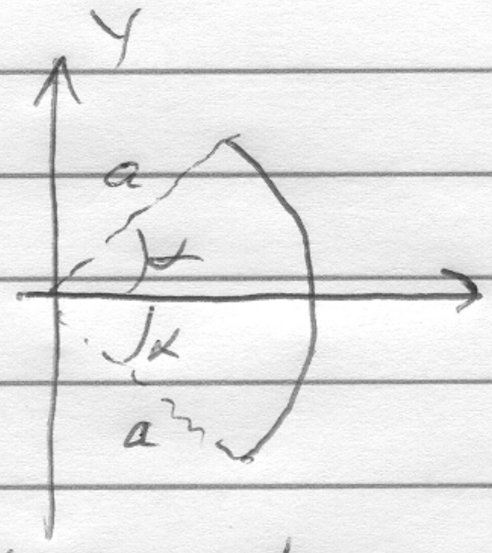
3.5-13



$$R = \sqrt{a^2 + z^2}$$

$$\phi(z) = \frac{\lambda}{4\pi\varepsilon_0} \int_{-\alpha}^{\alpha} \frac{a\,d\varphi'}{R}$$

$$\phi(z) = \frac{\lambda a}{4\pi\varepsilon_0} \frac{1}{\sqrt{a^2+z^2}} \varphi'\Big|_{-\alpha}^{\alpha} = \frac{2\lambda a\alpha}{4\pi\varepsilon_0} \frac{1}{\sqrt{a^2+z^2}}$$

$$\phi(z) = \frac{\lambda a \alpha}{2\pi\varepsilon_0 \sqrt{a^2+z^2}}$$

$$\vec{E} = -\nabla\phi \qquad E_z = -\frac{d}{dz}\phi(z)$$

$$E_z = -\frac{\lambda a\alpha}{2\pi\varepsilon_0} \frac{d}{dz}\left(\frac{1}{\sqrt{z^2+a^2}}\right) = -\frac{\lambda a\alpha}{2\pi\varepsilon_0}\left(-\frac{1}{2}\right)\frac{2z}{(z^2+a^2)^{3/2}}$$

$$E_z = \frac{\lambda a \alpha z}{2\pi\varepsilon_0 (z^2+a^2)^{3/2}}$$ correct!

We could only get the $\vec{E}$ component if we had $\phi(x,y,z)$.