# Special Relativity-6

- Read remainder of Ch. 39
- Problems for Thursday: Ch. 39—75,78,88

# Time Dilation

- Time between two events measured in the same place is called the proper time $\tau$
- Time interval in any other frame is always longer. In a frame, moving with a velocity $v = \beta c$ relative to the proper time frame, the measured time interval $t = \gamma\tau$

# Length Contraction

- A distance measured in the reference frame in which the two endpoints are at rest is called the proper length $L_p$
- In any other reference frame, the observed length is shorter, that is $L=L_p/\gamma$. This effect is known as Lorentz-Fitzgerald contraction

# Doppler Effect

- There is a Newtonian Doppler effect due to motion with respect to waves
- Special relativity modifies the Doppler effect because of time dilation/length contraction
- Doppler effect is “red shift” for receding source, “blue shift” for approaching source

# Doppler Effect

$$f' = f\sqrt{\frac{1 \pm \beta}{1 \mp \beta}} \quad \begin{matrix} approaching \\ \hline receding \end{matrix}$$

# Simultaneity

- You can synchronize clocks in one and only one reference frame
- Events that are simultaneous in one frame are not simultaneous in any other frame
- Two events are simultaneous in a reference frame if light signals reach an observer halfway between them with zero proper time difference

# Twin Paradox

- Two twins born at the same time in the same place
- One goes away and comes back
- Which one is younger?
- Not really a paradox because one twin is accelerated
- There is a special frame in the universe