Waves   Standing waves
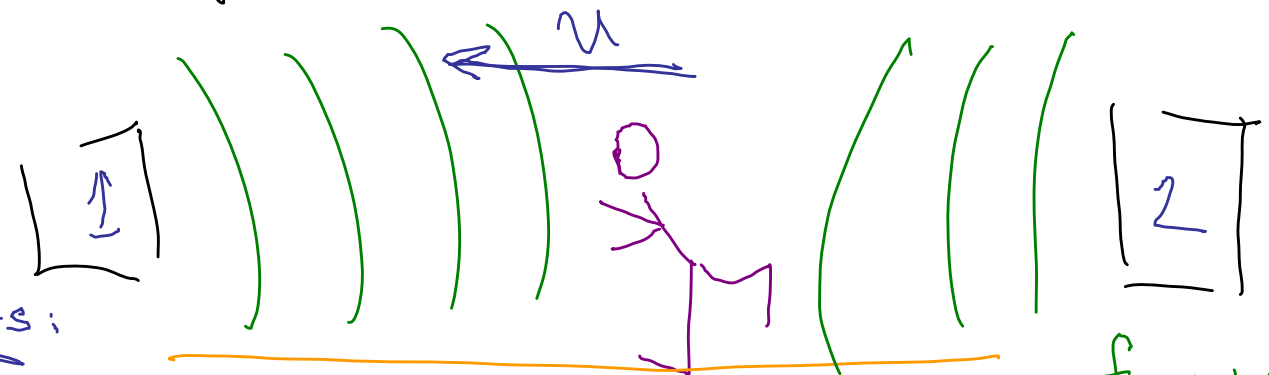   Doppler Effect

u_s u_o
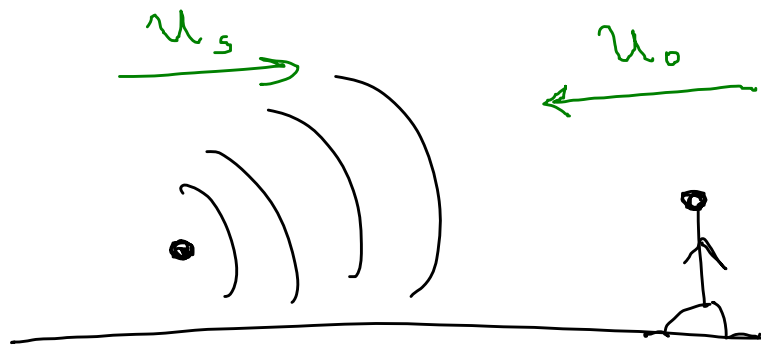
$V =$ speed of sound
$S =$ source
$O =$ observer

$$f' = f \left(\frac{1 \pm \frac{u_o}{V}}{1 \mp \frac{u_s}{V}} \right)$$

$signs = \begin{cases} toward \\ away \end{cases}$

14.74 You're between two loudspeakers emitting 180-Hz tones. How fast must you walk to perceive a beat frequency of 1.5 Hz between the two?

Hears:

$$f_1' = f\left(1 + \frac{u}{v}\right)$$

$$f = 180 \text{ Hz}$$

$$f_2' = f\left(1 - \frac{u}{v}\right)$$

Beats: $f_1' - f_2' = 1.5 \text{ Hz}$

$$f_1' - f_2' = f\left(1 + \frac{u}{v}\right) - f\left(1 - \frac{u}{v}\right) = 1.5 \text{ Hz}$$

$$f\frac{u}{v} + f\frac{u}{v} = \frac{2fu}{v} = 1.5 \text{ Hz}$$

$$u = \frac{(1.5 \text{ Hz})(343 \frac{m}{s})}{2(180 \text{ Hz})} = 1.43 \frac{m}{s}$$

14.78

Ultra sound

Freq shifted.

Two freq shifts.

f

f'