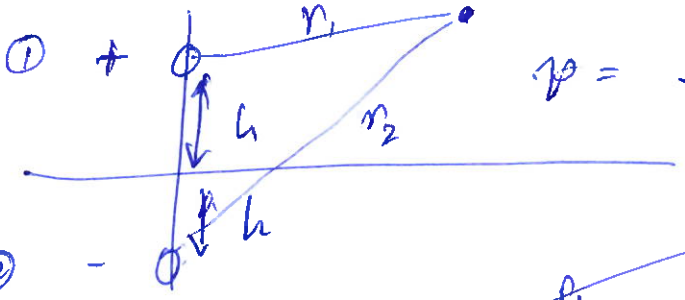
Pair of Monopoles. (antiphase).

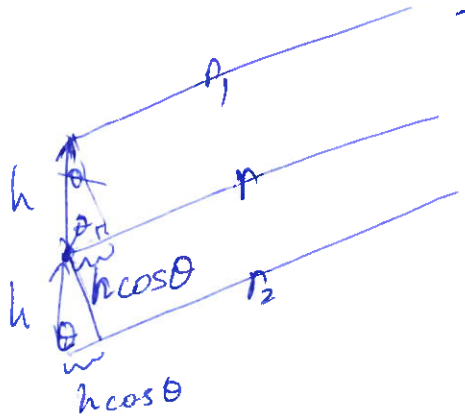


$$p = \frac{A}{r_1} e^{j(\omega t - kr_1)} - \frac{A}{r_2} e^{j(\omega t - kr_2)}$$

If $r \gg h$, then

$$r_1 = r - h\cos\theta$$

$$r_2 = r + h\cos\theta$$



Again and again we shall approximate the amplitudes to be equal and the phases to be different, viz.,

$$p = \frac{A}{r}\left[e^{j[\omega t - k(r - h\cos\theta)]} - e^{j[\omega t - k(r + h\cos\theta)]}\right].$$

Factor out $e^{j(\omega t - kr)}$:

$$p = \frac{A}{r} e^{j(\omega t - kr)}\left[\underbrace{e^{jkh\cos\theta} - e^{-jkh\cos\theta}}_{2j\sin(kh\cos\theta)}\right].$$

$$= \frac{2Aj}{r} e^{j(\omega t - kr)} \sin(kh\cos\theta)$$

How do we know this is a far-field representation?

→ θ and r have been separated functionally.

Finally take $kh \ll 1$ to give the dipole directivity:

$$p = \frac{2Aj}{r} e^{j(\omega t - kr)} kh\cos\theta.$$