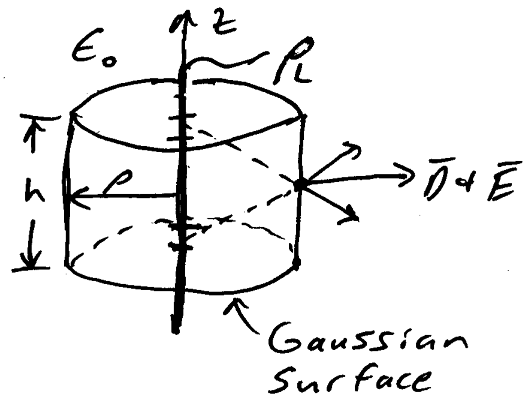
Example- Using Gauss' Law, find the electric flux density and electric field vectors due to an infinite uniform line charge on the *z*-axis in free space.



* By symmetry, we expect $\bar{D}$ + $\bar{E}$ to only have ρ-components
* At a fixed radial distance from the z-axis, we expect $|\bar{D}|$ = constant + $|\bar{E}|$ = constant

Based on these observations, choose a cylinder of radius ρ and height h, concentric w/ the z-axis as the Gaussian surface.

Gauss' Law $\oiint_S \bar{D} \cdot d\bar{s} = Q_{enc}$

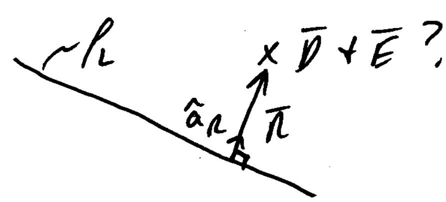
$$\iint_{Top} \hat{a}_\rho D_\rho \underbrace{\cdot + d\bar{s}_z}_{\to 0} + \iint_{Bott} \hat{a}_\rho D_\rho \underbrace{\cdot - d\bar{s}_z}_{\to 0} + \iint_{side} \hat{a}_\rho D_\rho \cdot d\bar{s}_\rho = \rho_L h$$

$$D_\rho \iint_{side} ds_\rho = D_\rho (2\pi \rho h) = \rho_L h$$

$$\hookrightarrow D_\rho = \frac{\rho_L}{2\pi\rho}$$

$\bar{D} = \hat{a}_\rho \frac{\rho_L}{2\pi\rho}$	$\rho > 0$
$\bar{E} = \bar{D}/\epsilon_0 = \hat{a}_\rho \frac{\rho_L}{2\pi\epsilon_0\rho}$	$\rho > 0$

What if we have a uniform line charge NOT on the z-axis?



$\bar{D} = \hat{a}_R \frac{\rho_L}{2\pi R}$	$R > 0$
$\bar{E} = \hat{a}_R \frac{\rho_L}{2\pi R}$	$R > 0$

$\bar{R}$ is radial vector normally out from line charge.