

Reminders 3-27-08:

- Chapter 20 homework due Tonight**
- Exam 3 April 1**
- Read 21.8-21.13**
- Lens Lab Has Been Changed**

Objectives:

- Properties of Electromagnetic Waves**
- Electromagnetic Spectrum**
- Nature of Light**
- Doppler Effect for Light**

- **Astronomers observe a shift in EM spectrum towards longer wavelengths when observing light emitted from distant galaxies. This is called the red shift. What does this imply (in regard to the universe)? Why?**

- A speeding car is approaching a police car on the side of a road. The direction of approach is essentially head-on. A wave from the radar gun ($f=8 \times 10^9 \text{ Hz}$) in a police car reflects from the speeding car and returns to the police car. Electronic equipment in the police car detects a frequency shift of 2100 Hz. Determine the speed of the car with respect to the highway.

$$f' = f \left(1 \pm \frac{v}{c} \right)$$

two doppler shifts

$$f' = f \left(1 + \frac{v}{c} \right)$$

$$f'' = f' \left(1 + \frac{v}{c} \right) = f \left(1 + \frac{v}{c} \right) \left(1 + \frac{v}{c} \right)$$

$$f'' - f = 2100 \text{ Hz}$$

$$= f \left(1 + \frac{v}{c} \right) \left(1 + \frac{v}{c} \right) - f$$

$$= f \left(1 + \frac{2v}{c} + \frac{v^2}{c^2} \right) - f$$

$$2100 = f \left(\frac{2u}{c} + \frac{u^2}{c^2} \right)$$

$\frac{u^2}{c^2}$ is $\ll \frac{u}{c}$ so let's ignore it.

$$2100 = \frac{2fu}{c}$$

$$u = \frac{(2100)c}{2f} = \frac{(2100)(3 \times 10^8)}{2(8 \times 10^9)}$$

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$$= \underline{39 \text{ m/s}}$$

$$\Delta f = f \left(1 + \frac{u}{c} \right)^2 - f$$

$$\frac{\Delta f}{f} = \left(1 + \frac{u}{c} \right)^2 - 1$$

$$\frac{\Delta f}{f} + 1 = \left(1 + \frac{u}{c} \right)^2$$