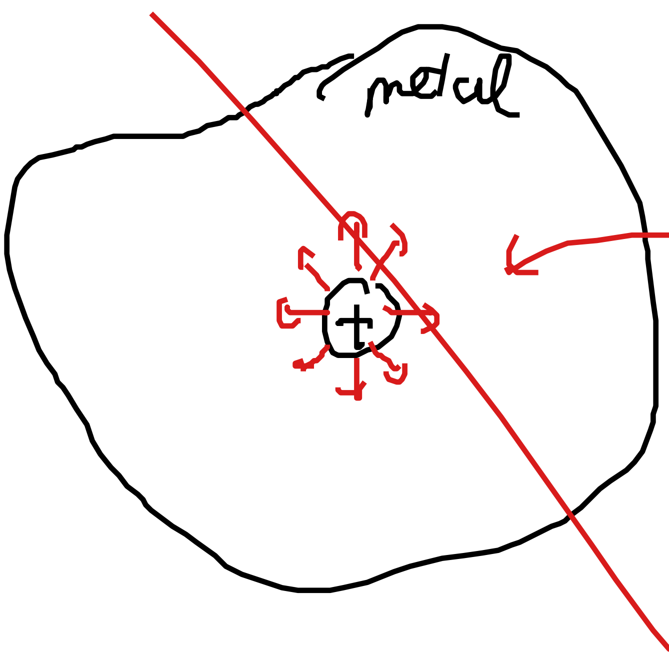
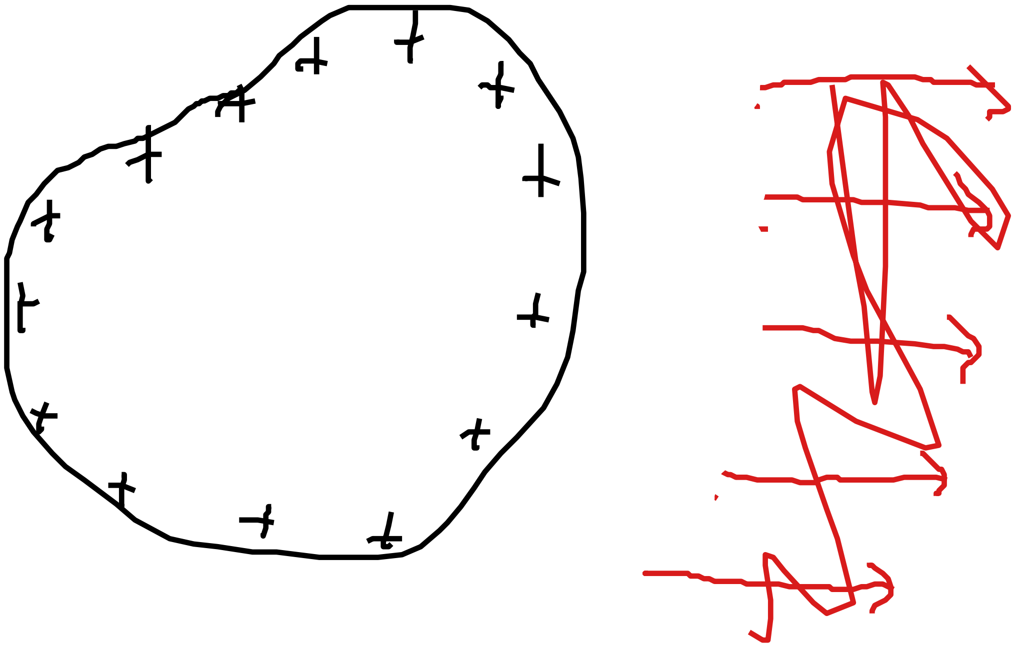
Conductors

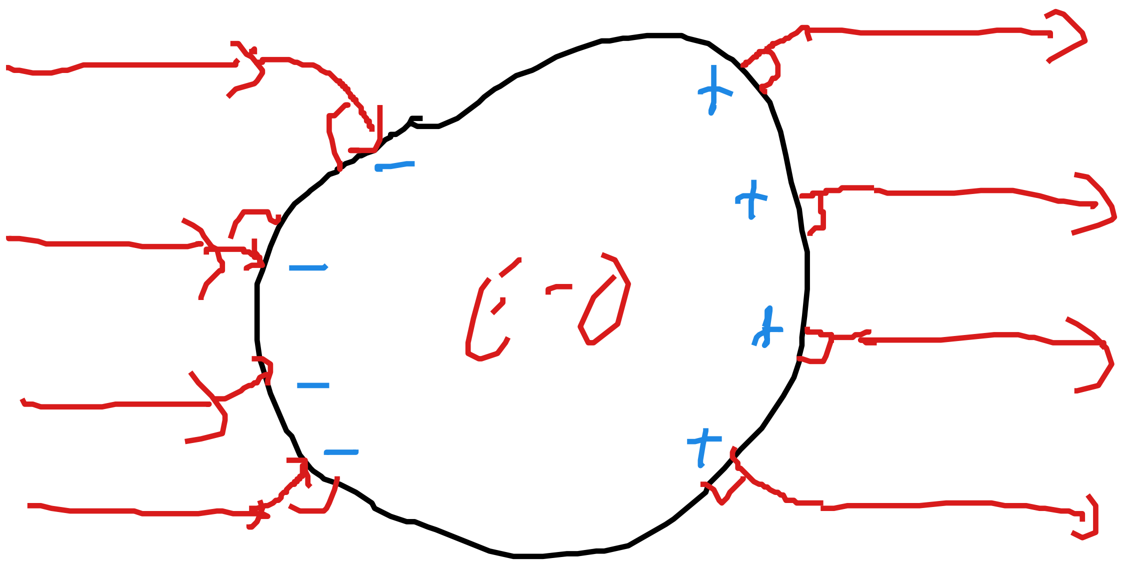
- A conductor in electrostatic equilibrium maintains $\vec{E} = 0$ inside.
- All excess charge on a conductor is on its surface.

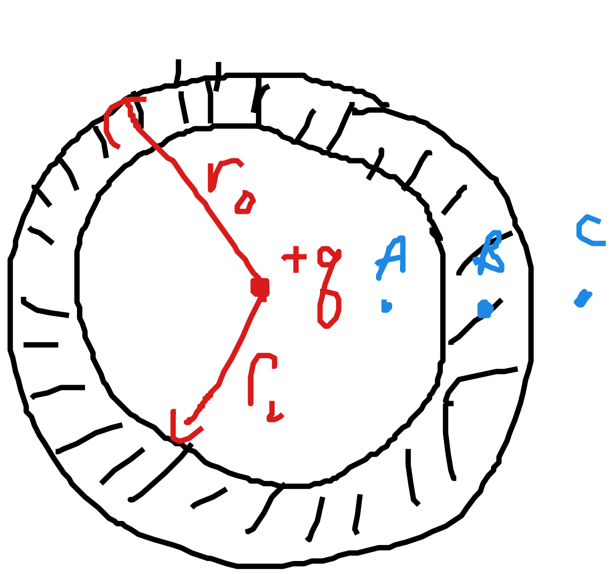


but wait $\vec{E} \neq 0$ now!



Immediately outside conductor the $\vec{E}$ is $\perp$ to surface.

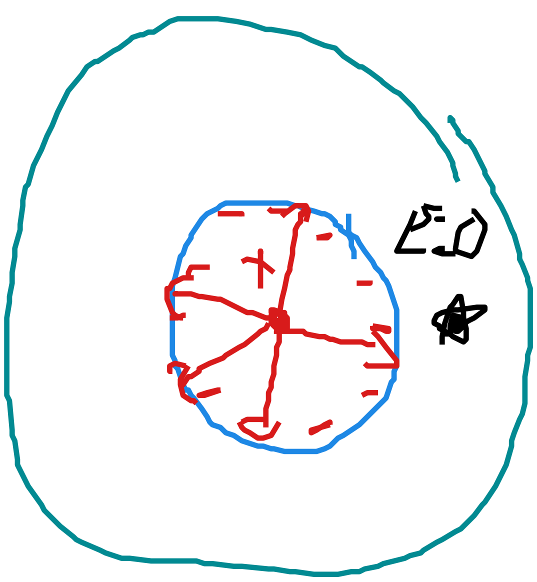


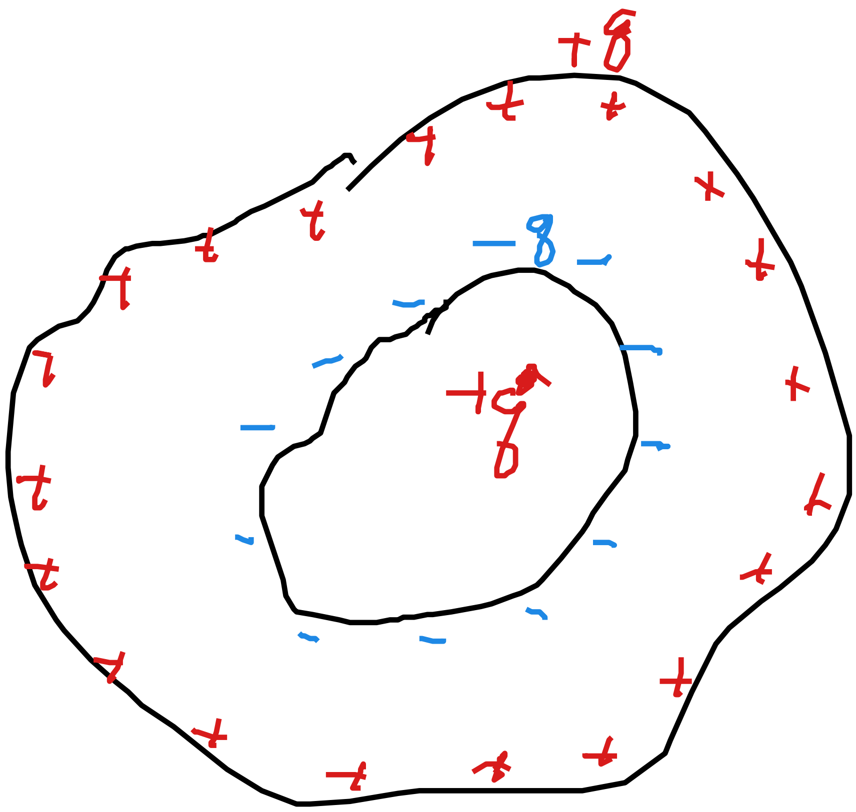


metal thick spherical shell with net charge of 0

At A, $\vec{E} \longrightarrow$ because of the positive charge at the center.

At B, $\vec{E} = 0$.

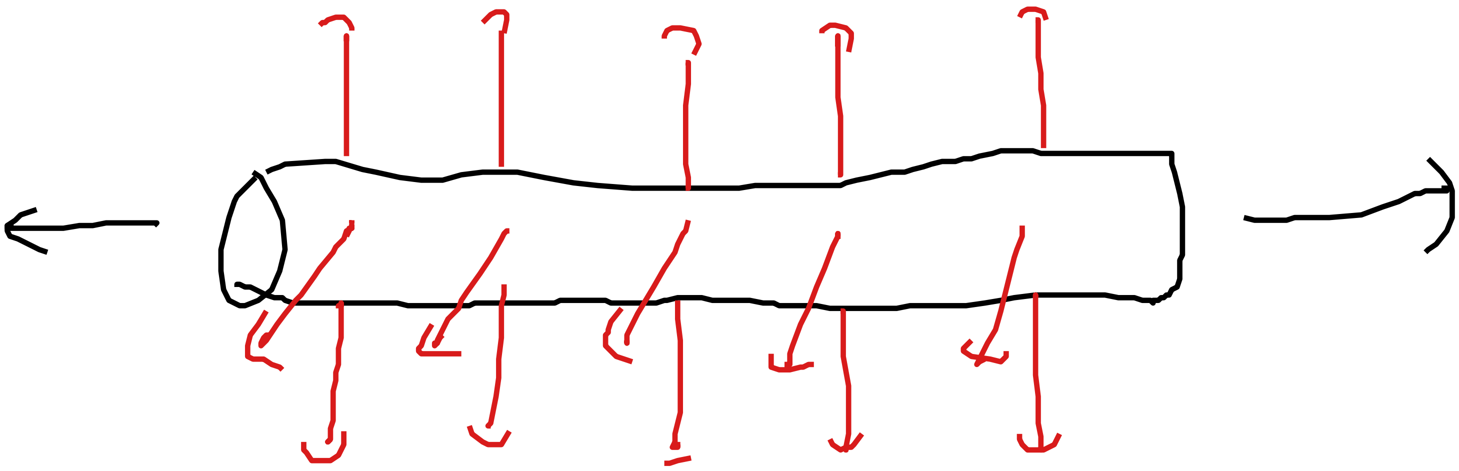




End conductors

(for now...)

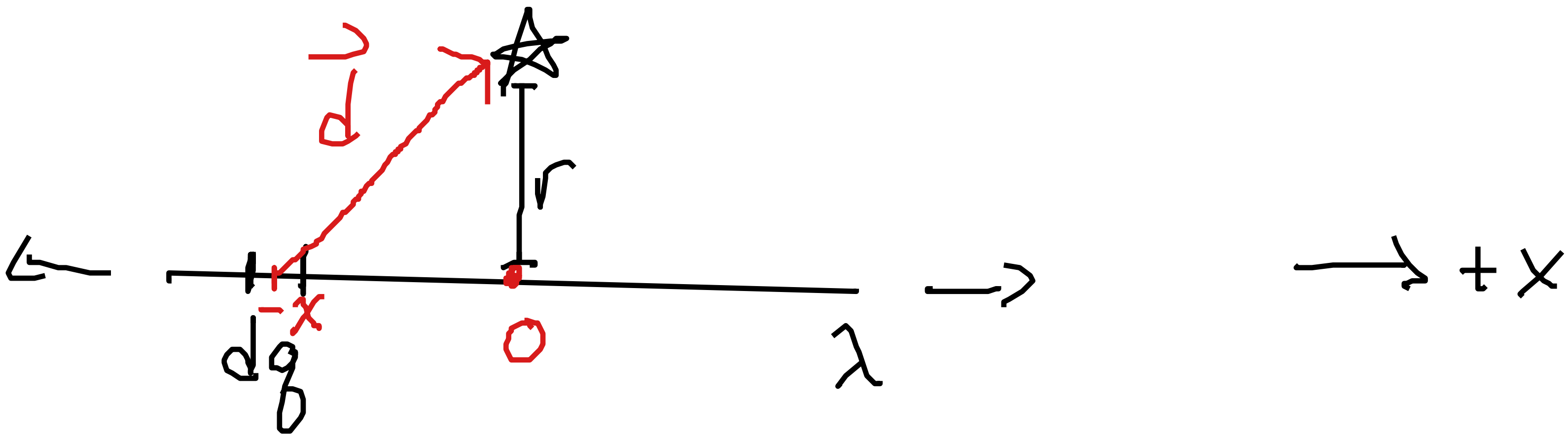
Infinite Cylindrical Symmetry



$\vec{E}$ is the same as the electric field of an infinite line charge with the same charge/length $\frac{Q}{L}$.

or λ.

Field of an Infinite Line

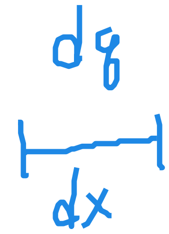


$$\vec{E}_{☆} = \int d\vec{E}$$

$$d\vec{E} = \frac{k\,dq}{d^3}\,\vec{d}$$

$$\vec{d} = +x\,\hat{x} + r\,\hat{y}$$

$$d = \sqrt{x^2 + r^2}$$



$$\boxed{dq = \lambda\,dx}$$

$$d\vec{E} = \frac{k\lambda\, dx}{(x^2+r^2)^{3/2}}\left(x\hat{x} + r\hat{y}\right)$$

$$\vec{E} = \int_{-\infty}^{\infty} \frac{k\lambda\, dx}{(x^2+r^2)^{3/2}}\, x\hat{x} + \int_{-\infty}^{\infty} \frac{k\lambda\, dx}{(x^2+r^2)^{3/2}}\, r\hat{y}$$

$$= k\lambda\hat{x}\int_{-\infty}^{\infty} \frac{x}{(x^2+r^2)^{3/2}}\, dx$$

$$+ k\lambda r\hat{y}\int_{-\infty}^{\infty} \frac{dx}{(x^2+r^2)^{3/2}}\, dx$$

$$= k\lambda\hat{x}\left[-\frac{1}{\sqrt{x^2+r^2}}\right]_{-L}^{L} + k\lambda r\hat{y}\left[\frac{x}{r^2\sqrt{r^2+x^2}}\right]_{-L}^{L}$$

$$= 0 + k\lambda r\hat{y}\left[\frac{L}{r^2\sqrt{r^2+L^2}} - \frac{-L}{r^2\sqrt{r^2+L^2}}\right]$$

$$= k\lambda r\hat{y}\left[\frac{2L}{r^2\sqrt{r^2+L^2}}\right]$$

$L \to \infty$ $\quad L$

$$= k\lambda r\hat{y}\left[\frac{2\cancel{L}}{r^2\cancel{L}}\right]$$

$$= \boxed{\frac{2k\lambda}{r}\hat{y}}$$

$\vec{E}$ of any ∞ cylindrical symmetric charge distribution with $\lambda = \frac{Q}{L}$