

$$f = \int_0^{\infty} 4\pi r^2 \rho(r) \frac{\sin(4\pi \sin \theta / \lambda \cdot r)}{4\pi \sin \theta / \lambda \cdot r} dr \leftarrow k = 4\pi \sin \theta / \lambda \quad \#1$$

$$= \int_0^{\infty} 4\pi r^2 \rho(r) \frac{\sin kr}{kr} dr \leftarrow I_1 = \int_0^{\infty} r e^{-\frac{2r}{a}} \sin kr dr \text{ involved.}$$

To obtain I_1

$$(uvw)' = u'vw + uv'w + uvw'$$

$$\int_0^{\infty} u'vw dr = [uvw]_0^{\infty} - \int_0^{\infty} uv'w dr - \int_0^{\infty} uvw' dr$$

use this

$$I_1 = \left[-\frac{a}{2} e^{-\frac{2r}{a}} r \sin kr \right]_0^{\infty} + \frac{a}{2} \int_0^{\infty} e^{-\frac{2r}{a}} \sin kr dr \quad I_3$$

$$+ \frac{ak}{2} \int_0^{\infty} e^{-\frac{2r}{a}} r \cos kr dr$$

(likewise

$$I_2 = \left[-\frac{a}{2} e^{-\frac{2r}{a}} r \cos kr \right]_0^{\infty} + \frac{a}{2} \int_0^{\infty} e^{-\frac{2r}{a}} \cos kr dr \quad I_4$$

$$- \frac{ak}{2} \int_0^{\infty} e^{-\frac{2r}{a}} r \sin kr dr \quad I_1$$

$$\therefore I_1 = \frac{a}{2} I_3 + \frac{ak}{2} I_2, \quad I_2 = \frac{a}{2} I_4 - \frac{ak}{2} I_1$$

keep on doing in the same way

$$I_3 = \left[-\frac{a}{2} e^{-\frac{2r}{a}} \sin kr \right]_0^{\infty} + \frac{ak}{2} \int_0^{\infty} e^{-\frac{2r}{a}} \cos kr dr$$

$$= \frac{ak}{2} \int_0^{\infty} e^{-\frac{2r}{a}} \cos kr dr \quad I_4$$

$$I_4 = \left[-\frac{a}{2} e^{-\frac{2r}{a}} \cos kr \right]_0^{\infty} - \frac{ak}{2} \int_0^{\infty} e^{-\frac{2r}{a}} \sin kr dr \quad I_3$$

$$= \frac{a}{2} - \frac{ak}{2} I_3$$

$$\therefore I_3 = \frac{ak}{2} \left(\frac{a}{2} - \frac{ak}{2} I_3 \right) \Rightarrow I_3 = \frac{a^2 k / 4}{1 + a^2 k^2 / 4}$$

#2

$$\begin{aligned}
 \therefore I_1 &= \frac{q}{2} I_3 + \frac{ak}{2} I_2 \\
 &= \frac{q}{2} I_3 + \frac{ak}{2} \left(\frac{q}{2} I_4 - \frac{ak}{2} I_1 \right) \\
 &= \frac{q}{2} I_3 + \frac{ak}{2} \left[\frac{q}{2} \left(\frac{q}{2} - \frac{ak}{2} I_3 \right) - \frac{ak}{2} I_1 \right]
 \end{aligned}$$

$$\begin{aligned}
 I_1 \left(1 + \frac{a^2 k^2}{4} \right) &= \frac{a^3 k}{8} + I_3 \frac{4a - a^3 k^2}{8} \\
 &= \frac{a^3 k}{8} + \frac{a^2 k / 4}{1 + \frac{a^2 k^2}{4}} \times \frac{4a - a^3 k^2}{8} \\
 &= \frac{a^3 k}{4 \left(1 + \frac{a^2 k^2}{4} \right)}
 \end{aligned}$$

$$\therefore I_1 = \frac{a^3 k}{4 \left(1 + \frac{a^2 k^2}{4} \right)^2}, \text{ supposed to give } f$$

$$\underbrace{\times 4\pi \times \frac{1}{\sqrt{\pi}} \frac{1}{\sqrt{\pi}} \times \frac{1}{k}}_{=}$$