Reminder:

First exam: Monday October 8, 2001

the exam covers:

- Homework
- Lab through Strings
- Study questions (will be handed out Monday)

- Review Sessions by TA's on October 6 or 7
  (times and rooms will be announced)

if you received no **e-mail** from PH109, you should deposit your correct e-mail address at registrar

Sound Waves in Air

- Sound waves in gases (air):
  longitudinal (compression) waves

wave length: $\lambda = v/f$

example (homework)
demo

- Speed of sound in air:
  $v = 344$ m/s = 1130 ft/s at 20^{O} C (68^{O}F)

v increases with temperature

(increase 0.6 m/s per degree C = 1 ft/s per deg F).

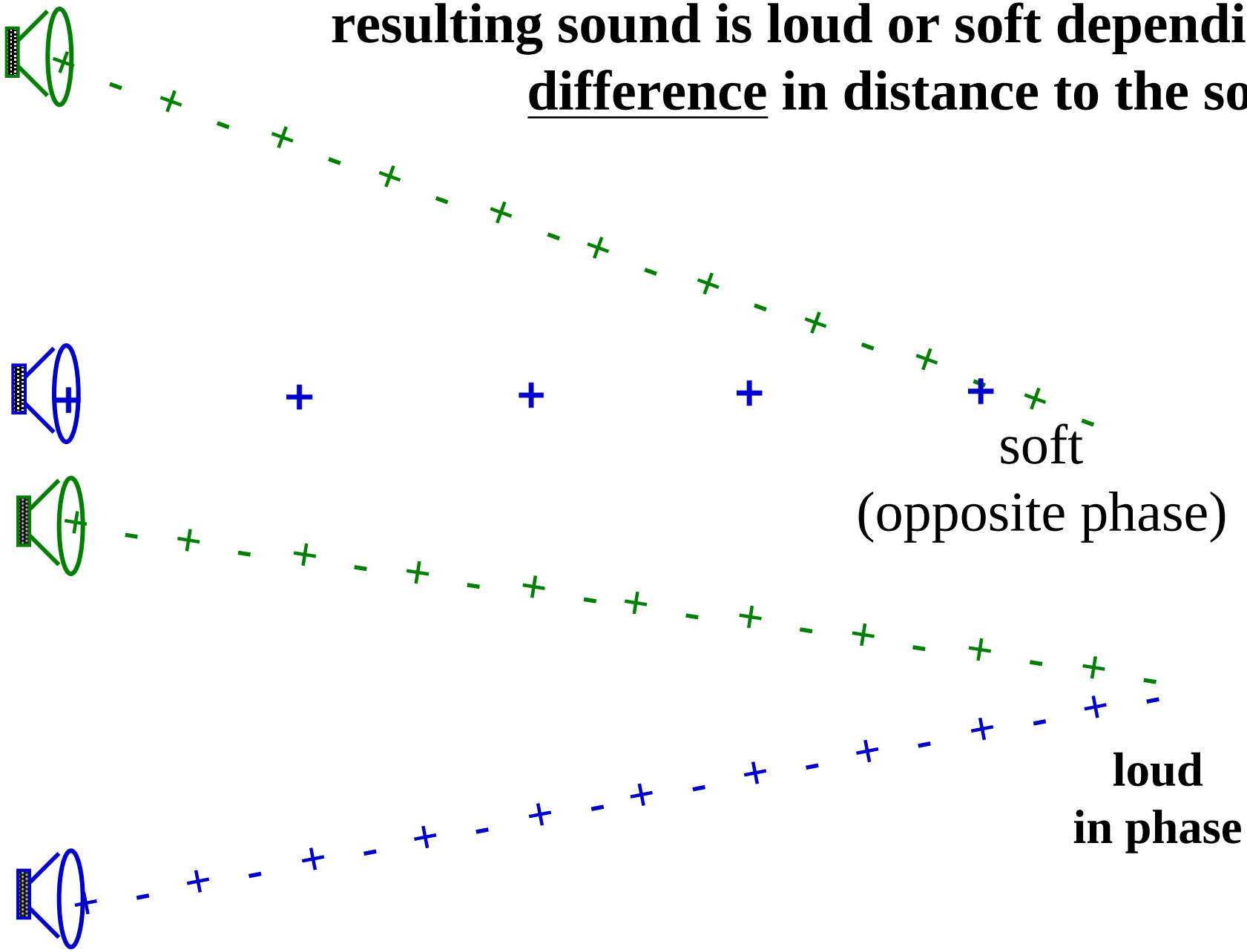
air pressure does not affect v!

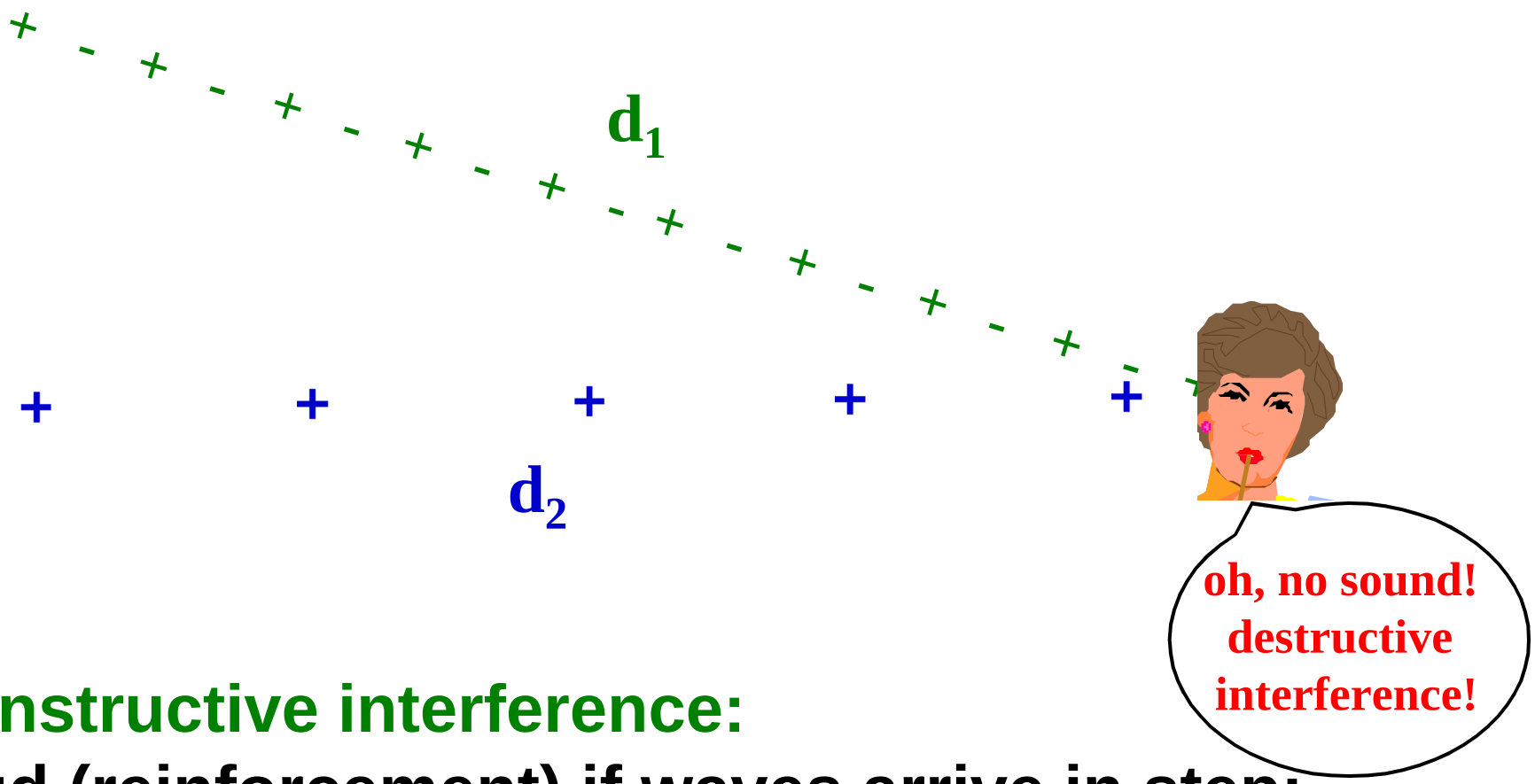
frequency does not affect v!

relevance: pitch of wind instruments changes with v

INTERFERENCE OF TWO SOUND SOURCES

resulting sound is loud or soft depending on <u>difference</u> in distance to the source





Constructive interference:

loud (reinforcement) if waves arrive in step:

$$|d_1 - d_2| = n\lambda \quad (n = \text{whole number, } 0, 1, 2, 3\ldots.)$$

Destructive interference:

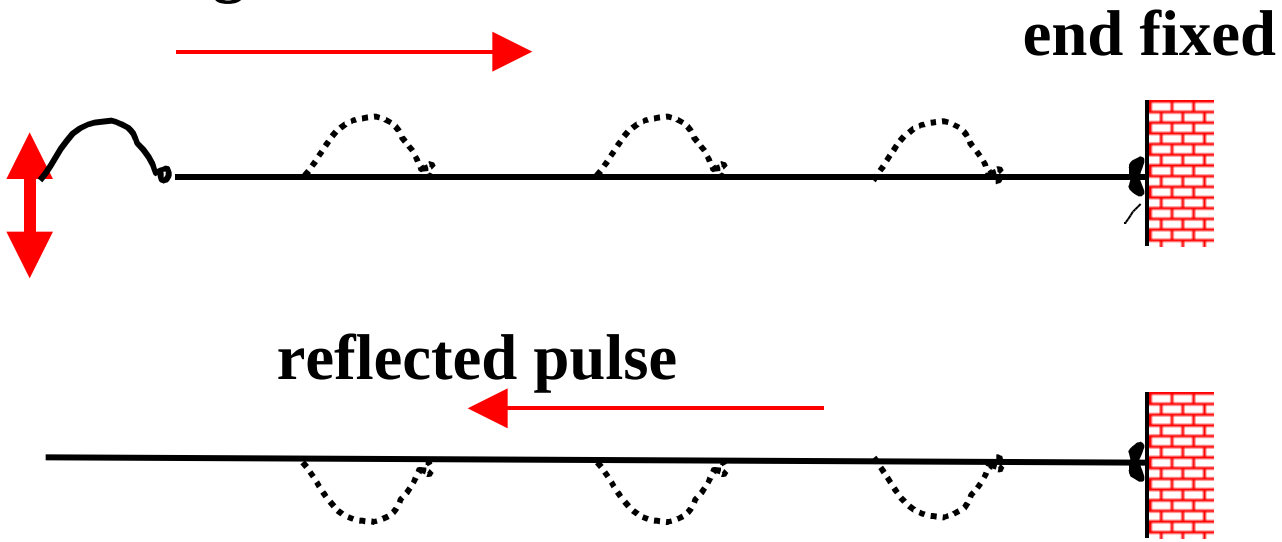
no sound if waves arrive 180^{O} out of step:

$$|d_1 - d_2| = (n+1/2)\lambda \quad (n = \text{whole number})$$

demo; example (homework)

TRANSVERSE WAVES ON STRING

Pulse on string



Speed v of pulse (or wave) on string depends on

- **pull on string - "tension" T in N (Newtons)**
- **how fat the string is - mass per meter length:** $\rho = m/\ell$

$$v = \sqrt{\frac{T}{\rho}} = \sqrt{\frac{T}{m/\ell}}$$

T: tension (in Newtons)

m/ℓ in kg/m

example (homework)

Vibration of Strings:

Transverse motion (displacement of string)

Travel time along string and back

$$time = period = 2L/v$$

Frequency f = 1/period

Fundamental frequency f_1

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

shorter string -> higher f (inverse proportion)

Demo: Slinky, Guitar

EXAMPLE (homework)

CD demo

Changing String Tension and Mass

$$f_1 = \frac{v}{2L} = \frac{1}{2L}\sqrt{\frac{T}{\rho}}$$

higher tension (larger T) - higher f

more massive string (larger ρ) - lower f

Example: string frequency 300 Hz for T= 40 N
find frequency for T = 50 N
hint: use proportions! (homework)

HIGHER MODES OF STRING

An oscillation is called a "MODE" if each point makes simple harmonic motion

Lowest mode: "fundamental"	freq. f_1
Second mode of string	$f_2 = 2 \times f_1$
Third mode of string	$f_3 = 3 \times f_1$

demo: modes of string

example: find frequencies of modes

oscillations called "harmonics" if frequencies are exact multiple of fundamental