 Phys 1402 2016-11-10 Lec 23

Doppler Effect - only way to change frequency of coupled oscillations.

As a car drives by hitting the horn:

① High-pitch, getting Louder
↑ not doppler
↕ doppler-shifted

② Pitch-change, Lond sound

③ Low-pitch, Getting quieter

↑ Doppler-shift of pitch depends on motion

↑ Loudness depends on distance

(2)

$$\frac{\Delta f}{f} = \frac{v_{rel}}{v_{wave}}$$

$$\frac{192\ Hz}{4705\ Hz} = \frac{v_{rel}}{340\ m/s} \qquad v_{rel} = 13.9\ m/s = 31\ MPH$$

This works for "slow" motion. $\frac{v_{rel}}{v_{wave}} < 0.1$

Doppler Radar - The doppler shift happens twice!

$$\frac{\Delta f}{f} = 2\frac{v_{rel}}{v_{wave}}$$

Ex: Police Radar at 5 GHz
Car driving away @ 30 m/s.

$$\frac{\Delta f}{(5\times10^9\ Hz)} = \frac{2\cdot 30\ m/s}{3\times10^8\ m/s}$$

$$\Delta f = 1000\ Hz$$

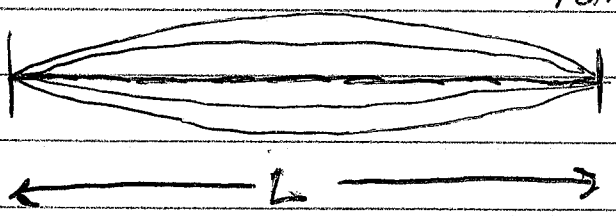
If "toward"

$$f_{obs} = 5,000,001,000\ Hz$$

Here: $f_{obs} = 4,998,999,000\ Hz$

Standing Waves

Lowest Freq: "Fundamental"

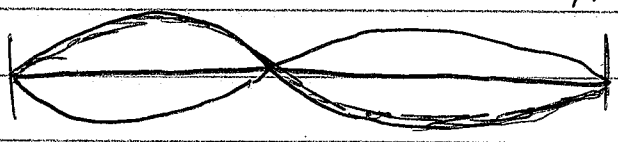


$$L = \frac{\lambda_1}{2}$$

$v = f\lambda$

$$f_1 = \frac{v}{\lambda_1} = \frac{v}{2L}$$

Next freq: "Harmonic"



$$L = \lambda_2$$

$$f_2 = \frac{v}{\lambda_2} = \frac{v}{L}$$

Next harmonic:

$$\frac{2}{3}L = \lambda_3$$

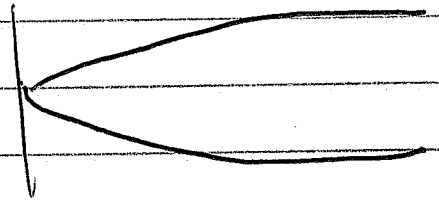
$$f_3 = \frac{v}{\lambda_3} = \frac{3v}{2L}$$

General: $f_n = n\left(\frac{v}{2L}\right) = n f_1$

(4)

Standing Waves w/ different ends

One side is "node", other is "peak"

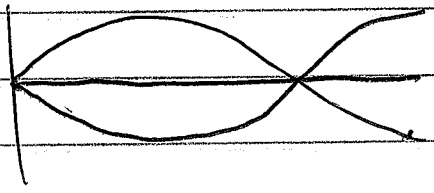


$L = \frac{\lambda_1}{4}$

$\lambda_1 = 4L$

$f_1 = \frac{v}{\lambda_1} = \frac{v}{4L}$

Next Harmonic:



$L = \lambda \frac{3}{4}$

$\lambda = \frac{4L}{3}$

$f = \frac{v}{\lambda} = 3\frac{v}{4L} = 3f_1$

Different Ends = Odd Harmonics