Gauss' Law

- Easier way to calculate *E* fields –

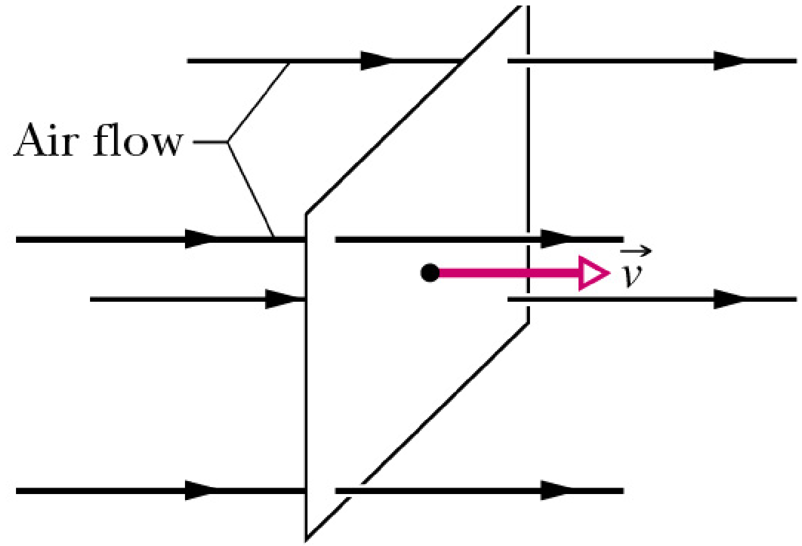
Gauss' Law

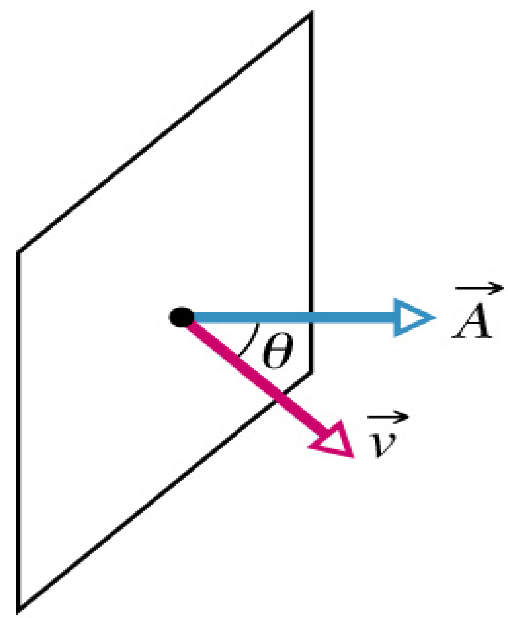
- Equivalent to Coulomb's law
- Use in symmetrical situations
- Gaussian surfaces – hypothetical closed surface

Flux

- Flux, Φ, is rate of flow through an area
- Create area vector, $\vec{A}$
  - magnitude is A,
  - direction is normal (⊥) to area
- Flux of a velocity field through an area
- Relate velocity and area by

$$\Phi = (v\cos\theta)A = \vec{v} \bullet \vec{A}$$



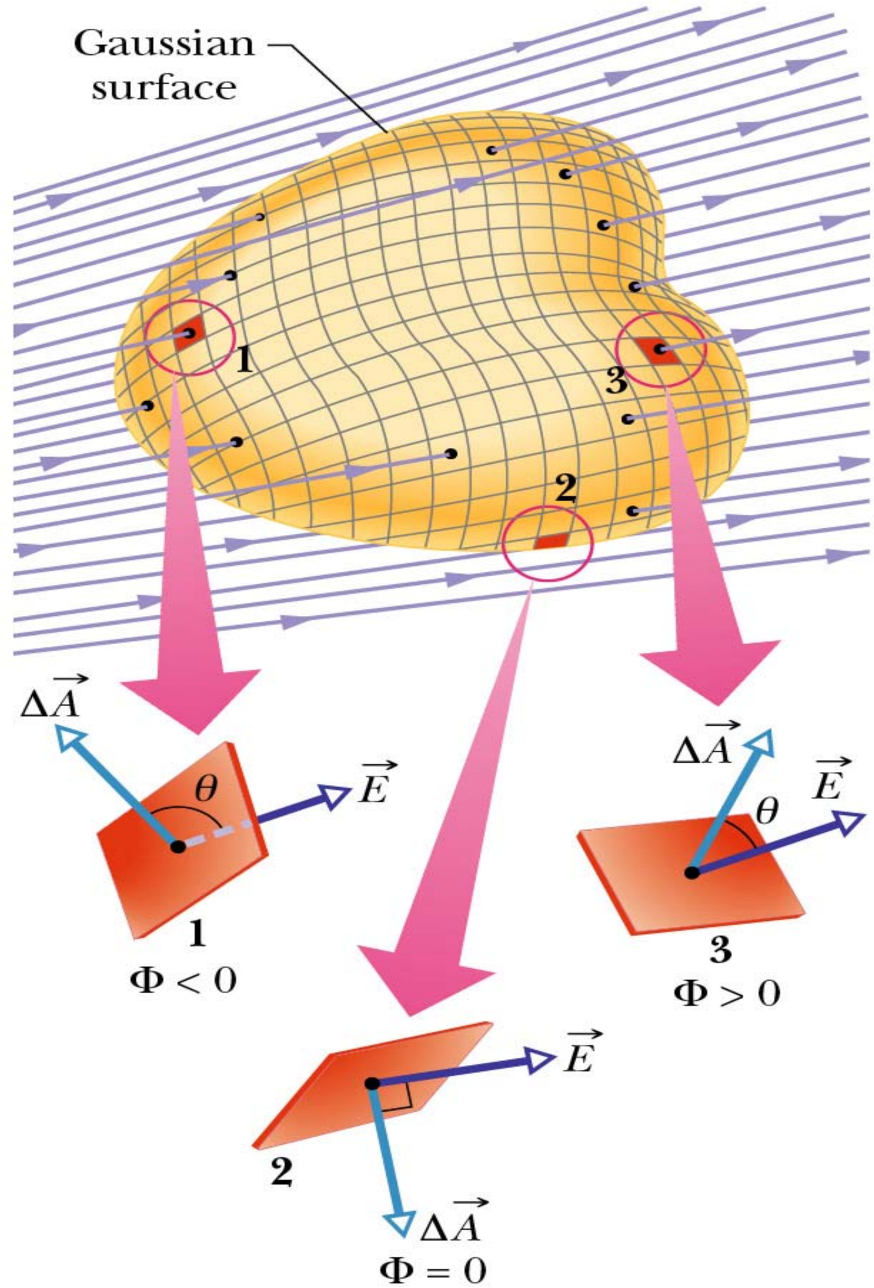


Flux

- Gaussian surface in non-uniform *E* field
- Divide Gaussian surface into squares of area ΔA

- Flux of *E* field is

$$\Phi = \sum \vec{E} \bullet \Delta\vec{A}$$



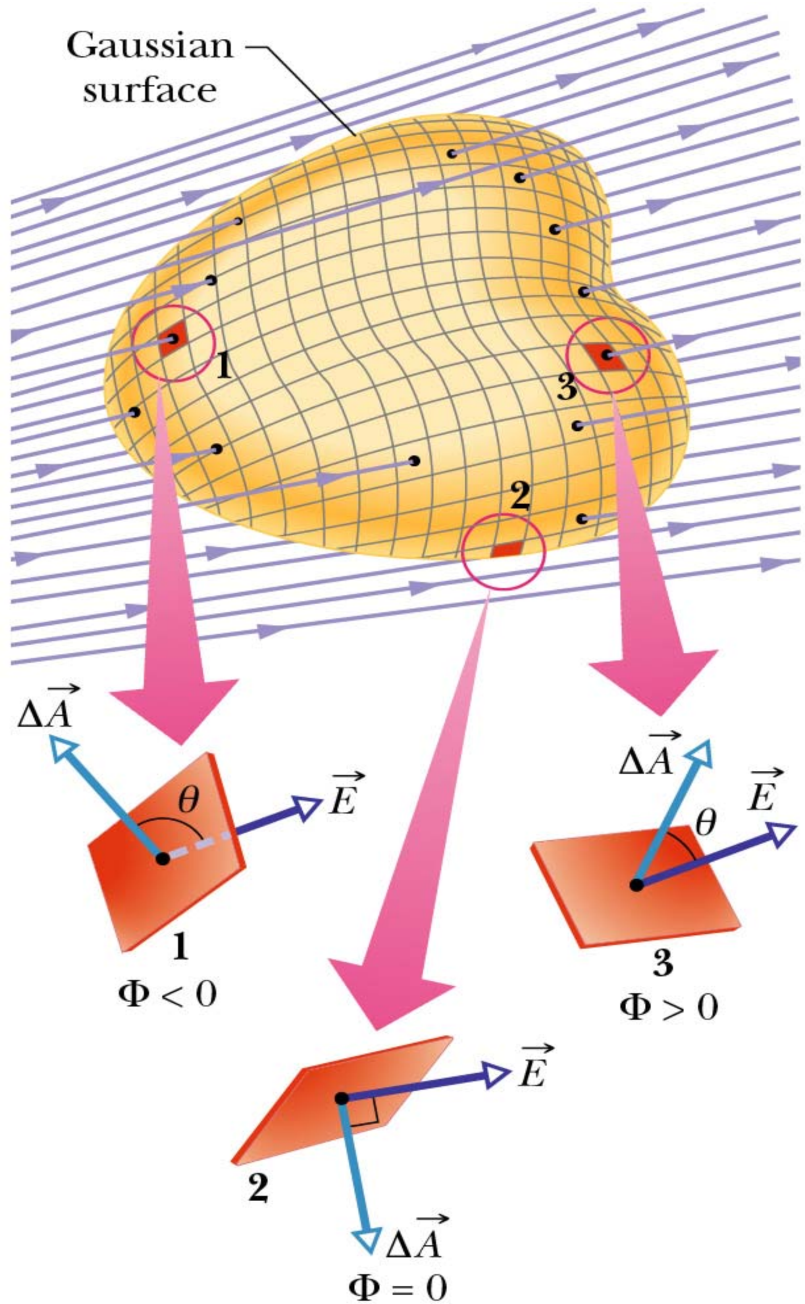
Flux

$$\Phi = \sum \vec{E} \bullet \Delta\vec{A}$$

- Let ΔA become small so flux becomes integral over Gaussian surface

$$\Phi = \oint \vec{E} \bullet d\vec{A}$$

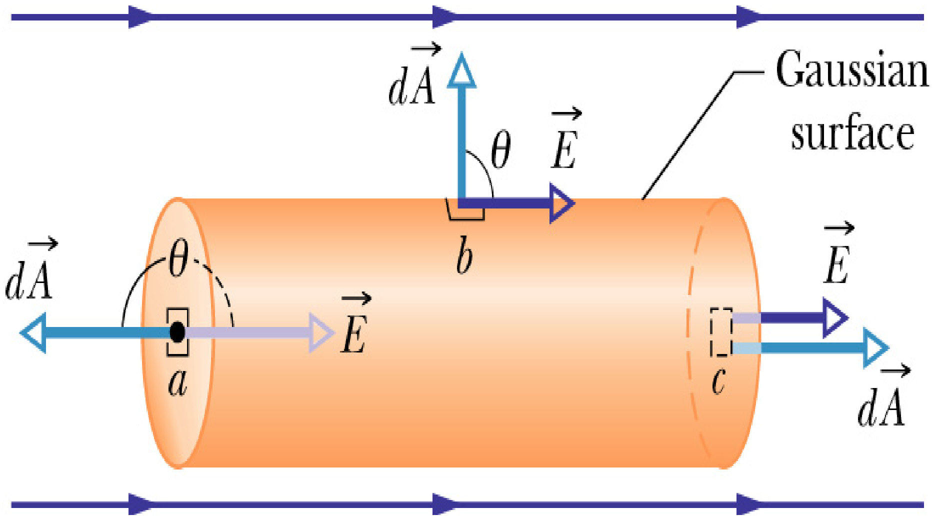
- Flux is proportional to net # of E field lines passing through surface



Flux

$$\Phi = \oint \vec{E} \bullet d\vec{A}$$

$$= \oint E \cos \theta dA$$

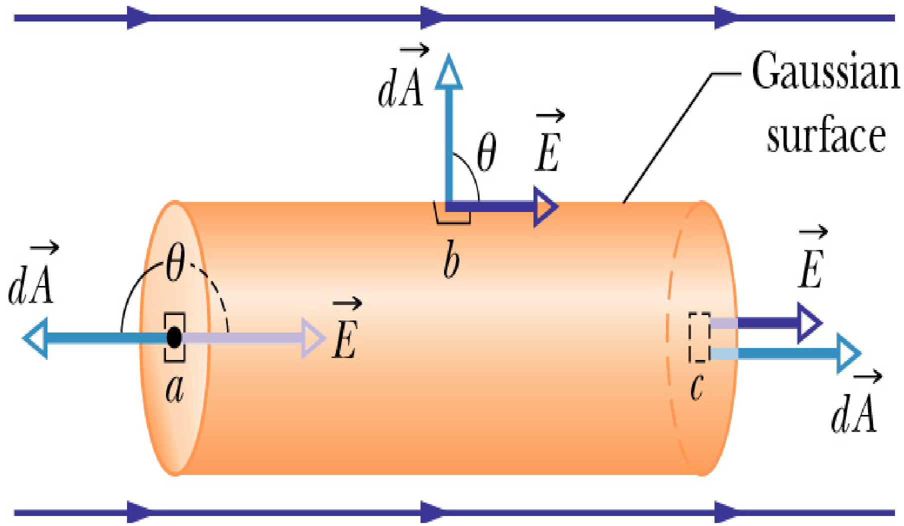


- If E field points inward at surface, Φ is –
- If E field points outward at surface, Φ is +
- If E field is along surface, Φ is zero
- If equal # of field lines enter as leave closed surface the net Φ is zero

Flux

- Calculate flux of uniform *E* through cylinder

$$\Phi = \oint \vec{E} \bullet d\vec{A}$$



- 3 surfaces - a, b, and c

$$\Phi = \int_a \vec{E} \bullet d\vec{A} + \int_b \vec{E} \bullet d\vec{A} + \int_c \vec{E} \bullet d\vec{A}$$

- Flux is

$$\Phi = 0$$