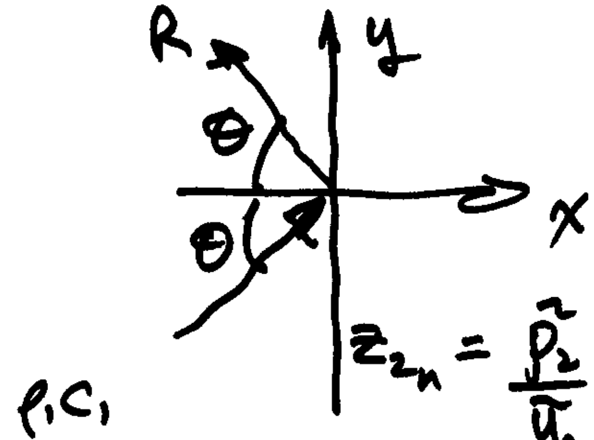
Reflection & Transmission



$$z_{2n} = \frac{\tilde{p}_2}{\tilde{u}_{2x}}\Big|_{x=0}$$

What do lose?
explicit knowledge of T

$$R = \frac{\zeta_{2n}\cos\theta_i - 1}{\zeta_{2n}\cos\theta_i + 1} \qquad \zeta_{2n} = \frac{z_{2n}}{\rho_1 c_1}$$

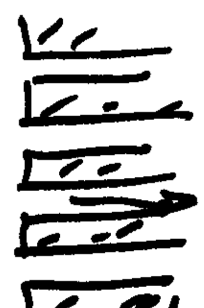
Thin, limp panel

$$z_{2n} = \underbrace{z_p}_{j\omega m_s} + z_b \qquad \| z_b$$

(i) for complex systems, z_{2n} can be found by calculation or measurement

(ii) when z_{2n} is independent of incidence angle "surface of local reaction"

can occur when $c_2 << c_1$, or when θ_t is forced to be $= 0$ by physical ~~nat~~ nature of region 2



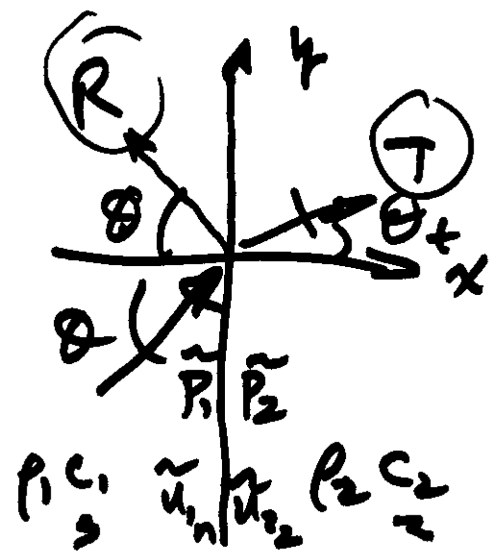
(iii) z_{2n} is normally a complex quantity $z_{2n} = r_n + i x_n$

Reflection & Transmission

- Summary Book Sections: 6.1 - 6.7

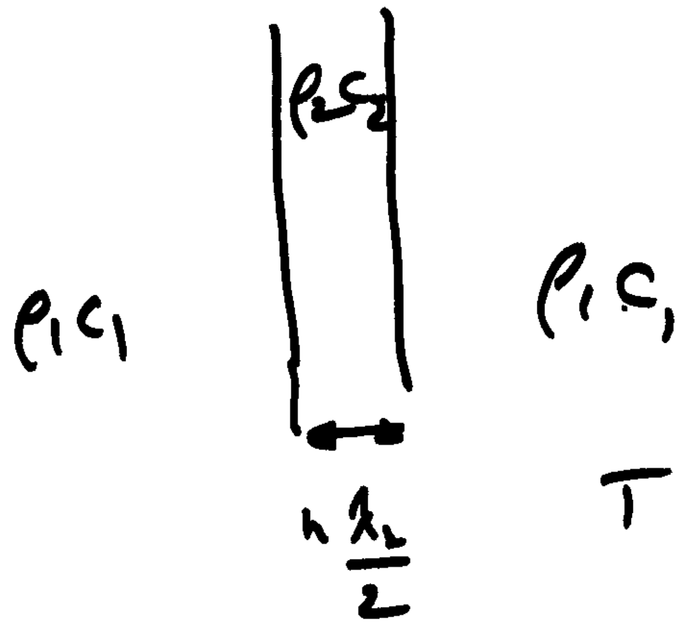
Snell's Law

Two fluid



$R + T \neq 1$

$R_I + T_I = 1$ Energy Conservation



$T \to 1$

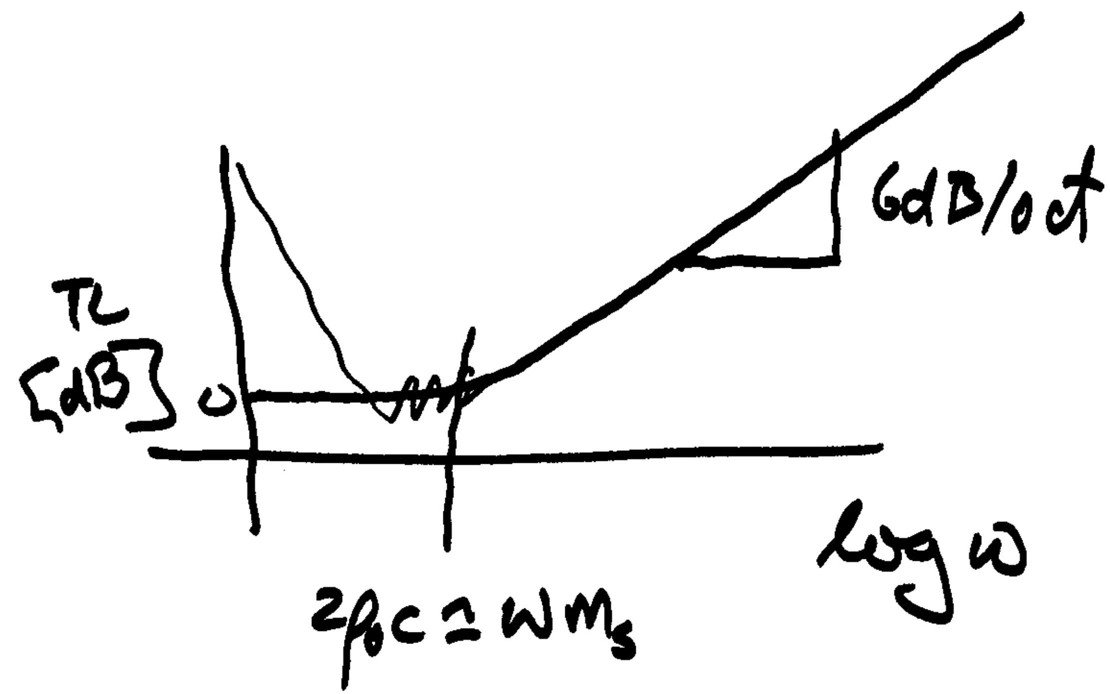
Thin, limp barrier

m_s mass/unit area

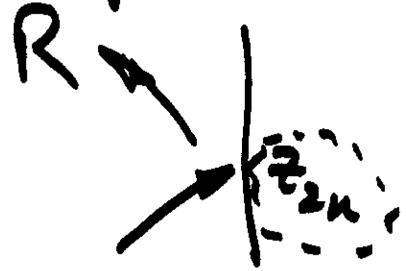
Mass Law

$$T \propto \frac{1}{\omega}$$

$$T \propto \frac{1}{m_s}$$



surface normal impedance



section 5: Sound Generation and Radiation in 3-D (Chapter 7)

<u>compact</u> sources: small compared to a wavelength

$D \ll \lambda$

- l/s at low freq's
- exhaust pipe outlet

"Special" compact sources

Simple sources

- monopole – volume velocity source

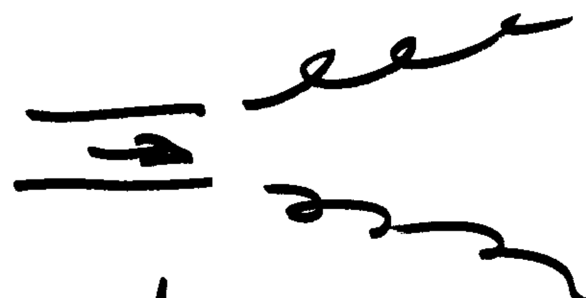
- dipole –

point force

– unbaffled loudspeaker

- quadrupole

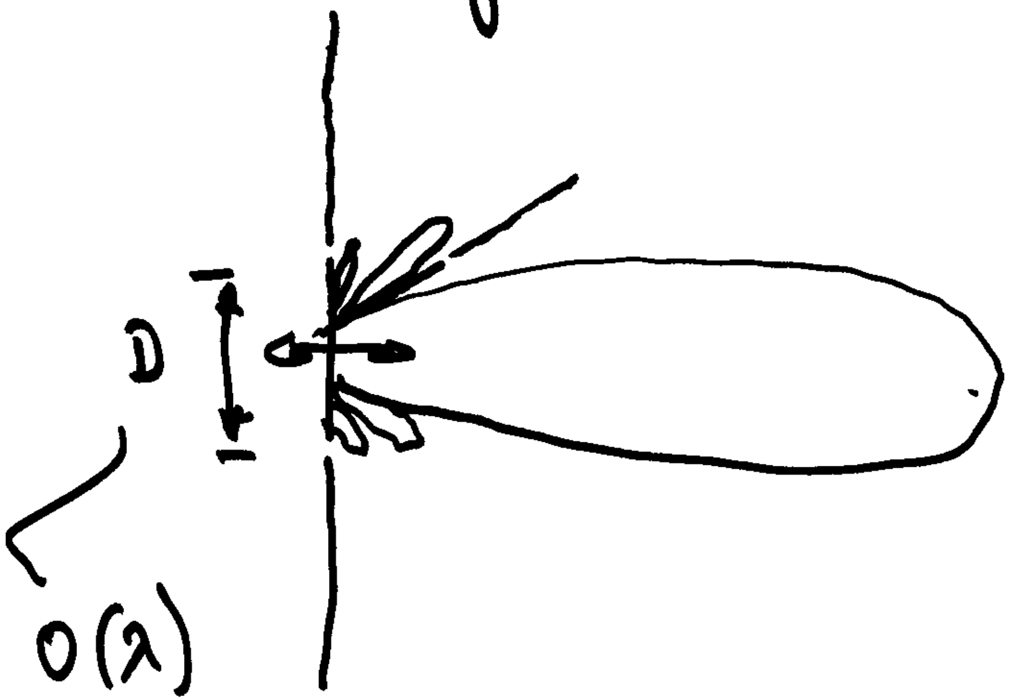
  - exerts an oscillating moment
  - sound generation by turbulence



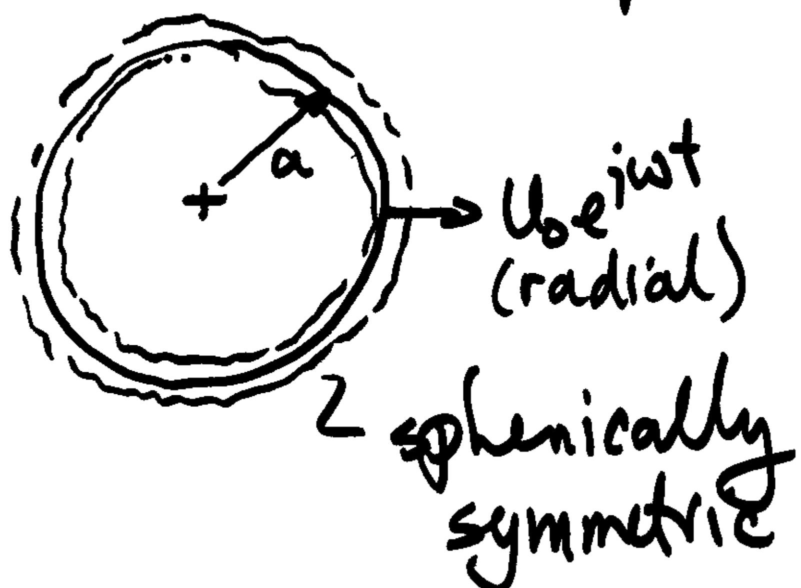
4 compact sources

  - simple sources

Non-compact sources - not small compared to a wavelength



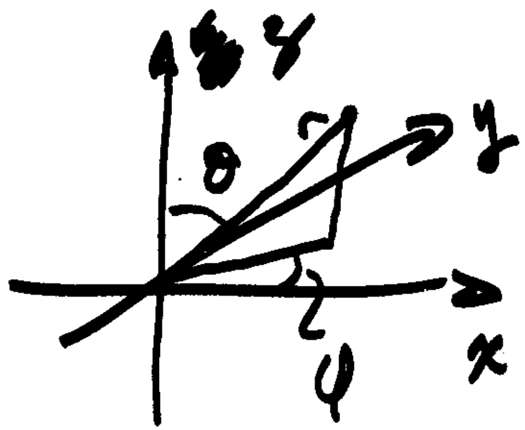
5.2 Sound radiation from a pulsating sphere



Write:
- a wave equation
- assume a solution
- apply a b.c. at $\underline{r = a}$

Volume Velocity Source

5.2.1 Spherically Symmetric Solutions



spatial dependence of $\tilde{p}$

Scalar Helmholtz Eqn

$$\hat{p}(r, \cancel{\theta}, \cancel{\phi}) \rightarrow \tilde{p}(r)$$

$$\nabla^2 \tilde{p} + k^2 \tilde{p} = 0 \qquad p(r,t) = \tilde{p}(r) e^{j\omega t}$$

$$k = \omega / c$$

$$\frac{\partial}{\partial\theta} \to 0 \qquad \frac{\partial}{\partial\phi} \to 0$$

$$\nabla^2 \to \frac{\partial^2}{\partial r^2} + \frac{2}{r}\frac{\partial}{\partial r} \to \text{wave eqn}$$

$$\frac{d^2\tilde{p}}{dr^2} + \frac{2}{r}\frac{d\tilde{p}}{dr} + k^2\tilde{p} = 0$$

$$\frac{d^2(r\tilde{p})}{dr^2} + k^2(r\tilde{p}) = 0$$

$$\tilde{p} = \underbrace{\frac{A}{r} e^{-jkr}}_{\text{outward}} + \cancel{\underbrace{\frac{B}{r} e^{+jkr}}_{\text{inward}}} \rightarrow 0 \qquad e^{j\omega t}$$

Free space] no reflecting surface

- outward-going wave only.

5.2.2 Boundary Conditions

set radial particle velocity at $r = a$ (in the fluid) to $U_0 e^{j\omega t}$

surface radial velocity $\underbrace{\tilde{u}_r(a)}_{\text{fluid velocity}} = \underbrace{U_0}_{\text{surface velocity of the source.}}$

$$-\nabla \hat{p} = \cancel{\rho} \, j\omega\beta \, \tilde{u}_r$$

$$\hat{u}_r = -\frac{1}{j\omega\beta} \nabla \hat{p}$$

spherical symmetry

$$\frac{\partial}{\partial \theta}, \frac{\partial}{\partial \phi} \to 0$$

$$\tilde{u}_r, \cancel{\tilde{u}_\theta}, \cancel{\tilde{u}_\phi}$$

purely radial particle velocity.