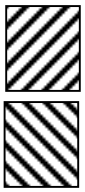
Plasma Response Time

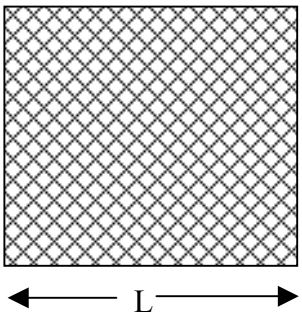
Slab Model

Assumes electrons and ions are cold



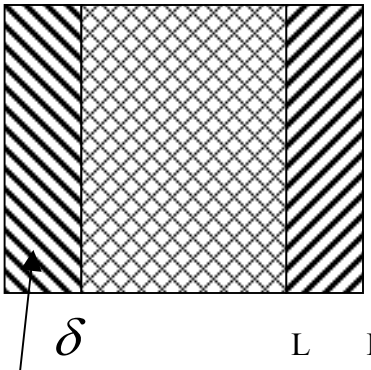
electrons

ions



$\rho = 0$

Now shift the electrons a small distance δ



$$\vec{\nabla}\cdot\vec{E} = \rho/\varepsilon_o$$

$$\frac{\partial E}{\partial x} = \rho/\varepsilon_o$$

$$E = \frac{ne\delta}{\varepsilon_o}$$ over most of the slab

Q/unit area= $ne\delta$

Force/unit area on these displaced electrons is

$$\text{Lorentz Force on whole slab} = E * \frac{\text{Charge}}{\text{Area}} = -neL\frac{ne\delta}{\varepsilon_o} = \frac{n^2e^2\delta L}{\varepsilon_o}$$

Now

$$\vec{F} = m\vec{a} \Rightarrow \frac{\text{Force}}{\text{Area}} = \text{Lorentz} = \frac{m}{\text{Area}} * \text{acceleration} = \frac{nm_eL}{}\frac{d^2x}{dt^2}$$

mass/area of slab