is moving directly towards Earth
 - How is star "B" moving relative to Earth when its lines are shifted the most to the red?
At that time, Star B is moving directly away from Earth
 - Go to: <http://www.howstuffworks.com/planet-hunting2.htm>
 - Read the material and watch the animation.
- How do we use the Doppler effect to help us detect the presence of planets around other stars?
Because the planet tugs on the star (gravity), the star moves in a tiny circle. This motion causes the absorption lines in the star's spectrum to shift back and forth, due to the Doppler effect. By observing the spectrum shifts, we know there must be a planet there, even if we can't see it!