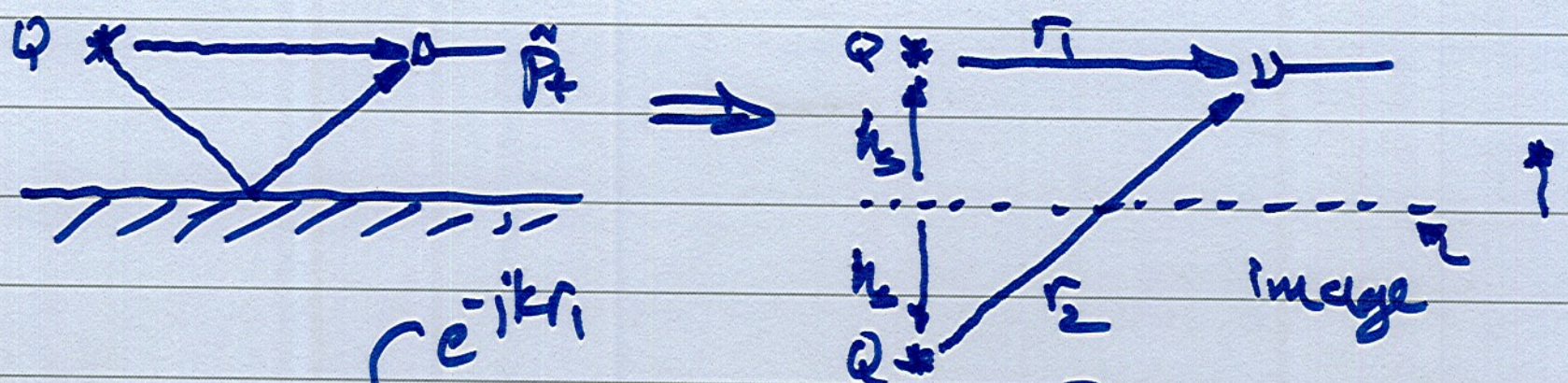
Reflection at a hard surface



$$\tilde{p}_t = j\rho_0 c k Q \frac{e^{-jkr_1}}{4\pi r_1}\left[1 + \left(\frac{r_1}{r_2}\right) e^{-jk(r_2 - r_1)}\right]$$

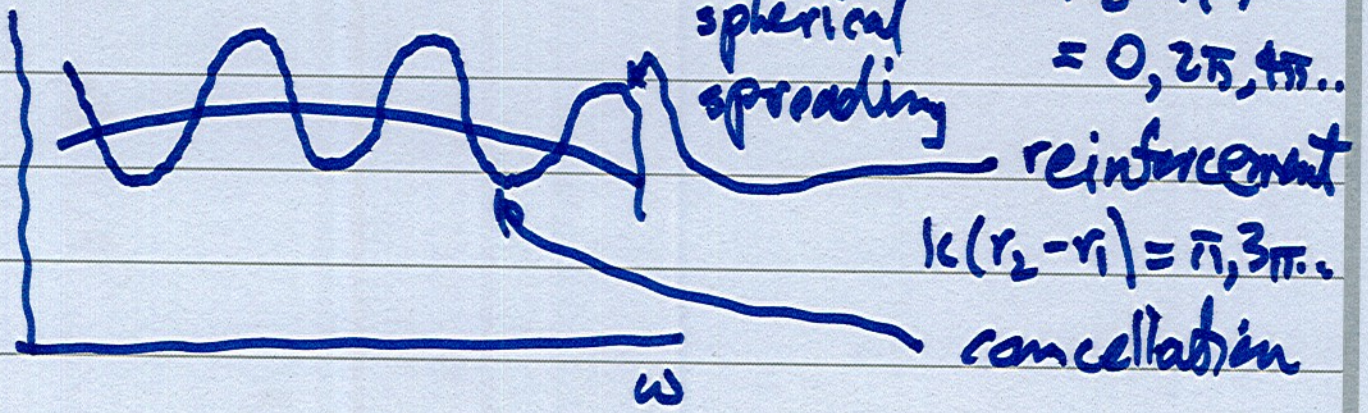
spherical spreading

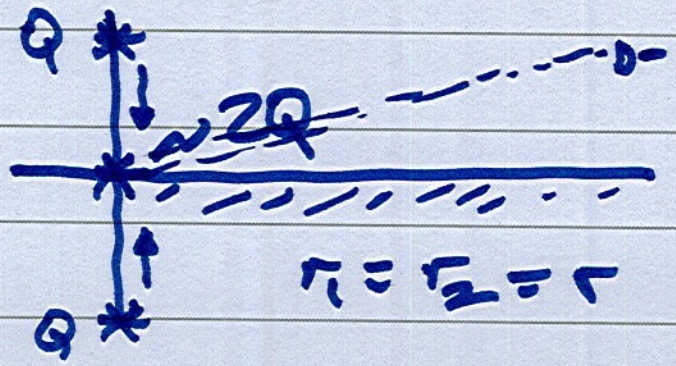
pld

$k(r_2 - r_1)$

$= 0, 2\pi, 4\pi \ldots$ reinforcement

$k(r_2 - r_1) = \pi, 3\pi \ldots$ cancellation





$r_1 = r_2 = r$

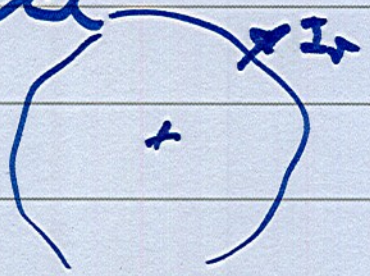
true source & the image source coalesce at the surface

$$\tilde{p}_t(r) = j\rho c \frac{kQ}{4\pi r} e^{-jkr}\left[1 + \underbrace{\left(\frac{r}{r}\right)}_{1} \underbrace{e^{-jk(r-r)}}_{1}\right]$$

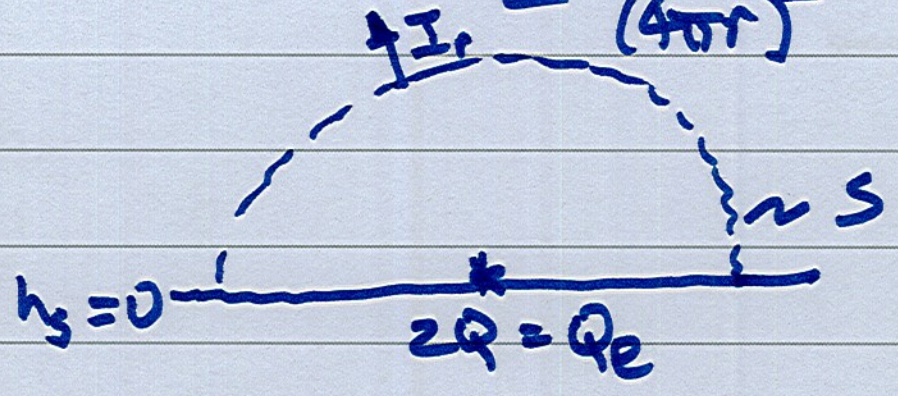
$$= j\rho c k \frac{2Q}{4\pi r} e^{-jkr}$$

sound pressure is doubled at the receiver location wrt a single monopole in free space

Recall monopole in free space



$$I_r = \frac{\beta c}{2} \frac{k^2 Q^2}{(4\pi r)^2}$$



$$W = \int_S I_r \, ds$$ over the hemisphere

$$I_r = \frac{\beta c}{2} \frac{k^2 Q_e^2}{(4\pi r)^2}$$ in the presence of the hard surface $h_s = 0$

$$= 2\beta_0 c \frac{k^2 Q^2}{(4\pi r)^2}$$

4 x the free space value

sound power is doubled

I_r increases $\times 4$

Area decreases by a factor of 2

hard surface has increased the sound power radiated, The source by

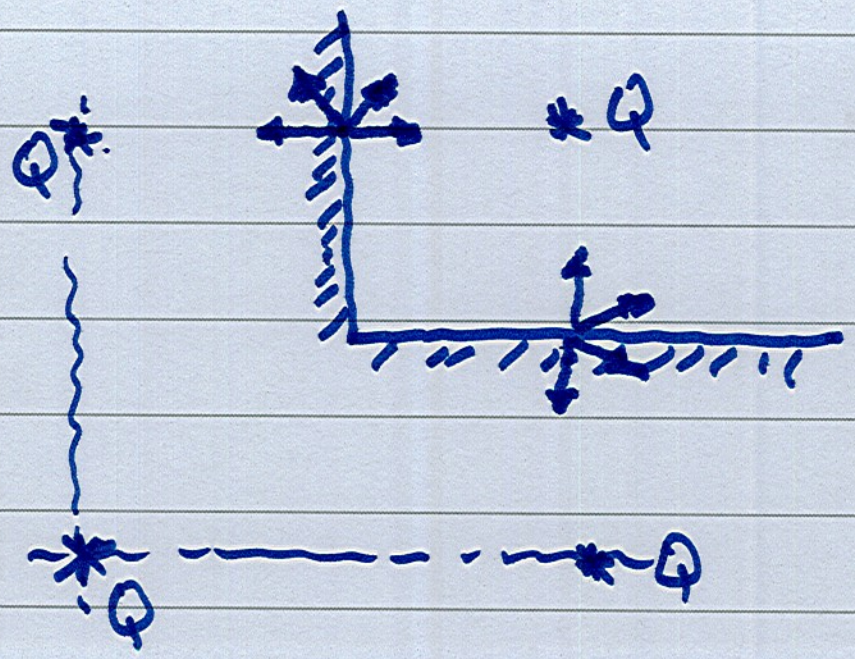
- assuming the output impedance of the source is infinite

Q is independent of load

So if a source is mounted in an infinite rigid baffle - Then a high ~~resp~~ impedance source radiates twice the sound power

(radiation resistance is increased)

5.3.3.2 Multiple Reflections



place a source close to the junction of two ~~not~~ infinite planes - hard surfaces

3 image sources

$\bar{u} \cdot \bar{n} = 0$ is satisfied at the surfaces

if source is moved into the corner

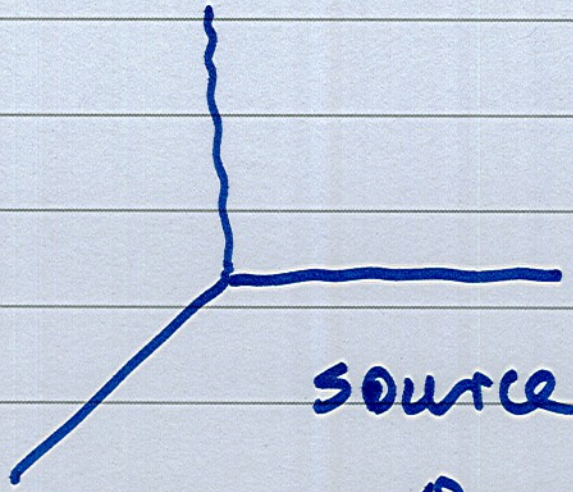
$Q_2 = 4Q$

I_r increases by 16

Sound radiates into $\frac{1}{4}$ sphere

W increases by a factor of 4

3 walls



7 images are required to reproduce $\bar{u} \cdot \bar{n} = 0$

source → corner

$Q = 8Q$

I increases by 64

Radiating into $\frac{1}{8}$ of a sphere

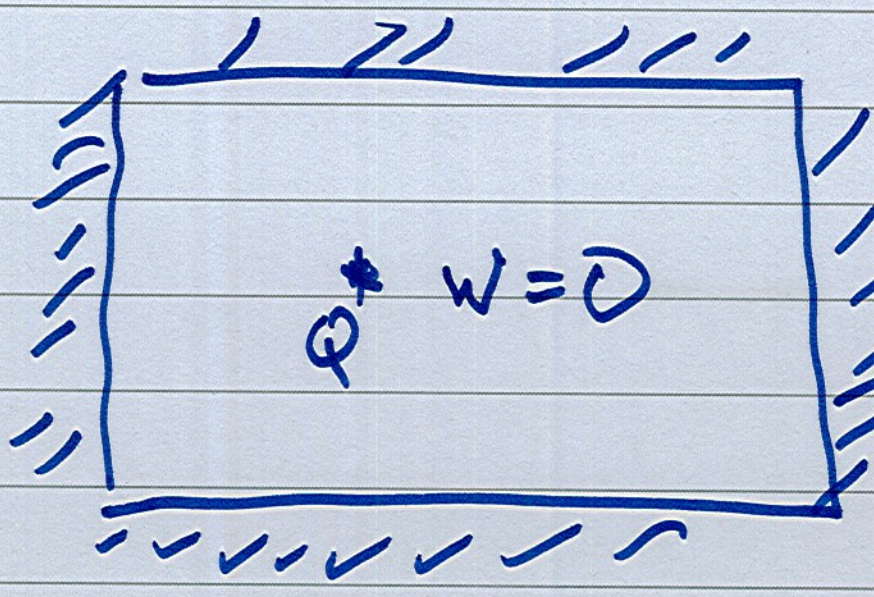
W increases by 8

- monopoles - used to represents "small" sources (compact sources) that exhibit a volume change

  $ka << 1$ small compared to a wavelength

- Assumed Q is independent of acoustic loading

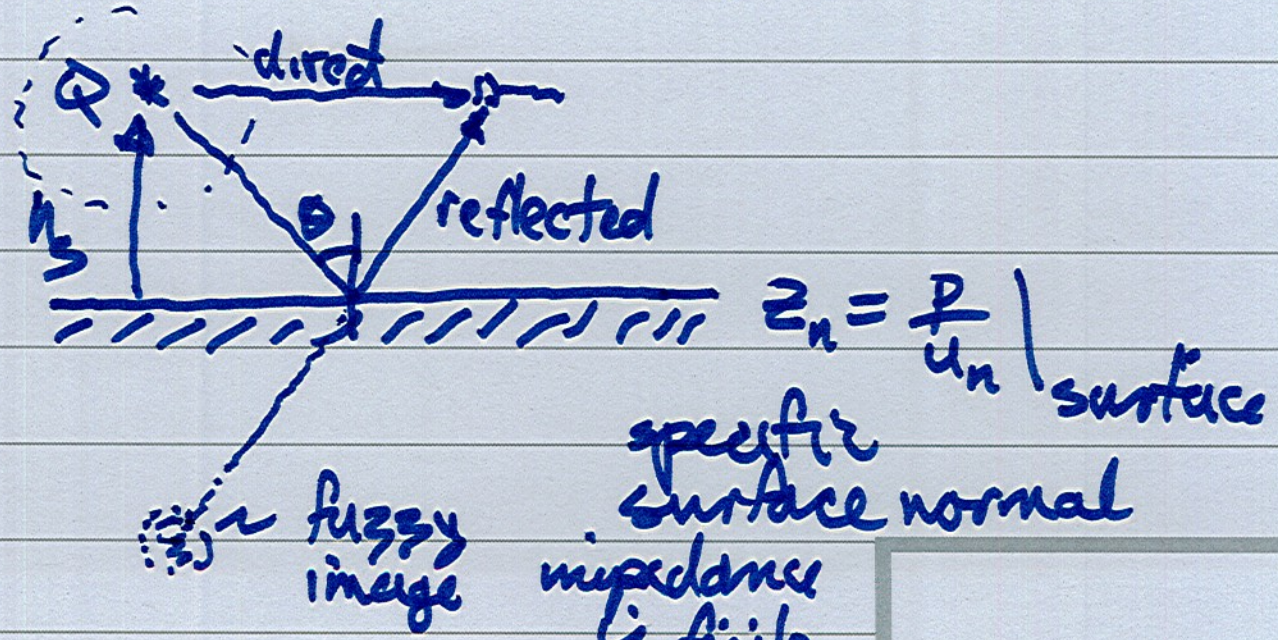
- Sound power of a ~~source~~ source is affected by the environment can be



closed box with rigid walls

5.3.4 Partially Reflecting Surfaces

5.4.3.1 Impedance surfaces



specify surface normal impedance is finite

Cannot satisfy impedance condition with a simple point image

- fuzzy image works for locally reacting surface $z_n \neq f(\theta)$

Approximate Solution

$$\tilde{p}(r) = A\left\{ \frac{e^{-jkr_1}}{r_1} + R(\theta)\frac{e^{-jkr_2}}{r_2} + \underbrace{[1-R(\theta)]F(w)\frac{e^{-jkr_2}}{r_2}}_{\text{ground \& surface waves}} \right\}$$

(complicated)

direct

specular reflection