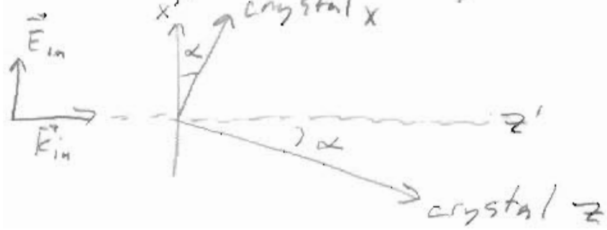
Walkoff

consider plane wave normally incident on surface

- input $\vec{E}$ along $\vec{S}$ outside crystal
- input is at angle to crystal axes:



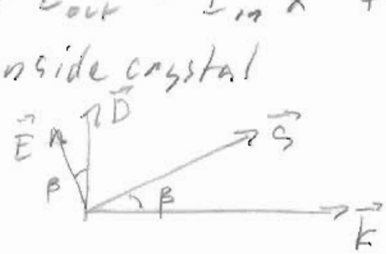
boundary conditions: $D^{\perp}$ and $E^{\parallel}$ are continuous.

know that $\vec{E} \nparallel \vec{D}$ $\therefore$ one of them bends.

$\vec{D}_{in}$ must be $\parallel$ to $\vec{D}_{out}$

but $\vec{E}_{out} = E_{in}\hat{x}' + E_{new}\hat{z}'$ is ok.

$\therefore$ inside crystal



beam can refract even at normal inc.

but opposite polarization does not refract if it's along crystal y axis

→ double image for unpolarized light

two rays walk off from each other: angle β

$$\cos\beta = \frac{\vec{E}\cdot\vec{D}}{E_0 D_0} = \frac{D_x^2/\varepsilon_x + D_y^2/\varepsilon_y + D_z^2/\varepsilon_z}{E_0 D_0}$$

$$\vec{D}_{in} = D_0\hat{x}' = D_0\cos\alpha\,\hat{x} - D_0\sin\alpha\,\hat{z} \qquad D_y = 0$$

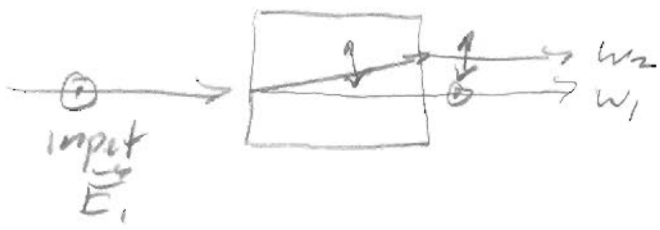
$$\cos\beta = \frac{D_0^2\left(\cos^2\alpha/\varepsilon_x + \sin^2\alpha/\varepsilon_z\right)}{D_0^2\left(\frac{\cos^2\alpha}{\varepsilon_x^2} + \frac{\sin^2\alpha}{\varepsilon_z^2}\right)^{1/2}\underbrace{\left(\cos^2\alpha + \sin^2\alpha\right)^{1/2}}_{1}}$$

calcite: $n_x = 1.658$ $n_z = 1.486$ $\alpha = 35°$ $\rightarrow \beta = 6.1°$

Beam walk off.

harmonic propagates w/ $\vec{k}$ // crystal axis,

→ redirection of power flow



if using small beams (e.g. in focus)

→ power walks off, less efficient