PHYS 5C: Gauss's Law

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Gauss's Law

flux $\int E\,\mathrm{dA} = \frac{Q_{\text{encl}}}{\epsilon_0}$

dA points normal to surface outward

I. Guass Law

- Example 1: positive Q in sphere with radius r

  $Q_{\text{encl}} = Q$

  $\int E\,\mathrm{dA} = E4\pi r^2$ $\quad$ E same over surface by symmetrically $E||\mathrm{dA}$ over surface

  $\frac{Q_{\text{encl}}}{\epsilon_0} = E4\pi r^2 \Rightarrow E = \frac{Q}{4\pi r^2 \varepsilon_0}$

- Thin sheet of uniform charged density σ.

  By symmetry, E$\perp$to sheet=> E$\perp$dA over the label surfaceof can (cylinder)

  E$\|$dA at ends

  $\int \mathrm{EdA} = \mathrm{AE}_{\text{top face}} + \mathrm{AE}_{\text{bottom face}} + 0_{\text{label face}}$

  $=2\mathrm{AE} \equiv \frac{Q_{\text{enclav}}}{\varepsilon_0} = \frac{\sigma A}{\varepsilon_0} \Rightarrow E = \frac{\sigma}{2\varepsilon_0}$

- ∞ line charge density λ

  $E \perp$ to line of charge

  on curved(label) side $e \parallel$ dA and constant.

  $\int \mathrm{EdA} = E2\pi\mathrm{rl} = \frac{Q_{\text{encl}}}{\varepsilon_0} = \lambda l \Rightarrow E = \frac{\lambda}{2\pi\varepsilon_0 r}$