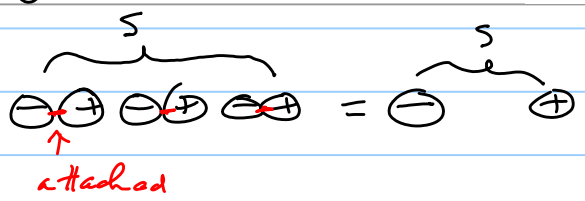
Physical Interpretation of Bound Charge

Note Title 2/19/2009

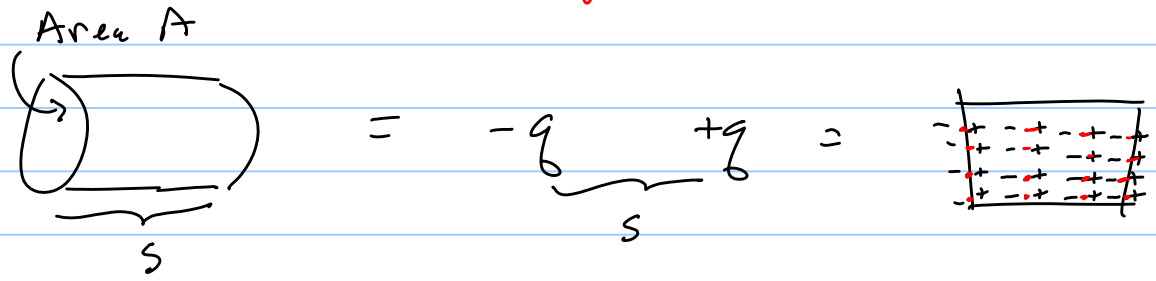
Consider a string of dipoles



The head of one "cancels" the tail of its neighbor except at the ends where charge is left over.

Net charge at ends is the bound charge.

Assume uniform polarization or $\vec{P}$ = constant



This is equivalent to dipole moment $qs = PAs$

since $\vec{P}_{total} = \sum \vec{p}_i = \vec{P}\,\underbrace{Ad}_{Vol}$

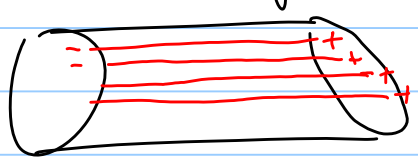
$\vec{p}_i$ ← atom dipole moments

$\vec{P}$ ← dipole mom/vol

so $q = PA$

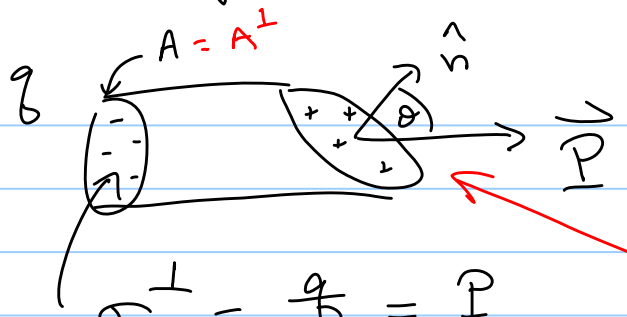
The surface charge density is $\frac{q_b}{A} = P$

For an oblique cut the charge is still the same



Think of each charge at the end of a fiber through the material. The number of fibers at the end is the same no matter what the cut.

If charge is same and area increases then σ decreases.



$$\sigma_b^{\perp} = \frac{q_b}{A} = P$$

A_{end}

$A^{\perp} = A = A_{end}\cos\theta$ so $\sigma_b = \frac{q_b}{A_{end}}$

$$\sigma_b = \frac{q_b}{A^{\perp}/\cos\theta} = \frac{q_b}{A^{\perp}}\cos\theta = \sigma_b^{\perp}\cos\theta = \vec{P}\cdot\hat{n} \quad \text{AT SURFACE}$$