PH 422: Day 1

Please read Sections 2.6–2.9 from the mathematics notes.

18 Flux

Recall that

$$V = -\int \vec{\boldsymbol{E}} \cdot d\vec{\boldsymbol{r}}$$

This is the integral of $\vec{\boldsymbol{E}}$ along a curve. What sort of integral can you take of $\vec{\boldsymbol{E}}$ over a surface? Along a curve, there is a natural direction, namely that tangent to the curve. The line integral above adds up the *tangential* component of $\vec{\boldsymbol{E}}$ along the curve. The most natural direction associated with a surface, on the other hand, is the direction perpendicular to it. Therefore, the natural integral to compute over a surface adds up the *normal* component of $\vec{\boldsymbol{E}}$. This is called the *flux* of $\vec{\boldsymbol{E}}$ through the given surface (in the given direction):

$$\text{flux} = \int \vec{\boldsymbol{E}} \cdot \hat{\boldsymbol{n}}\, dA = \int \vec{\boldsymbol{E}} \cdot d\vec{\boldsymbol{A}}$$

Be warned that some authors use two integral signs rather than one, and other letters, such as S or σ are often used in place of A.