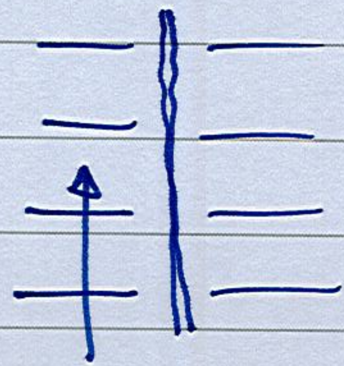
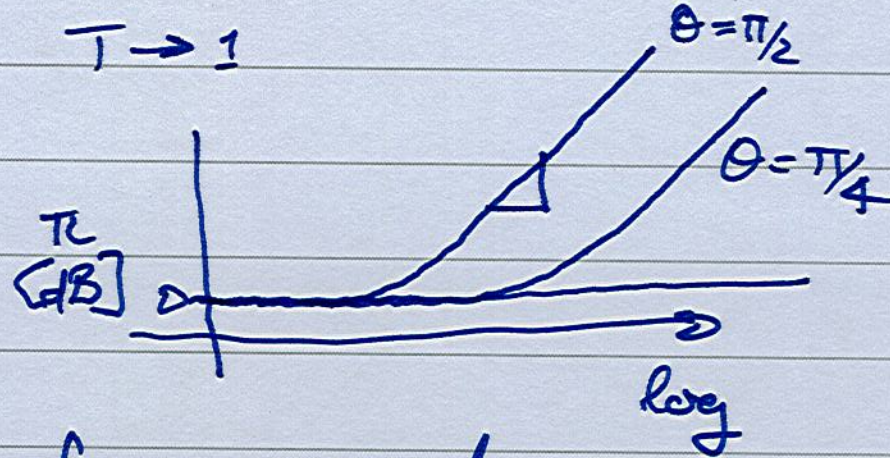
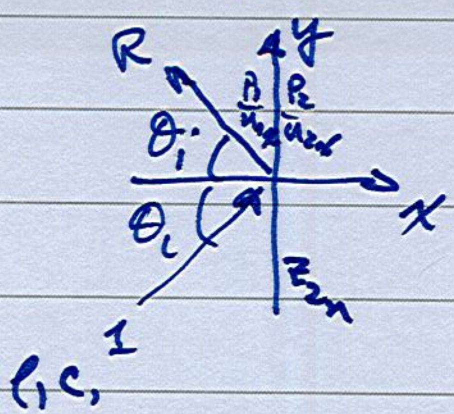


$\theta = \frac{\pi}{2}$ $\quad T \to 1$



Reflection using surface normal impedances

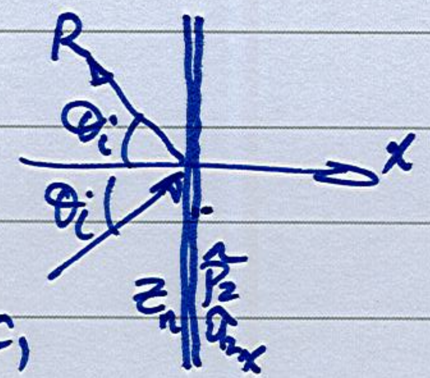


Impedance B.C.

$$R = \frac{\zeta_{2n}\cos\theta_i - 1}{\zeta_{2n}\cos\theta_i + 1}$$

$$\zeta_{2n} = \frac{z_{2n}}{\rho_1 c_1}$$

Thin limp panel



$$\frac{\hat{p}_1}{\hat{u}_{1x}} = z_n = j\omega m_s + \frac{\hat{p}_2}{\hat{u}_{2x}}$$

$$= z_p + z_b$$

z_b — specific surface normal impedance of the backing space

z_p — in vacuo specific mechanical impedance of the panel

$$z_n = z_p + z_b$$

series addition

$$R(\theta_i) = \frac{\zeta_{zn}\cos\theta_i - 1}{\zeta_{zn}\cos\theta_i + 1} \qquad \zeta_{zn} = \frac{z_n}{\rho_1 c_1}$$

Notes

(i) for complex systems z_n can be found by calculation or measurement

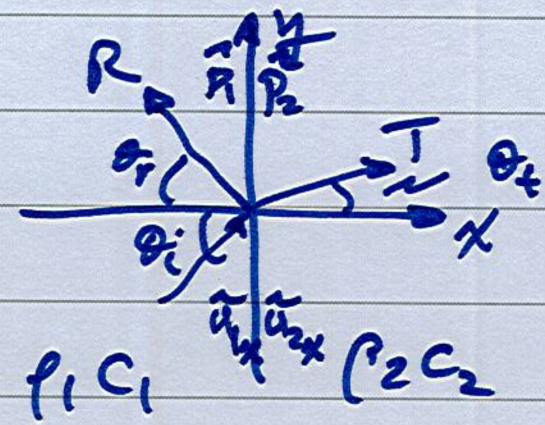
(ii) when z_n is independent of incidence angle - "surface of local reaction"

- occurs when $c_2 << c_1$ or when θ_t is forced to be $= 0$ by the physical nature of region ②

(iii) z_n is normally complex

$$z_n = r_n + j x_n$$

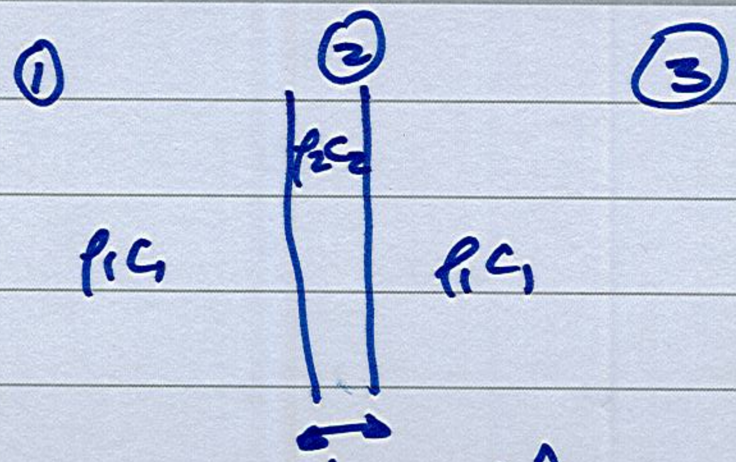
Summary Book section 6.1 - 6.7



Snell's law

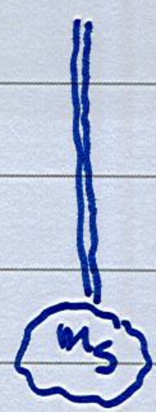
$R + T \neq 1$

$R_I + T_I = 1$ Energy Conservation



$L = n\frac{\lambda_2}{2}$ $\quad T \to 1$

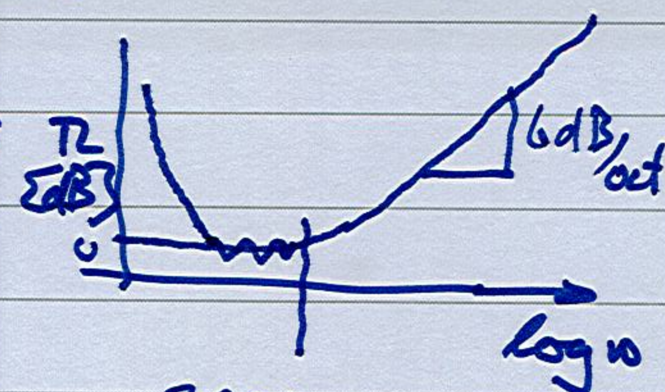
Thin, limp barrier



Mass Law

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

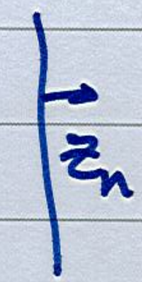
$T \propto \frac{1}{\omega}$



$2\rho c \simeq \frac{\omega m_s}{2}$

surface normal impedances

$\Longrightarrow R$



Section 5: Sound Generation & Radiation
in 3-D (Chapter 7)

<u>Compact Sources</u>: small compared to a wave length

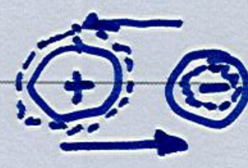
$\vdash D \dashv$ — l/s at low freqs

$\ll \lambda$ — exhaust pipe outlet

"simple" sources

- monopole - volume velocity source

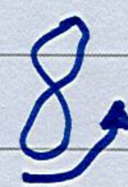
- dipole



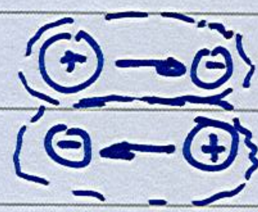
point force applied to a fluid

- unbaffled loudspeaker

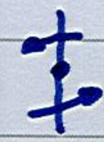
Axial Fans



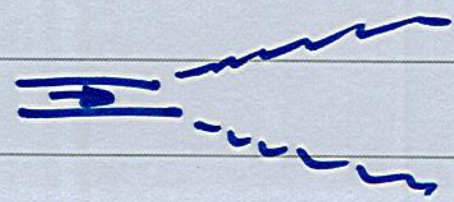
- quadrupole



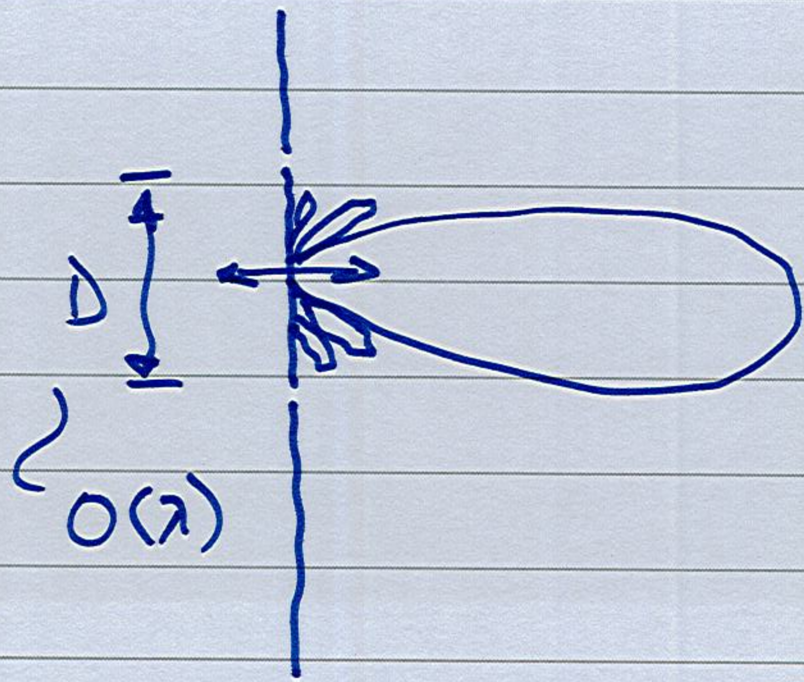
- exerts an oscillating moment



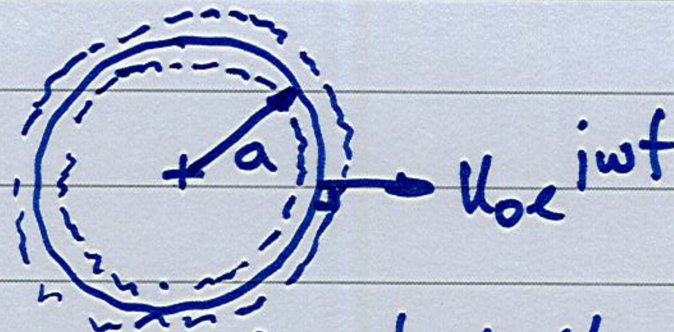
- sound generation by turbulence



Non-Compact Sources - not small compared to a wavelength.



5.2 Sound radiation from a <u>pulsating sphere</u>

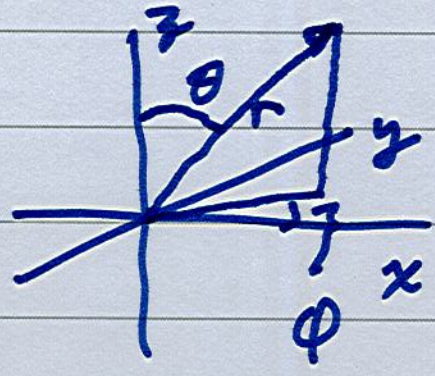


{ spherically symmetric

Write: - a wave equation
- assume a solution]
- apply a b.c. at $r=a$

Volume Velocity Source

5.2.1 spherically symmetric solutions



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

spherical symmetry

Scalar Helmholtz Eqn

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

$k = \frac{\omega}{c}$

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

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

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

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

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

Free space] no reflecting surfaces

- outward going waves only

5.2.2 Boundary Condition