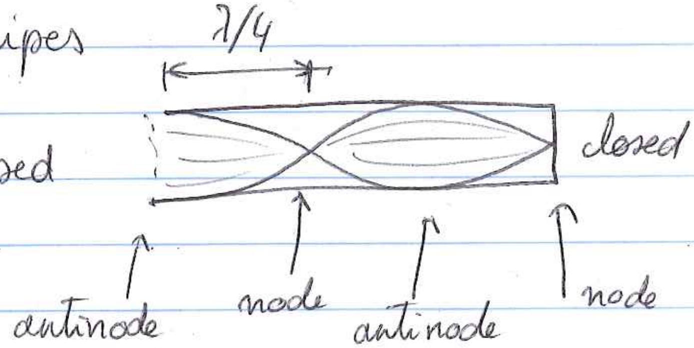
PHYS 107 - Week 15 - Friday

* Organ pipes

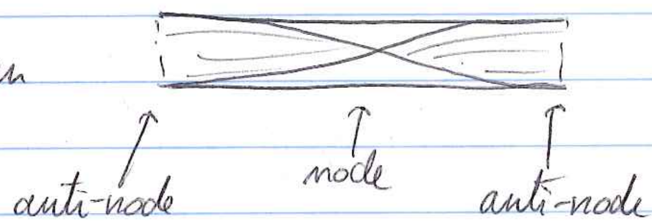
open / closed



(1^{st} overtone)

$$L = n\frac{\lambda}{4} \quad \text{or} \quad f = \frac{nv}{4L}, \text{ for } n = 1, 3, 5, \ldots$$
(odd only)

open / open



(fundamental)

$$L = n\frac{\lambda}{2} \quad \text{or} \quad f = \frac{nv}{2L} \text{ for } n = 1, 2, 3, \ldots$$
(odd and even)

Q open vs. closed pipes

Demo Rubens tube

* Doppler effect : how does the frequency of sound change when the source or observer is moving ?

- moving source (ambulance siren)

$$f_{obs} = f_s\left(\frac{v}{v \pm v_s}\right)$$

+ : moving away
− : moving towards

- moving observer :

$$f_{obs} = f_s\left(\frac{v \pm v_{obs}}{v}\right)$$

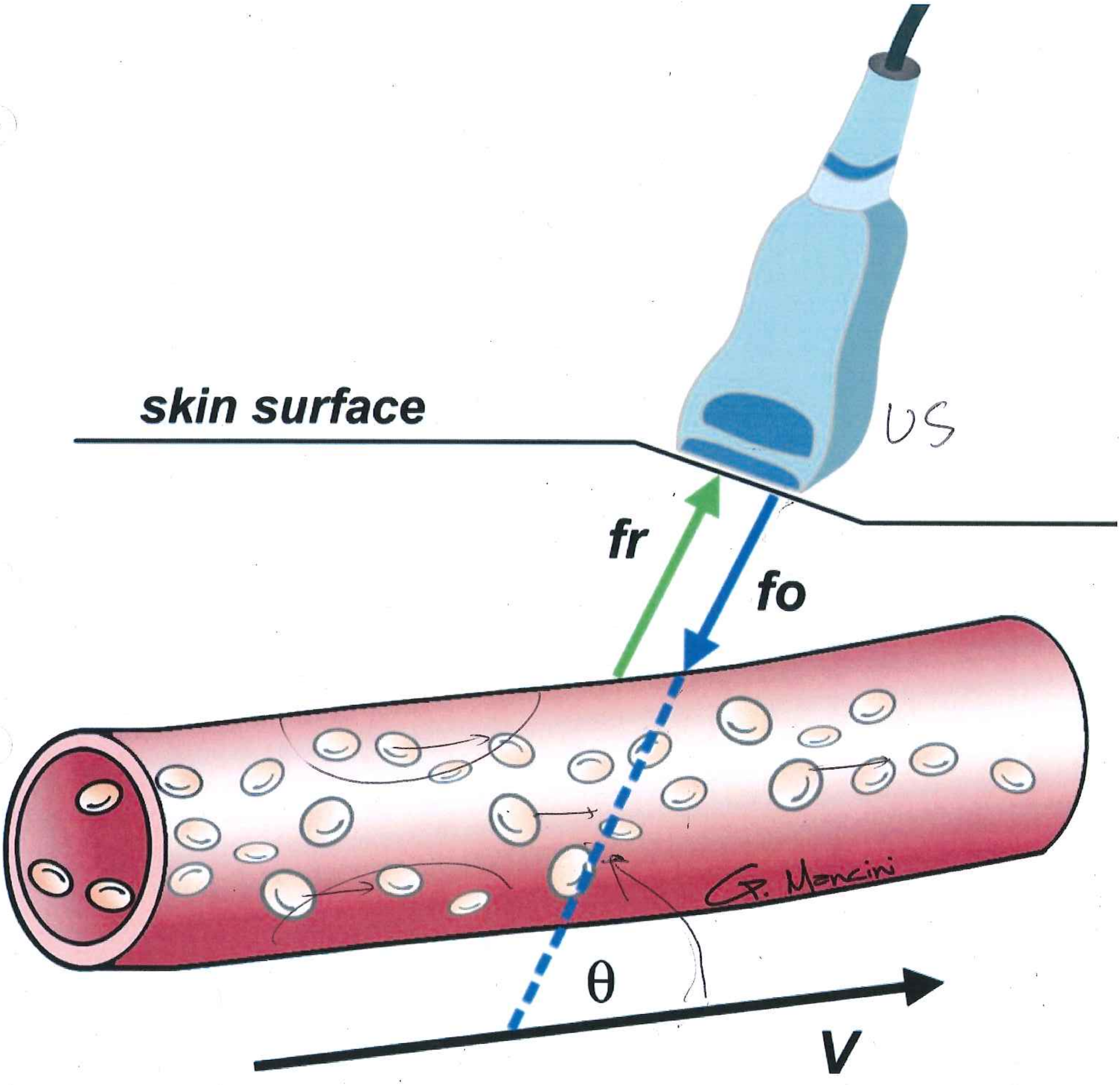
+ : moving towards
− : moving away

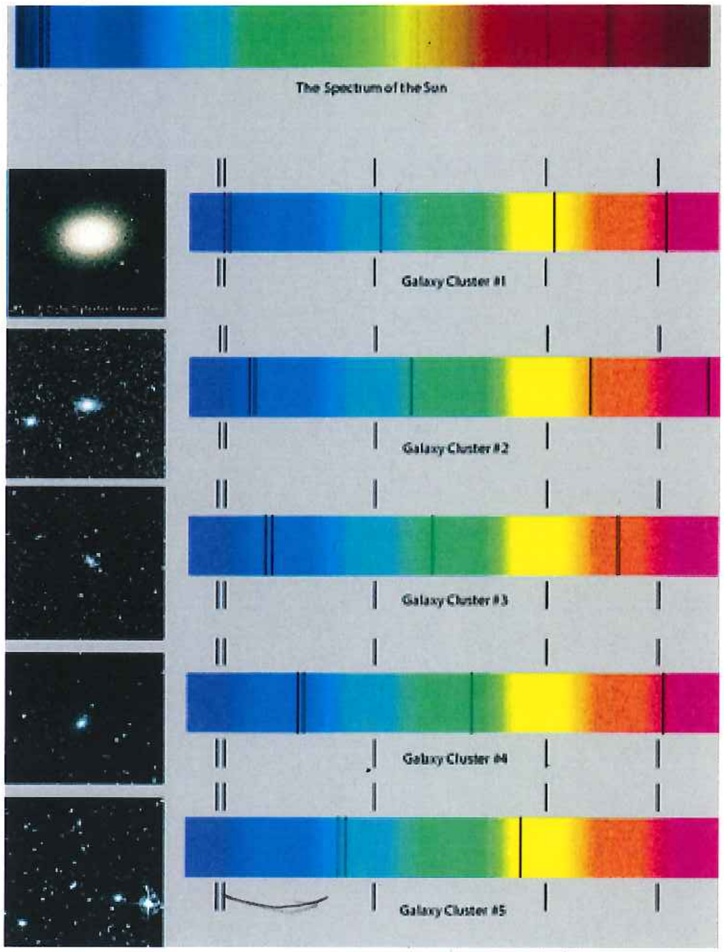
Example: train arrives in station with whistle at 1000 Hz $= f_s$
observer hears a whistle with $f_{obs} = 1122$ Hz

1) How fast is the train going ($T = 0°C$) ?

$$f_{obs} = f_s\left(\frac{v}{v - v_s}\right) \quad \text{(moving towards)}$$

$$\hookrightarrow \frac{v}{v - v_s} = \frac{f_{obs}}{f_s} \rightarrow v_s = v\left(1 - \frac{f_s}{f_{obs}}\right) = \underline{36\ m/s}$$


skin surface
US
fr
fo
G. Mancini
θ
V


The Spectrum of the Sun
Galaxy Cluster #1
Galaxy Cluster #2
Galaxy Cluster #3
Galaxy Cluster #4
Galaxy Cluster #5

2) What is f_{obs} when the train is moving away?

$$f_{obs} = f_s \frac{v}{v + v_s} = 90\text{ Hz}$$

Applications of Doppler effect?

* bats, echolocation → determine direction, speed
* police radar gun (also baseball)
* blood vessel ultra sound
* Doppler radar for weather
* Redshift in stars

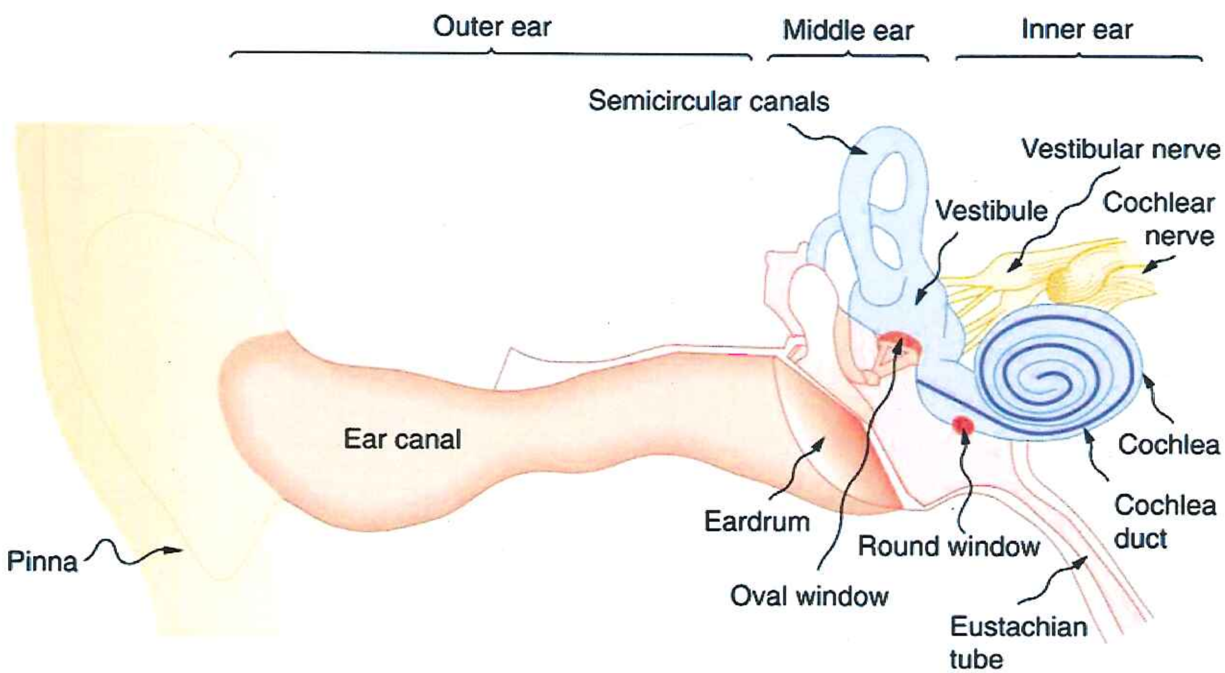
Mach cone: faster than sound

$$f_{obs} = f_s \frac{v}{v - v_s} \rightarrow \text{if } v = v_s \rightarrow \text{"blows up"}$$

waves pile up

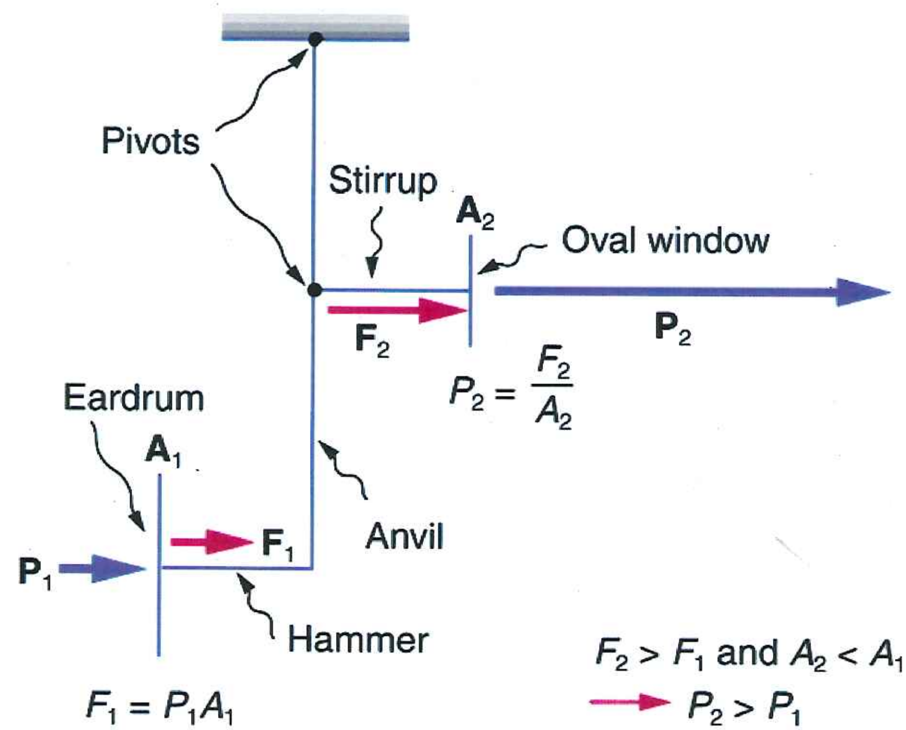
$$\text{Mach \#} = \frac{v}{v_s} \rightarrow v_s = v = 331\ \text{m/s}\ (0^\circ C) \text{ is Mach 1}$$

FIGURE 17.39



The illustration shows the gross anatomy of the human ear.

FIGURE 17.40



This schematic shows the middle ear's system for converting sound pressure into force, increasing that force through a lever system, and applying the increased force to a small area of the cochlea, thereby creating a pressure about 40 times that in the original sound wave. A protective muscle reaction to intense sounds greatly reduces the mechanical advantage of the lever system.