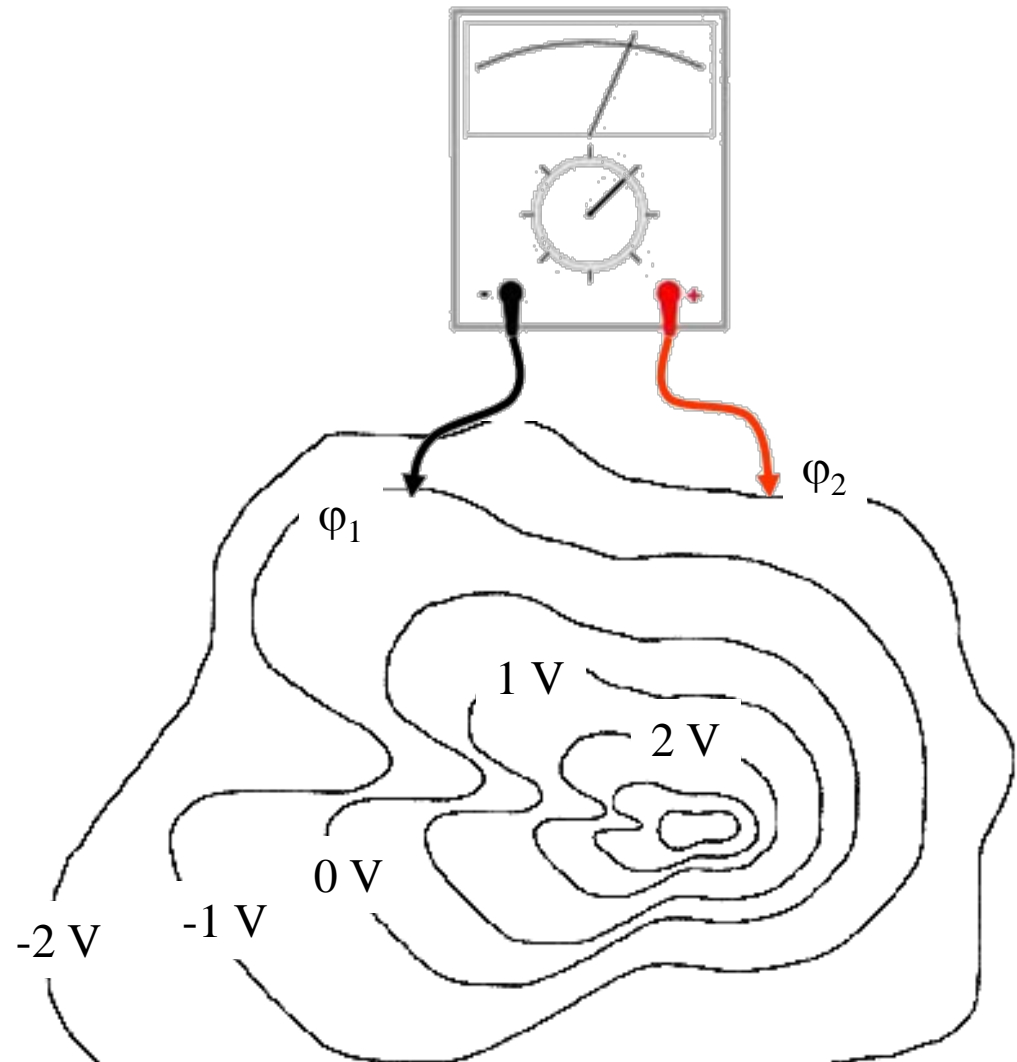


Spannung

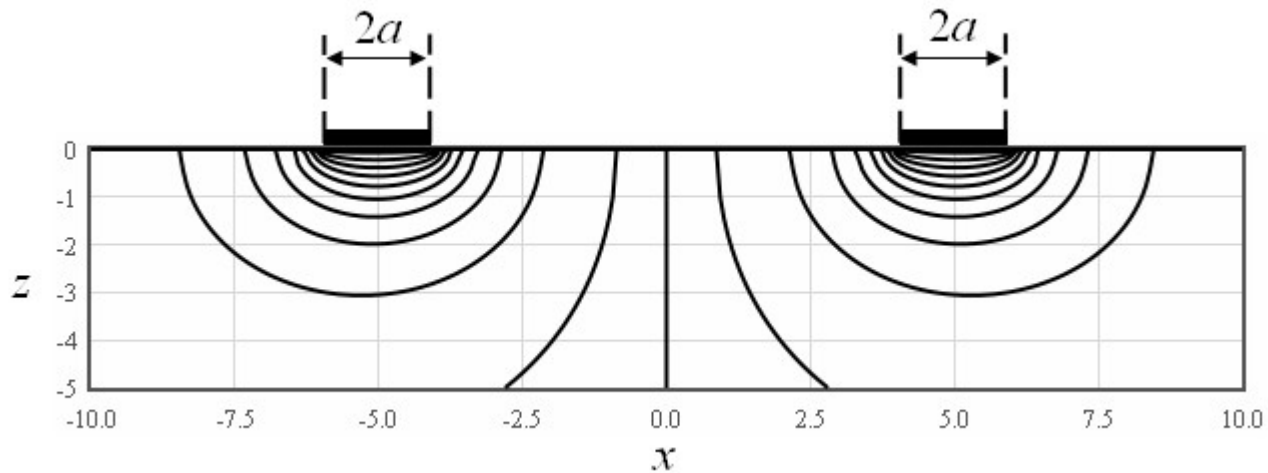
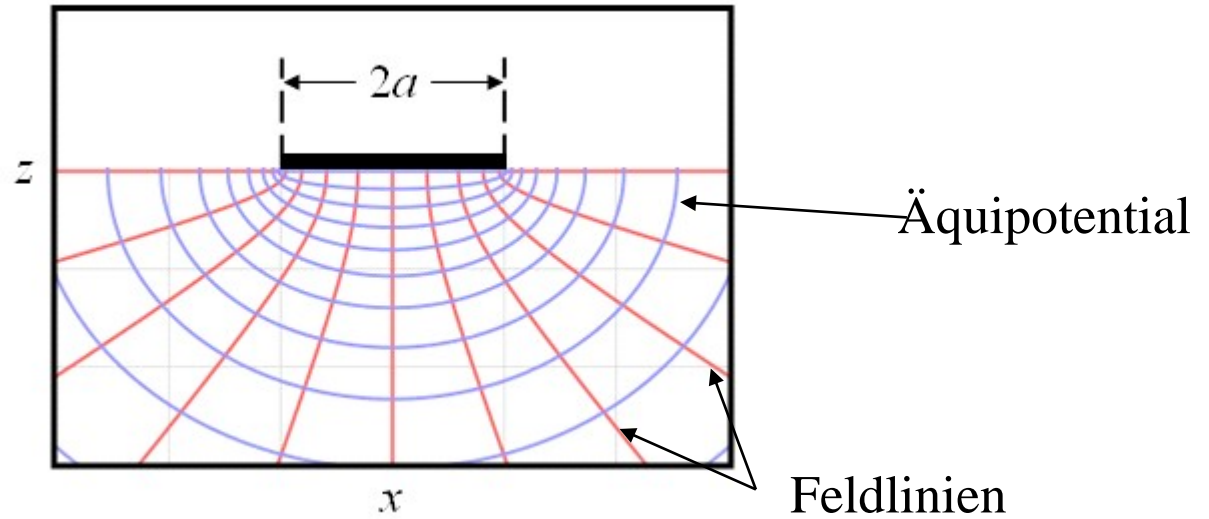
$$V = \varphi_2 - \varphi_1 \quad \text{Volts}$$

Elektrostatische Potential [Volts]

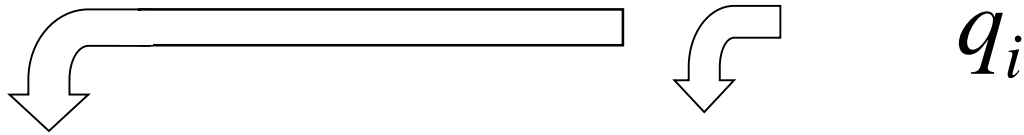
$$\vec{E} = -\nabla \varphi$$



Äquipotentialfläche - Feldlinien

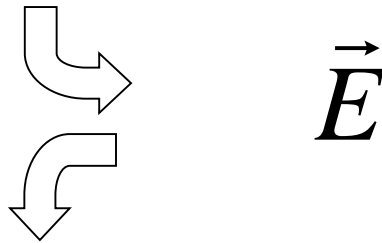


Elektrostatik



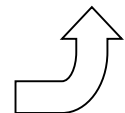
$$\vec{E}(\vec{r}) = \sum_{i=1}^N \frac{q_i (\vec{r} - \vec{r}_i)}{4\pi\epsilon_0 |\vec{r} - \vec{r}_i|^3}$$

$$\varphi(\vec{r}) = \sum_i \frac{q_i}{4\pi\epsilon_0 |\vec{r} - \vec{r}_i|}$$



$$\varphi = -\int \vec{E} \cdot d\vec{r} + \varphi_0$$

$$\vec{E} = -\nabla \varphi$$



Ladungsdichte

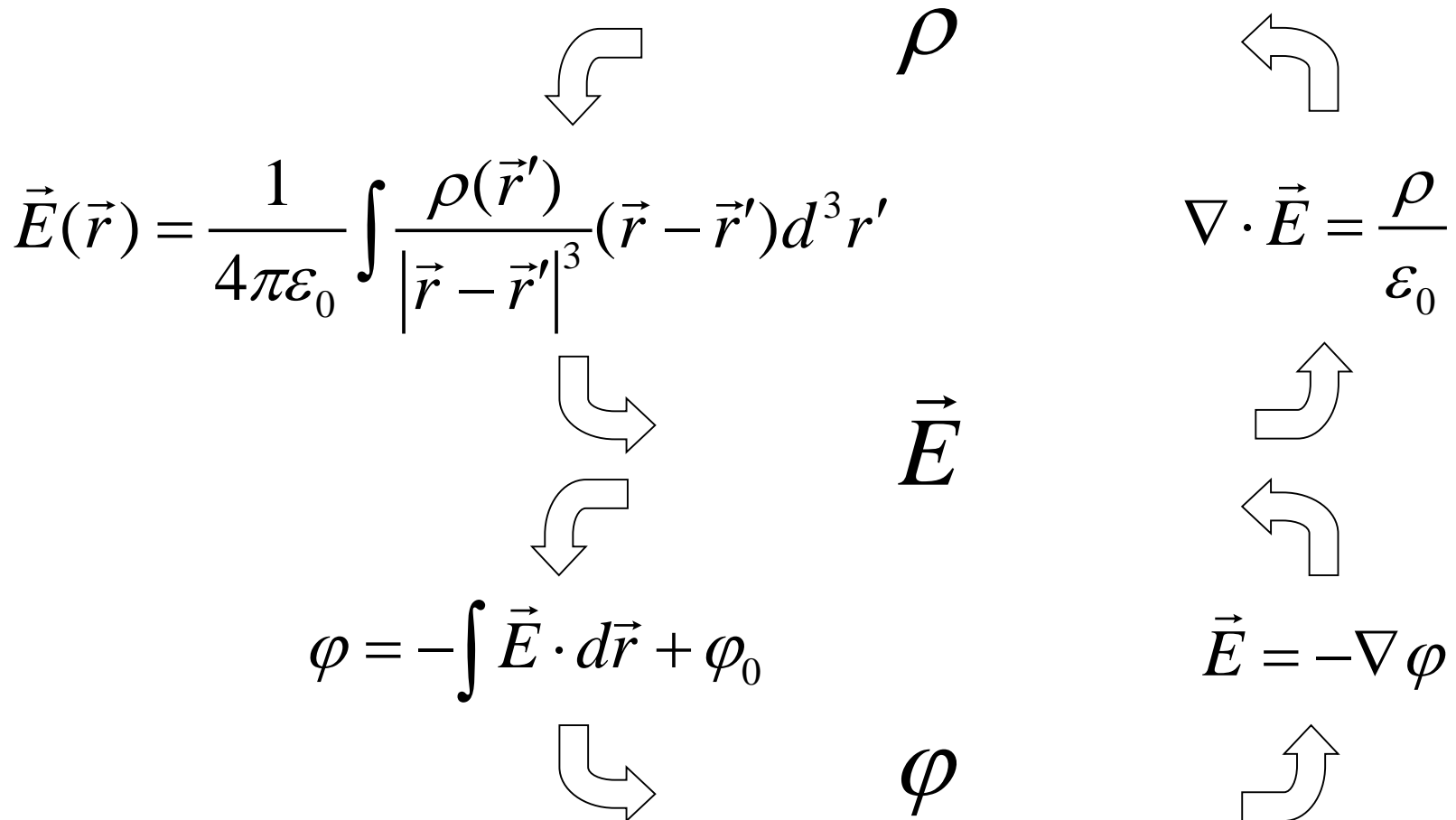
für viele elektrische Ladungen

$$\sum_i q_i \quad \Longrightarrow \quad \rho(\vec{r})$$

$$\vec{E}(\vec{r}) = \sum_{i=1}^N \frac{q_i (\vec{r} - \vec{r}_i)}{4\pi\epsilon_0 |\vec{r} - \vec{r}_i|^3}$$

$$\vec{E}(\vec{r}) = \frac{1}{4\pi\epsilon_0} \iiint_{\text{vol}} \frac{\rho(\vec{r}')}{|\vec{r} - \vec{r}'|^3} (\vec{r} - \vec{r}') dx' dy' dz'$$

Elektrostatik



Gaußsches Gesetz

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

Divergenz

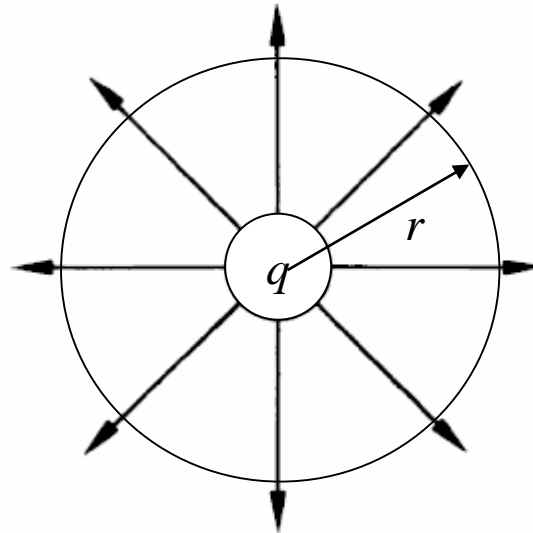
elektrische Feldkonstante

$$8.854187817 \times 10^{-12} \frac{\text{A s}^4}{\text{kg m}^3}$$

$$\nabla \cdot \vec{E} = \text{div } \vec{E} = \frac{\partial E_x}{\partial x} + \frac{\partial E_y}{\partial y} + \frac{\partial E_z}{\partial z}$$

Gaußsches Gesetz

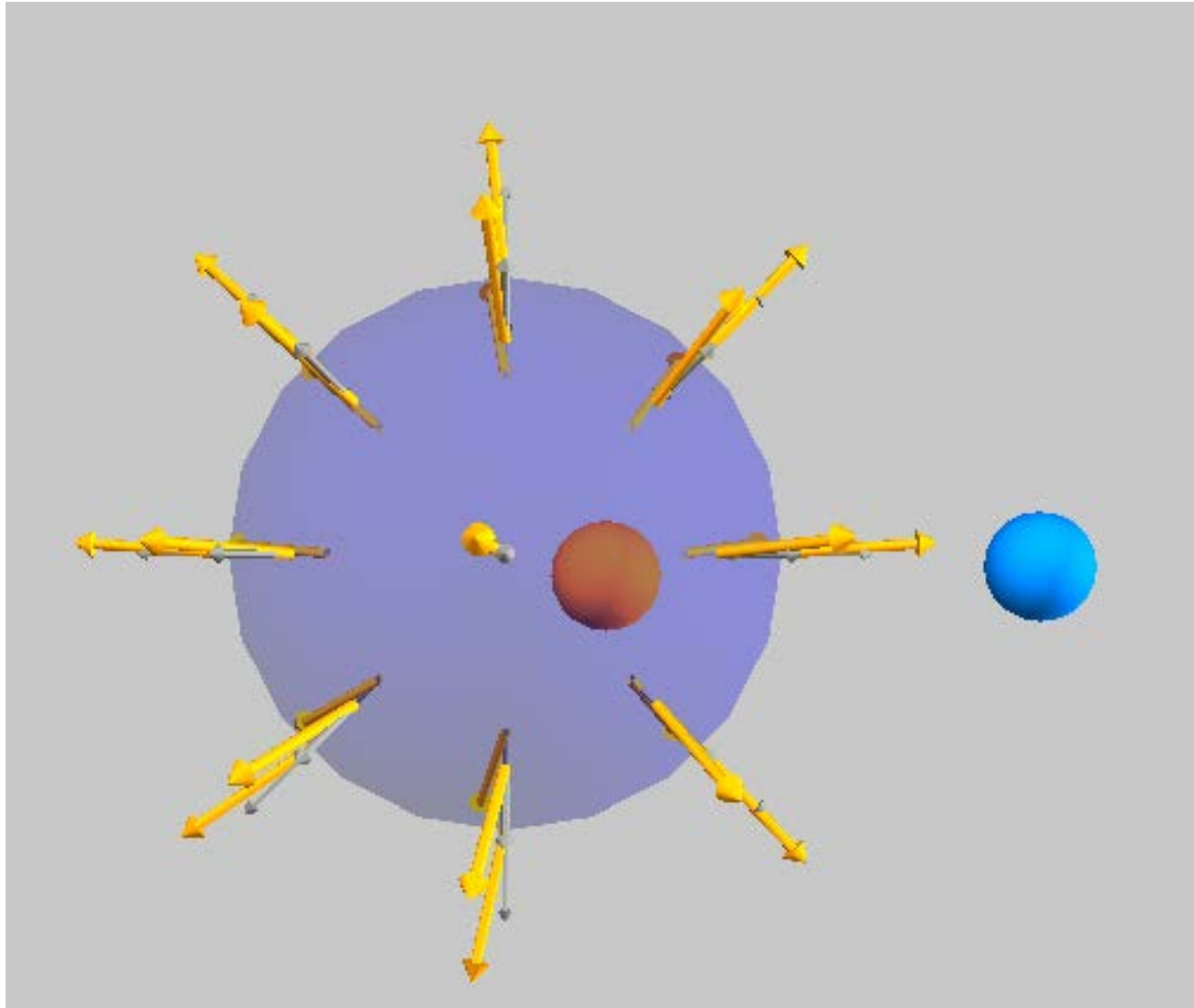
$$\vec{E}(\vec{r}) = \frac{q}{4\pi\epsilon_0 r^2} \hat{r}$$



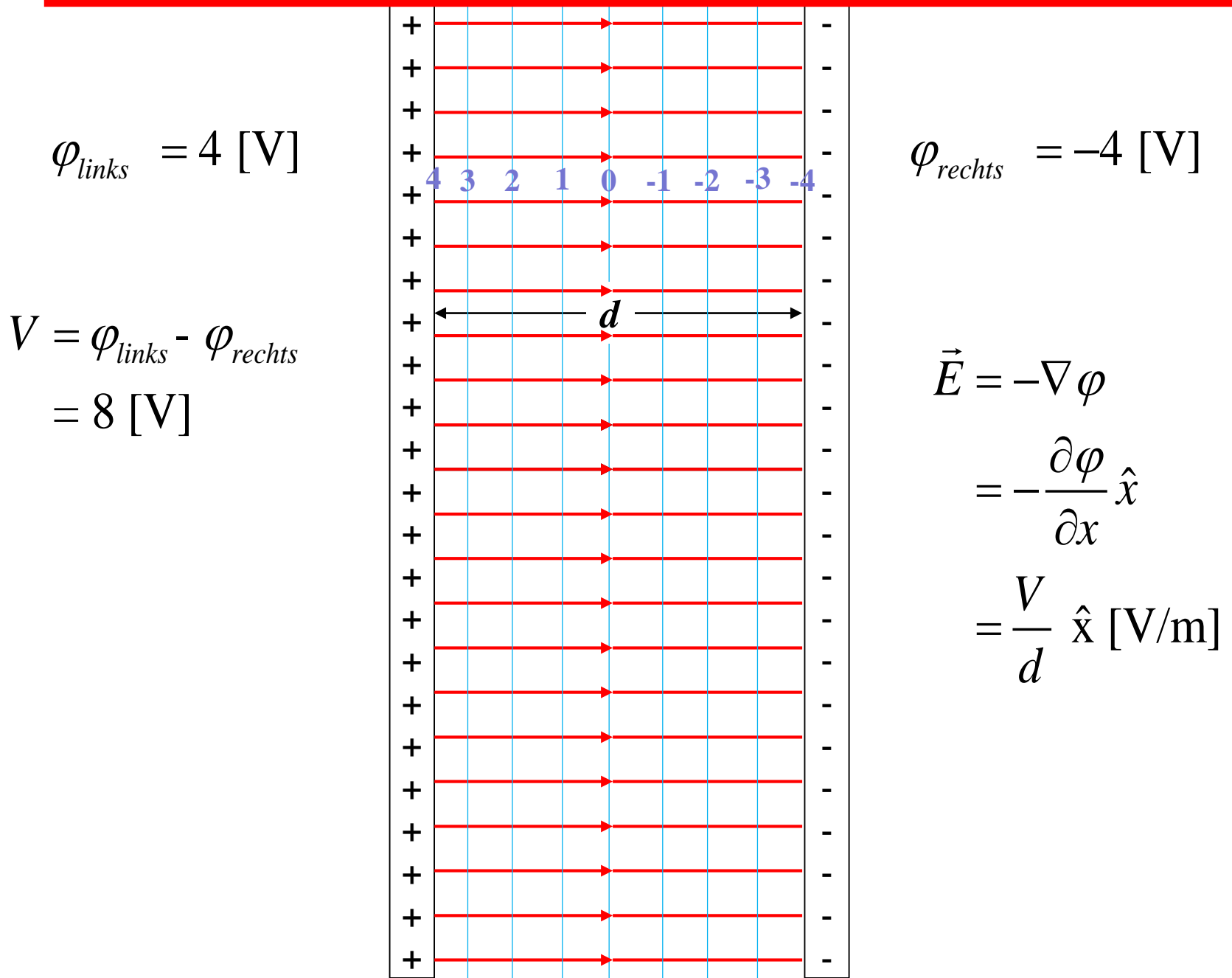
Elektrisches Feld \times Oberfläche = $\frac{q}{4\pi\epsilon_0 r^2} \times 4\pi r^2 = \frac{q}{\epsilon_0}$

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

Gaußsches Gesetz



parallelen Platten



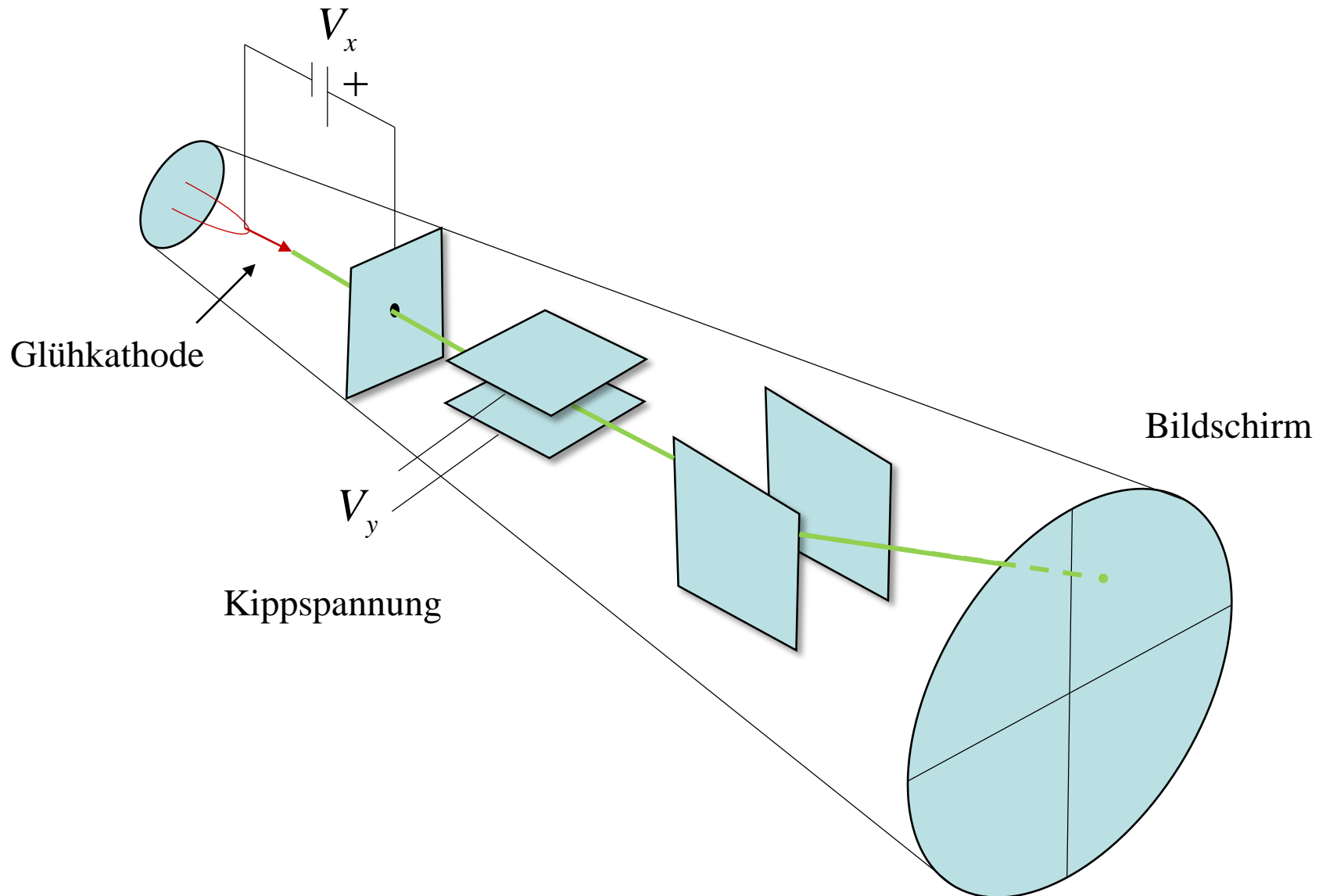
$$\varphi_{links} = 4 \text{ [V]}$$

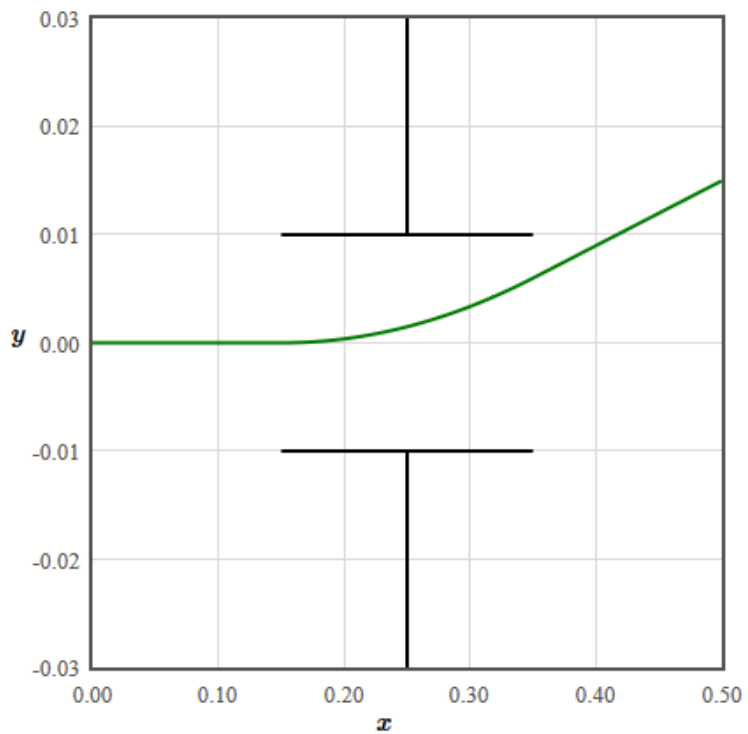
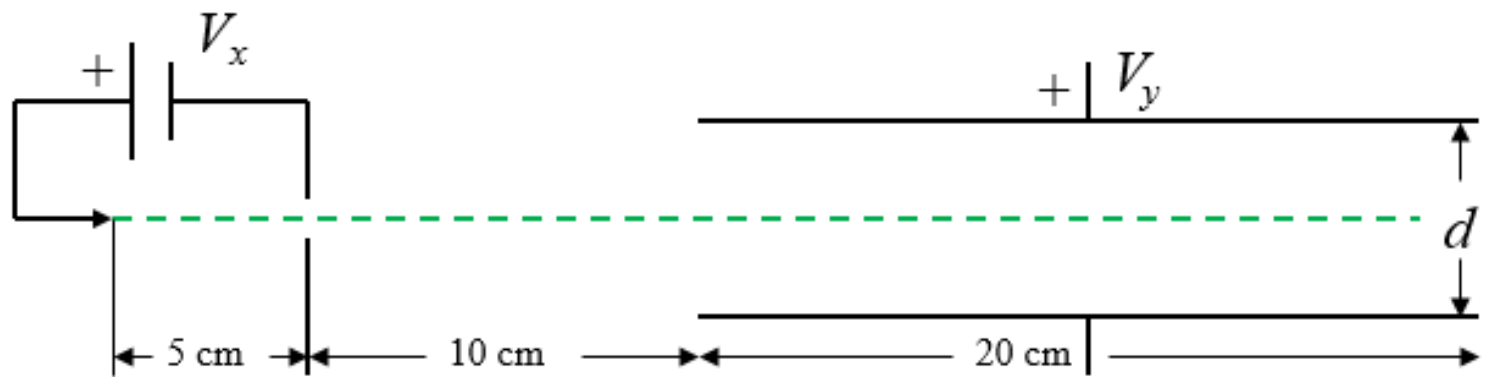
$$\varphi_{rechts} = -4 \text{ [V]}$$

$$V = \varphi_{links} - \varphi_{rechts} = 8 \text{ [V]}$$

$$\begin{aligned} \vec{E} &= -\nabla\varphi \\ &= -\frac{\partial\varphi}{\partial x}\hat{x} \\ &= \frac{V}{d}\hat{x} \text{ [V/m]} \end{aligned}$$

Elektronenstrahl



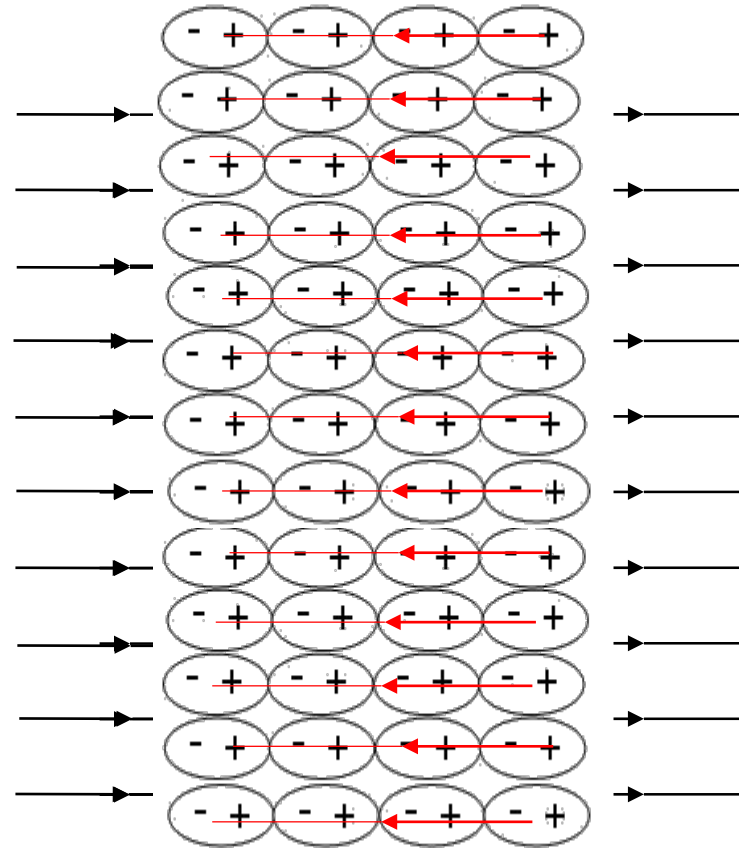


$V_x = 5000$ [V]
 $V_y = 60$ [V]
 $d = 0.02$ [m]

Dielektrikum

$$\epsilon_r = \frac{E_{vacuum}}{E_{dielekt}} = \frac{E_{vacuum}}{E_{dielekt}}$$

relative Dielektrizitätszahl



Nichtleiter (Isolator)

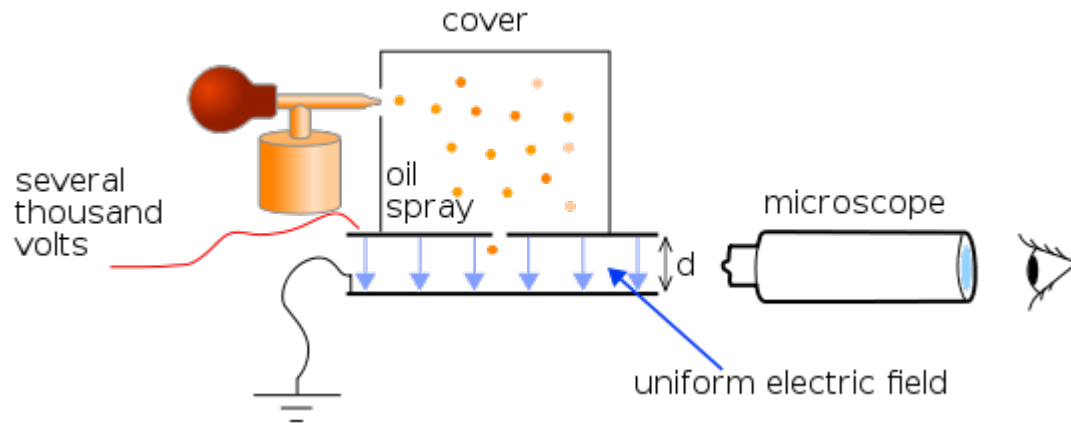
Elektrostatik

The diagram illustrates the relationships between electrostatic quantities:

- ρ (charge density) is related to \vec{E} (electric field) via the integral equation:
$$\vec{E}(\vec{r}) = \frac{1}{4\pi\epsilon_r\epsilon_0} \int \frac{\rho(\vec{r}')}{|\vec{r} - \vec{r}'|^3} (\vec{r} - \vec{r}') d^3 r'$$
- ρ is related to \vec{E} via the divergence equation:
$$\nabla \cdot \vec{E} = \frac{\rho}{\epsilon_r\epsilon_0}$$
- \vec{E} is related to φ (potential) via the line integral equation:
$$\varphi = -\int \vec{E} \cdot d\vec{r} + \varphi_0$$
- \vec{E} is related to φ via the gradient equation:
$$\vec{E} = -\nabla \varphi$$

Arrows indicate the direction of derivation: $\rho \rightarrow \vec{E}$ (top-left), $\rho \rightarrow \nabla \cdot \vec{E}$ (top-right), $\vec{E} \rightarrow \varphi$ (bottom-left), and $\vec{E} \rightarrow \vec{E} = -\nabla \varphi$ (bottom-right).

Millikan-Versuch



Brownian Motion

Display Charge

Display Radius

$E = 0 \frac{\text{V}}{\text{m}}$

Change electric field

$t = 7.58 \text{ s}$