Doppler Shift and Vision

9-30-2005

Opening Discussion

- Do you have any questions about the quiz?
- Have you seen anything interesting in the news?
- Timing of quizzes and assignments.
- Interpreting spectra. Determining elements.
- A blackbody is an object that absorbs all incident light.
- What is light? Why doesn't light travel faster? How can light be both a wave and a particle?
- Why can't we feel radio waves? Are radio wave photons big?
- What elements have the most spectral lines?

More Questions

- How do chameleons change color?
- Do CDs and DVDs use different colored lasers? Does wavelength impact capacity?
- Does gravity bend light? If so, how can we really know where stars are?
- What does it mean for light to be polarized?
- The spectrometers had gratings on the side you looked through.
- Photon torpedoes and burning Titan.

Doppler Shift

- Light carries information about not only composition and temperature, it also carries information about motion. This it because the Doppler shift changes the wavelengths of light for sources moving toward or away from the viewer.
- Movement away makes wavelength longer or “red shifted”. Movement toward makes them shorter or “blue shifted”.
- You are likely used to hearing the Doppler shift for sounds.

Using Doppler Shifts

- Because we know the wavelengths that various elements emit and absorb at, we can measure very accurately how much they are shifted up or down.
- The amount of shift is related to the speed of relative motion by the following.

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

- Note that $\Delta\lambda$ is the shifted wavelength over the rest wavelength. The sign matters.

Measuring Rotation

- When an object is rotating, part of it is moving toward you and part of it is moving away.
- This means that light from one side is red shifted while light from the other side is blue shifted.
- This causes the spectral lines to appear broader than they would normally be. By measuring the thickness of various spectral lines and comparing them to lab measured values, we can estimate how quickly an object is spinning.

Vision

- You now have a decent understanding of the nature of light and the way that light interacts with matter. The last thing we need to know before we launch into a full discussion of the planets is something about how we see that light.
- We'll talk about telescopes next class. Before going into that though, we need to talk about the basics of how we see.
- Our eyes work just like cameras. They have a lens that focuses incoming light at a particular distance onto a surface that can do something with the image.

Photodetectors

- The back of your eye is covered with structures called rods and cones that detect photons and send signals to your brain which processes the signals into the cognition of sight.
- In a film camera the light is sent back to a substance that reacts to light exposure by changing its properties.
- Digital cameras use chips called CCDs (charge-coupled devices) that turn photons into charges in a grid and then count those charges. These have the advantage that they have a higher quantum efficiency and don't saturate easily.

Minute Essay

- Doppler shifts can only detect motion toward or away from us. What do we have to do to detect other motion? Is that easier or harder to do for astronomical objects?
- Assignment #3 is due next class.