$$\vec{\nabla}\cdot\left(\frac{\hat{r}}{r^2}\right) = 4\pi\delta^3(\vec{r})$$

$\vec{\nabla}\cdot\vec{E}$ $\Rightarrow$ EMT $\Rightarrow$ U(1)

Sym $\longleftrightarrow$ Cons (Korunumlu)

Noether

Time tras $\longleftrightarrow$ En. Cons.

$t \to t+\Delta t \longleftrightarrow \mathcal{L}$ $\quad \frac{1}{2}mv^2$

$x \to x+\Delta x \longleftrightarrow$ Mom. Cons

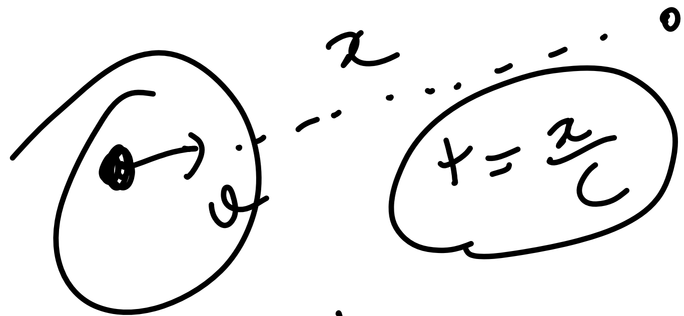
$x_i \xrightarrow{\theta} R_{ij} x_j \to$ Space Uzay Tras $\longleftrightarrow$ Mom. Cons Açı. Mom.

U(1) $\longleftrightarrow$ el. yükü korunumu

$A \leftarrow e^{i\alpha} A$

$\{ SU(2) \times SU(3) \times U(1) \} \longrightarrow$ S.M.

Elektrostatik



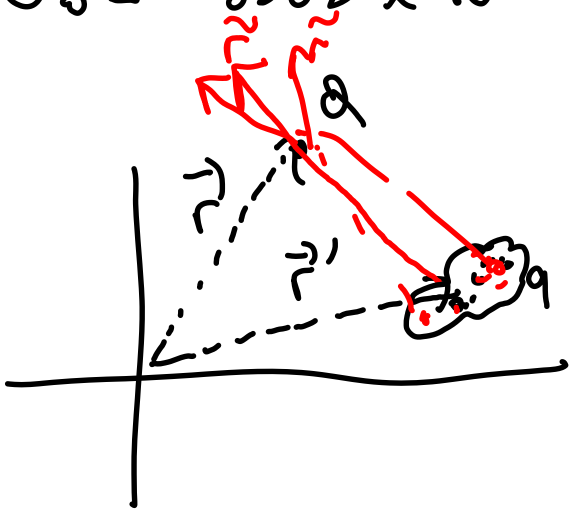
Coulomb Kuvveti :

$$\vec{F} = \frac{1}{4\pi\epsilon_0}\frac{qQ}{\tilde{r}^2}\hat{\tilde{r}}$$

$$\epsilon_0 = 8.85 \times 10^{-12}\ \frac{C^2}{Nm^2}$$

q ⇒ kaynak

Q ⇒ test parçacığı



$$\tilde{r} = \vec{r} - \vec{r}'$$

$$\vec{F}_T = \vec{F}_1 + \vec{F}_2 + \cdots$$

$$\vec{F}_T = \frac{Q}{4\pi\epsilon_0}\left(\frac{q_1}{r_1^2}\hat{r}_1 + \frac{q_2}{r_2^2}\hat{r}_2 + \cdots\right)$$

$$\vec{F}_T = Q\vec{E} \Rightarrow \vec{E} = \frac{1}{4\pi\epsilon_0}\sum_{i=1}^{n}\frac{q_i}{r_i^2}\hat{r}_i$$

$$\vec{F}_t = Q\vec{E} \Rightarrow \int d\vec{E} = \int \frac{1}{4\pi\epsilon_0}\frac{dq}{r^2}\hat{r}$$

$$\vec{E} = \int \frac{1}{4\pi\epsilon_0}\frac{dq}{r^2}\hat{r}$$

cizgisel $\lambda \Rightarrow dq = \lambda dx$

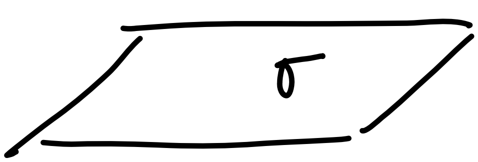
$$E = \frac{1}{4\pi\epsilon_0}\int \frac{\lambda(r')\,\hat{r}\,dl'}{r^2}$$

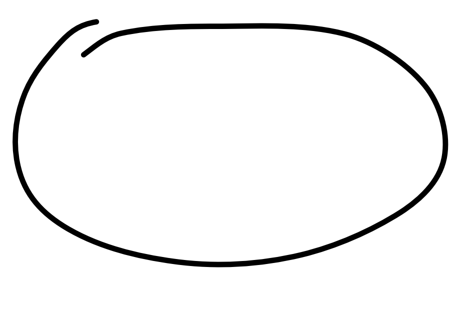
surface

$$\sigma \Rightarrow E = \frac{1}{4\pi\epsilon_0}\int \frac{\sigma(r')\,\hat{r}\,da'}{r^2}$$

volume

$$\rho \Rightarrow E = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(r')\,\hat{r}\,d\tau'}{r^2}$$

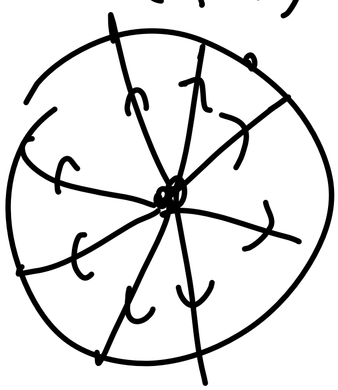




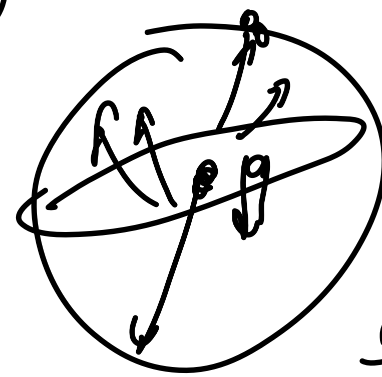
$\circ$ $E = \dfrac{\sigma}{\varepsilon_0}$

Gauss' Kanunu:

Flux (Akı) $\rightarrow$ $\Phi_E = \int \vec{E} \cdot d\vec{a}$



$$\frac{n}{2\pi r}$$



$$\frac{n}{4\pi r^2}$$

E ~ bu yoğunlukla orantılı

$$\vec{E} = \frac{q}{4\pi\epsilon_0}\frac{\hat{r}}{r^2}$$

$$\int \vec{E} \cdot d\vec{a}$$

$$d\vec{a} = r^2 \sin\theta \, d\theta \, d\phi \, \hat{r}$$

$$\int \frac{q}{4\pi\epsilon_0}\frac{\cancel{r^2}}{\cancel{r^2}} \sin\theta \, d\theta \, d\phi = \frac{q}{\cancel{4\pi}\epsilon_0}\int_0^{\pi} \sin\theta \, d\theta \underbrace{\int_0^{2\pi} d\phi}_{\cancel{2\pi}}$$

$$\frac{q}{\cancel{2}\epsilon_0}\left(\overbrace{-\cos\theta \Big|_0^{\pi}}^{\cancel{2}}\right) = q/\epsilon_0$$

$$-[\underbrace{\cos\pi}_{-1} - \underbrace{\cos 0}_{1}]$$

$$\Phi = \oint \vec{E} \cdot d\vec{a} = q/\epsilon_0$$

$$\vec{E} = \sum_{i=1}^{n} E_i$$

$$\oint \vec{E} \cdot d\vec{a} = \oint \left(\sum_{i=1}^{n} \vec{E}_i \right) \cdot d\vec{a}$$

$$\sum_{i=1}^{n} \oint (\vec{E}_i) \cdot d\vec{a} = \sum_{i=1}^{n} q_i / \varepsilon_0 = \frac{Q_{enc}}{\varepsilon_0}$$

$\leftarrow Q_T$

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\varepsilon_0}$$

$$\oint \vec{E} \cdot d\vec{a} = \int_V (\vec{\nabla} \cdot \vec{E})\, dV = \int_V \frac{\rho\, dV}{\varepsilon_0}$$

$\rightarrow V$

Div. thm

Gauss' thm

$$Q = \int_V \rho\, dV$$

$$\boxed{\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\varepsilon_0}};$$

$$E = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^2} \hat{r}$$

$$\vec{\nabla} \cdot \vec{E}(\vec{r}) = \frac{1}{4\pi\varepsilon_0} \vec{\nabla} \cdot \int_V \frac{\rho(\vec{r}')\, dV' \, \hat{\mathscr{r}}}{\mathscr{r}^2}$$

$$\vec{\mathscr{r}} = \vec{r} - \vec{r}' \Rightarrow \mathscr{r} = r - r'$$

$$\vec{\nabla}_{\vec{r}}\cdot\vec{E}(\vec{r}) = \frac{1}{4\pi\epsilon_0}\int \rho(\vec{r}\,')\,dV'\;\underbrace{\vec{\nabla}\cdot\left(\frac{\hat{\tilde{r}}}{\tilde{r}^2}\right)}_{4\pi\,\delta^3(\vec{\tilde{r}})}$$

$$\nabla \qquad \underbrace{\frac{\partial}{\partial r}} = \underbrace{\frac{\partial}{\partial \tilde{r}}}\;\underbrace{\frac{\partial \tilde{r}}{\partial r}}_{1}$$

$$\frac{1}{\cancel{4\pi}\epsilon_0}\int \rho(\vec{r}\,')\,\underbrace{dV'}\,\cancel{4\pi}\,\underbrace{\delta^3(\vec{r}-\vec{r}\,')}$$

$$\vec{\nabla}\cdot\vec{E} = \frac{\rho(\vec{r})}{\epsilon_0}$$

$$\boxed{\vec{\nabla}\cdot\vec{E} = \frac{\rho}{\epsilon_0}};$$

$$\int_V \underbrace{dV\left(\vec{\nabla}\cdot\vec{E}\right)} = \int \frac{\rho(\vec{r})}{\epsilon_0}\,dV = \frac{1}{\epsilon_0}\underbrace{\int \rho\,dV}_{Q_{enc}}$$

$$\underline{\oint_S \vec{E}\cdot d\vec{a} = \Phi} = \frac{Q_{enc}}{\epsilon_0}$$

$\vec{E}$'nin Curl'ü :

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$$

$$d\vec{l} = dr\,\hat{r} + r\,d\theta\,\cancel{\hat{\theta}} + r\sin\theta\,d\phi\,\cancel{\hat{\phi}}$$

$$\int_a^b \vec{E}\cdot d\vec{l} = \int_a^b \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\,dr$$

$$\frac{q}{4\pi\epsilon_0}\left(-\frac{1}{r}\right)\Big|_a^b = \frac{q}{4\pi\epsilon_0}\left(\frac{1}{r_a}-\frac{1}{r_b}\right)$$

$$\oint \vec{E}\cdot d\vec{l} = 0 \qquad \oint \Rightarrow r_b = r_a$$

$\Downarrow$

Stokes

$$\int_S (\vec{\nabla}\times\vec{E})\cdot d\vec{a} = 0$$

valid for any surface

$$\boxed{\vec{\nabla}\times\vec{E} = 0}$$