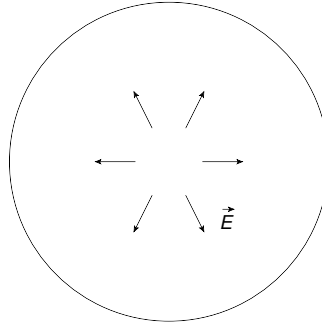**1.** For a cylindrical waveguide, the lowest TM mode, the TM_{01}, exhibits a purely outward (or purely inward, depending on the time) electric field in the radial direction. This is very peculiar given that there is no free charge within the waveguide.

(cross section in x−y plane)

Show for this mode, that when thinking properly in 3D, the total flux through a surface surrounding a point on the axis of the waveguide is in fact zero.

As a reminder, you should have in your notes that for the TM_{01} mode,

$$E_z = E_0 J_0(\gamma\rho) e^{i(kz-\omega t)},$$

$$E_\rho = -\frac{ik}{\gamma} E_0 J_1(\gamma\rho) e^{i(kz-\omega t)},$$

$$E_\phi = 0.$$

2. Jackson problem 8.2.

3. (a) Find for electric dipole radiation in the far zone, also known as the radiation zone and characterized by $r/\lambda \gg 1$, the ratio

$$\frac{|c\vec{B}|}{|\vec{E}|}.$$

(b) Find the same ratio for the near zone, also known as the static zone and characterized by $r/\lambda \ll 1$.

(c & d) Find the same ratio for magnetic dipole radiation in the far and near zones.