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A Very Accurate Test of Coulomb's Law of Force Between Charges

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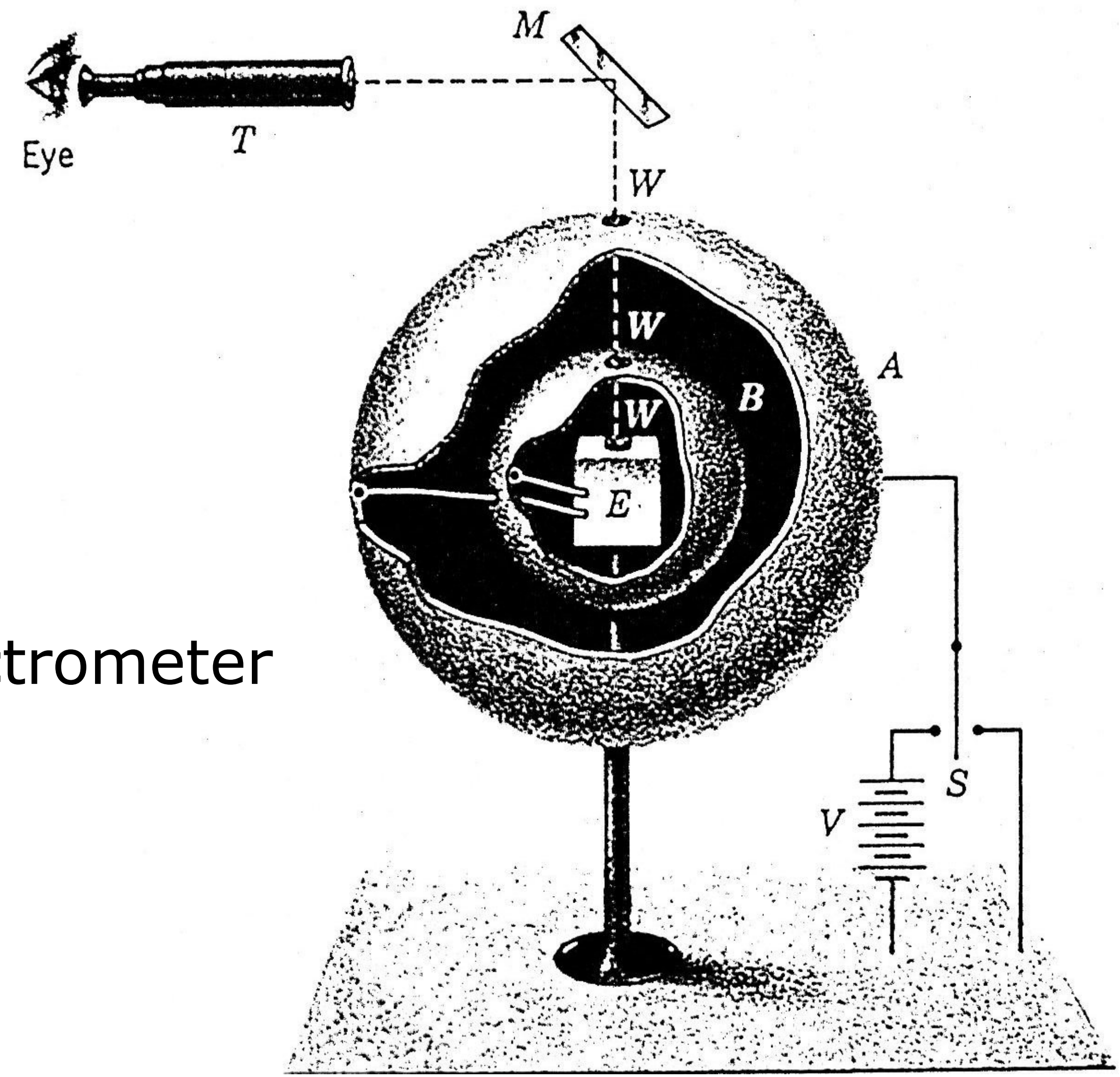


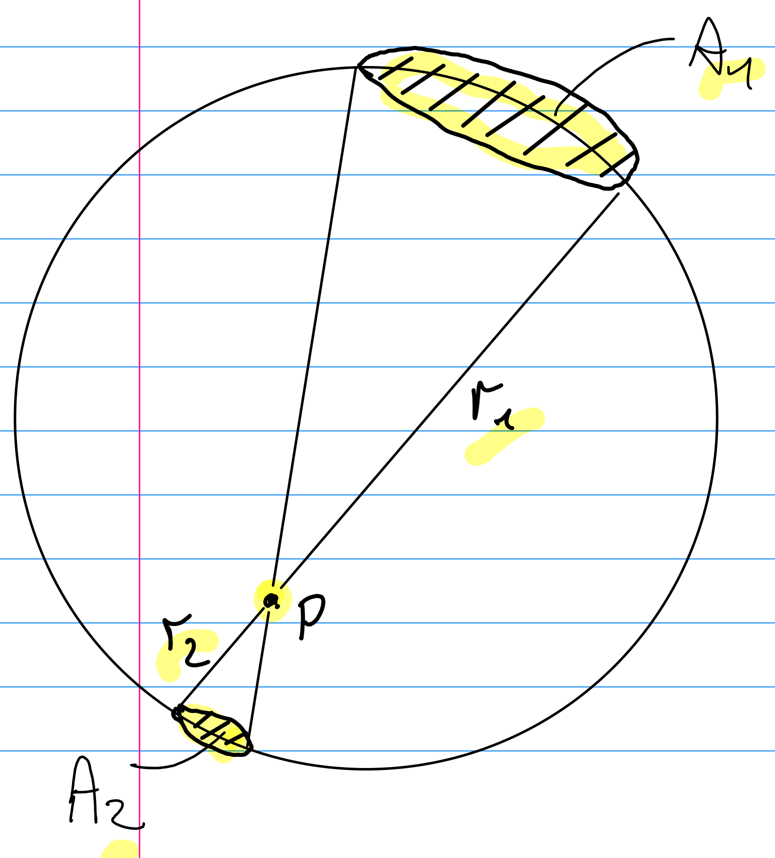
E)lectrometer

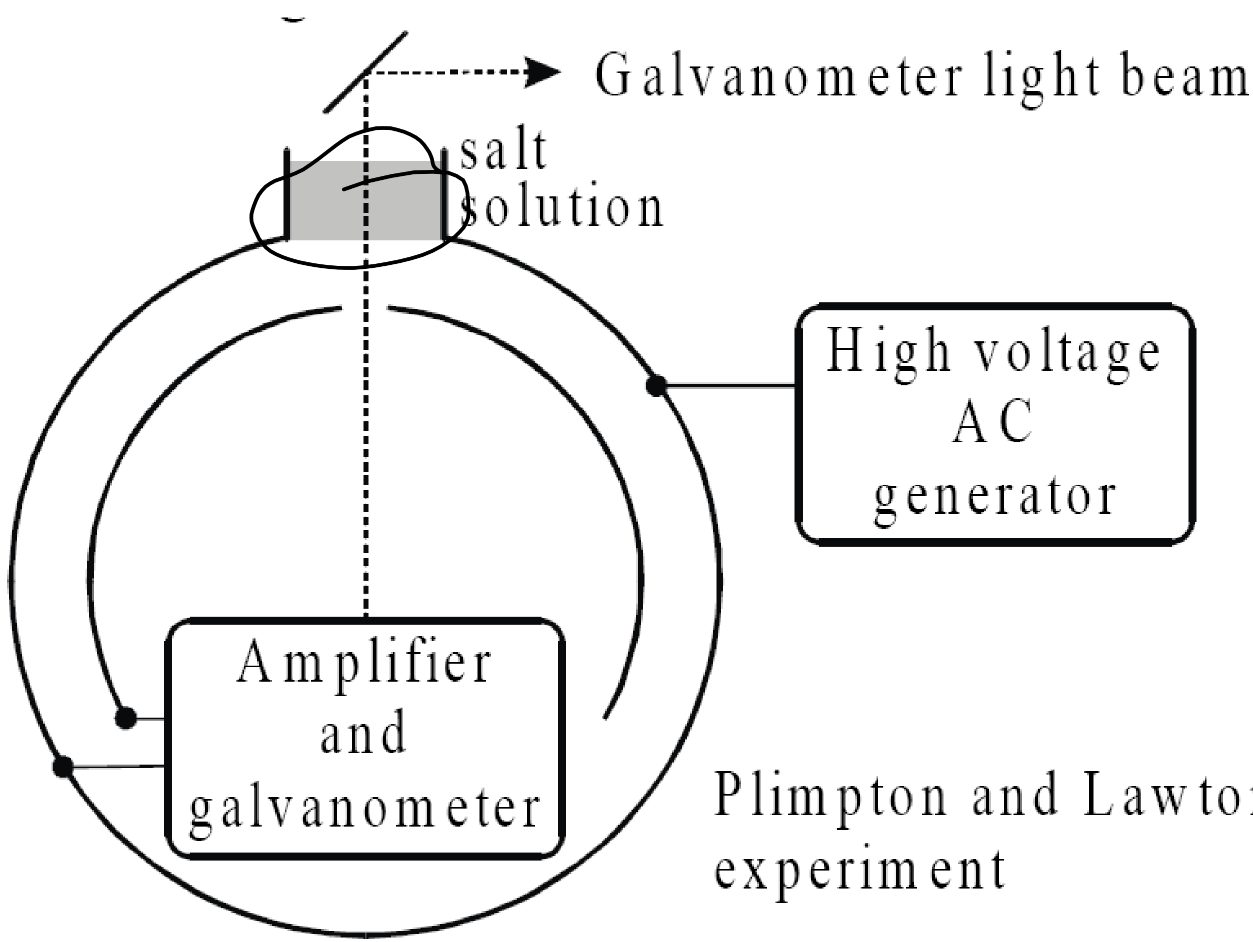
$$\frac{A_2}{A_1} = \frac{r_2^2}{r_1^2} \qquad \frac{q_2}{q_1} = \frac{A_2}{A_1}$$

$$\frac{|E_2|}{|E_1|} = \frac{|q_2| / r_2^{2+\varepsilon}}{|q_1| / r_1^{2+\varepsilon}} \overset{\varepsilon = 0}{\underset{\downarrow}{=}} 1$$

$\varepsilon \neq 0 \quad |E_2| \neq |E_1|$

$\Rightarrow E(P) \neq 0$





Plimpton and Lawton's experiment

In this method the detector was employed as a *resonance electrometer*. The high voltage was applied to the outer globe as a smooth sinusoidal wave of very low frequency, so as to build up a resonant vibration of the galvanometer. This

Elektrostatik im Alltagsleben

- Graphit im Reifen
- Farbspritzen auf Körperrückseite
- Partikelfilter
- Xerographie

- Moleküle ausrichten in Kontakten

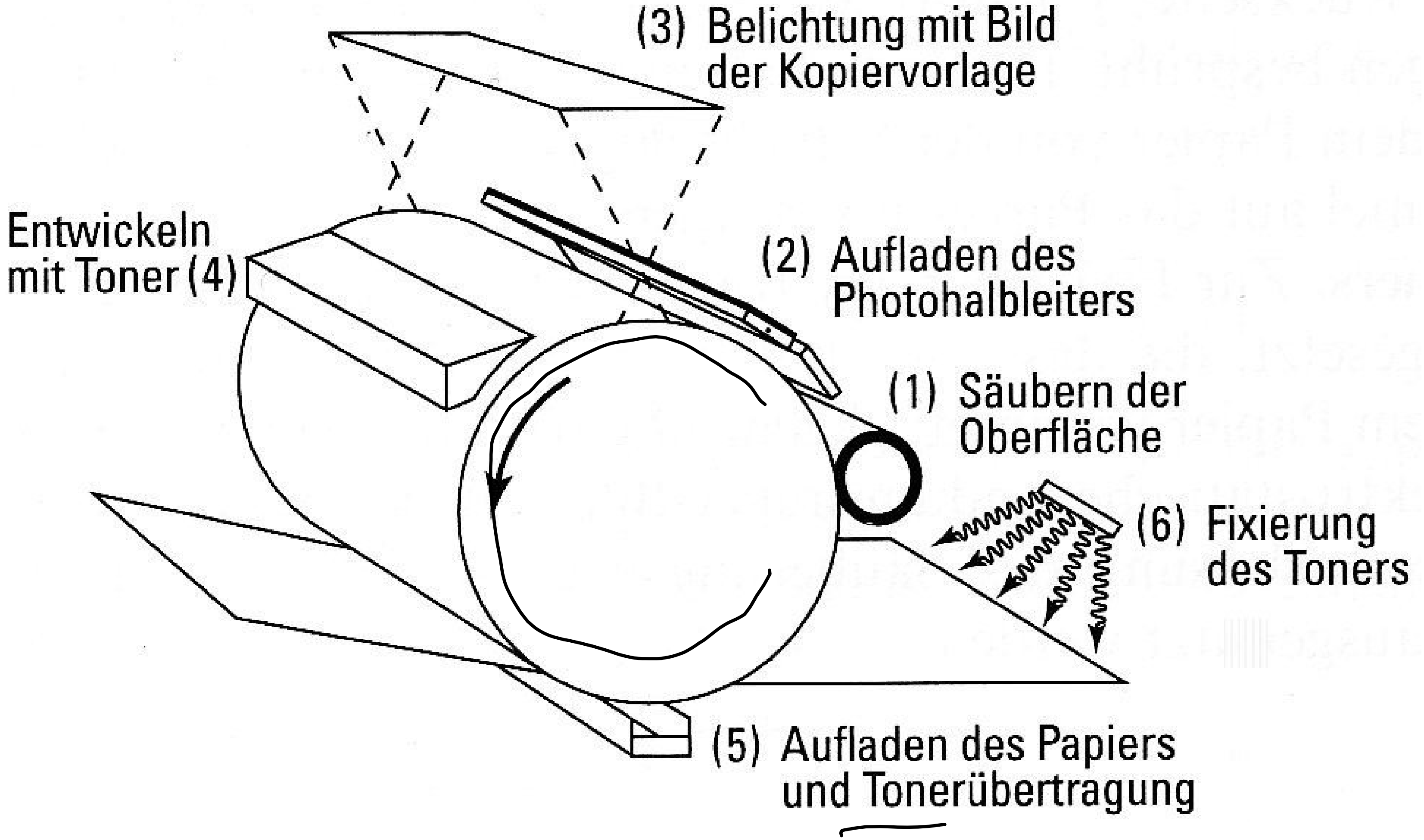
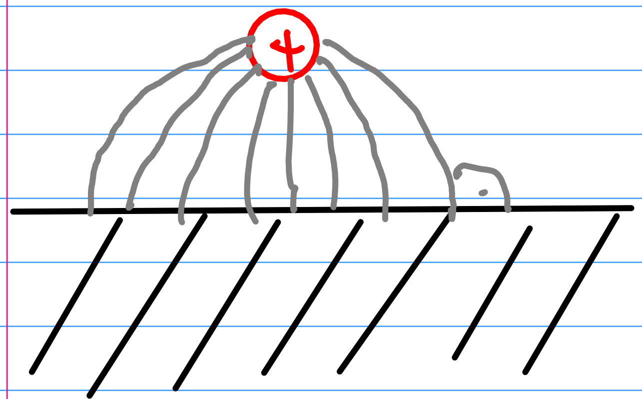
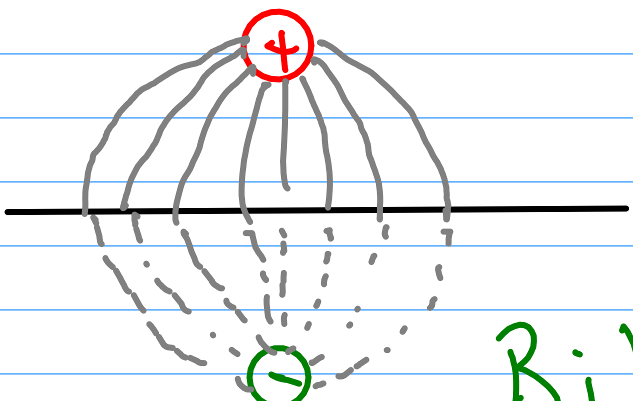


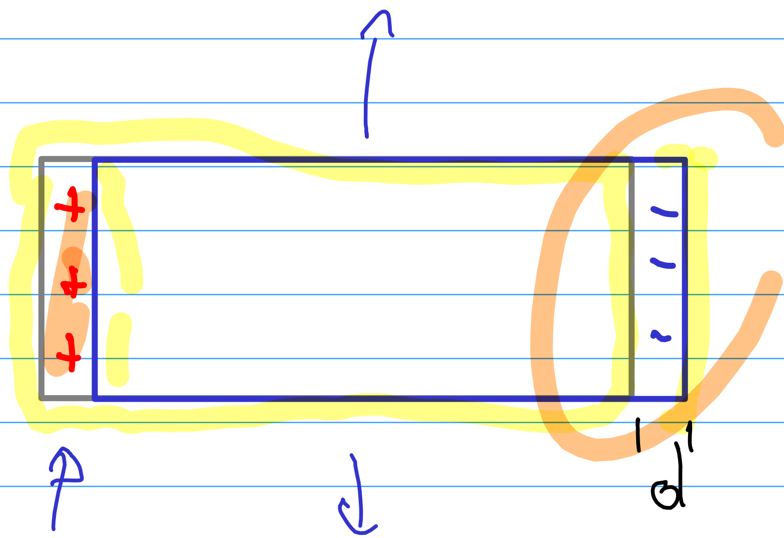
Abb. 2.54 Die verschiedenen Schritte des Kopierverfahrens (schematisch): Die Trommeloberfläche trägt den Photohalbleiter, das Papier wird hier als Endlos-Band unten an der Trommel vorbeigeführt.





Bildladung

Wie schnell können Elektronen in einem Metall auf Wechselfeld reagieren?



$$E_x = \frac{n d e}{\varepsilon_0}$$

$$F = -e E_x = -\frac{n d e^2}{\varepsilon_0}$$

$$m_e \ddot{d} + \frac{n d e^2}{\varepsilon_0} = 0$$

$\sigma_+ = n d e$ $\qquad$ $\sigma_- = -n d e$

e^--Dichte

$$10\,\text{eV} \approx \hbar\omega_p \approx \sqrt{\frac{n e^2}{\varepsilon_0 m_e}}\,\hbar$$

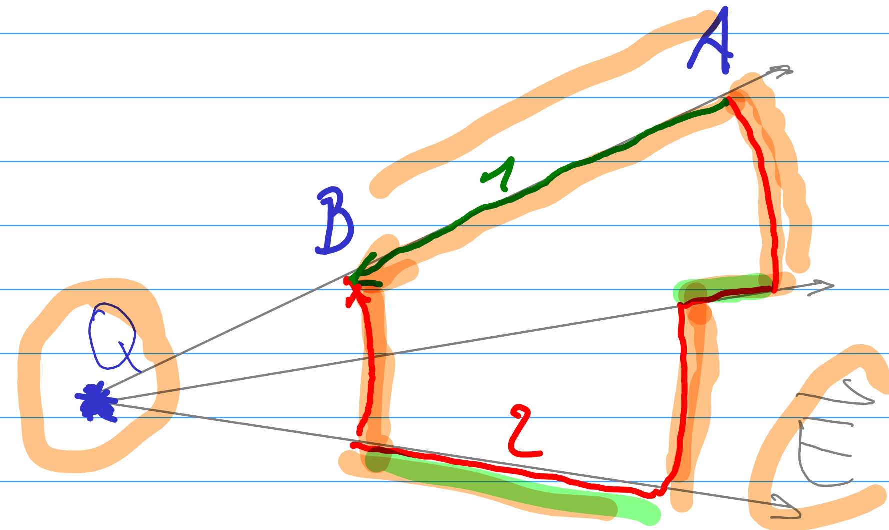
Elektrisches Potential $V(\vec{r})$

$\vec{E}(\vec{r}) \longrightarrow V(\vec{r})$

$$V_B - V_A = \frac{W_{AB}}{q_0}$$

$$= \frac{1}{q_0} \left(- \int_A^B \vec{F}(\vec{r})\, d\vec{r} \right)$$

$$\left(W = - \int \vec{F}\, d\vec{r} \right)$$



$W_1 = W_2$

$\oint \vec{E}\, d\vec{r} = 0$

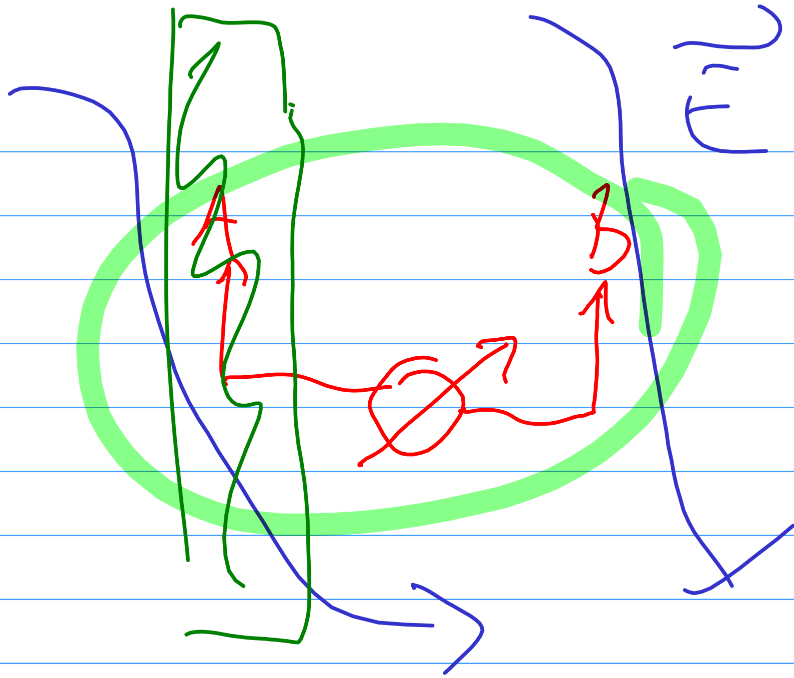
Punktladung: wähle $A \to \infty$

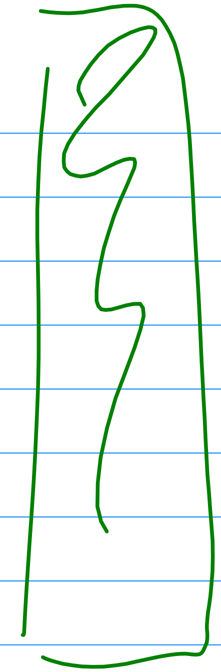
$$V(A) = V(\infty) = 0$$

$$V(r) = -\frac{1}{4\pi\varepsilon_0} \int_{\infty}^{r} \frac{q\, q_0}{r'^2}\, dr' \frac{1}{q_0}$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{q}{r}$$

$$[V] = \frac{J}{C} = \text{Volt} \qquad [E] = \frac{N}{C} = \frac{V}{m}$$





Äqui-potential-linien

Lad.-dichte

$$V = \sum_i \frac{1}{4\pi\varepsilon_0} \frac{q_i}{r_i} \longrightarrow \frac{1}{4\pi\varepsilon_0} \int \frac{\rho}{r}\, dV$$

Potentialdifferenz = Spannung

Potential eines Atomkerns : Au

$V = \frac{1}{4\pi\varepsilon_0} \frac{q}{r}$; $q = 79e$; $r = 6{,}9\ \text{fm}$

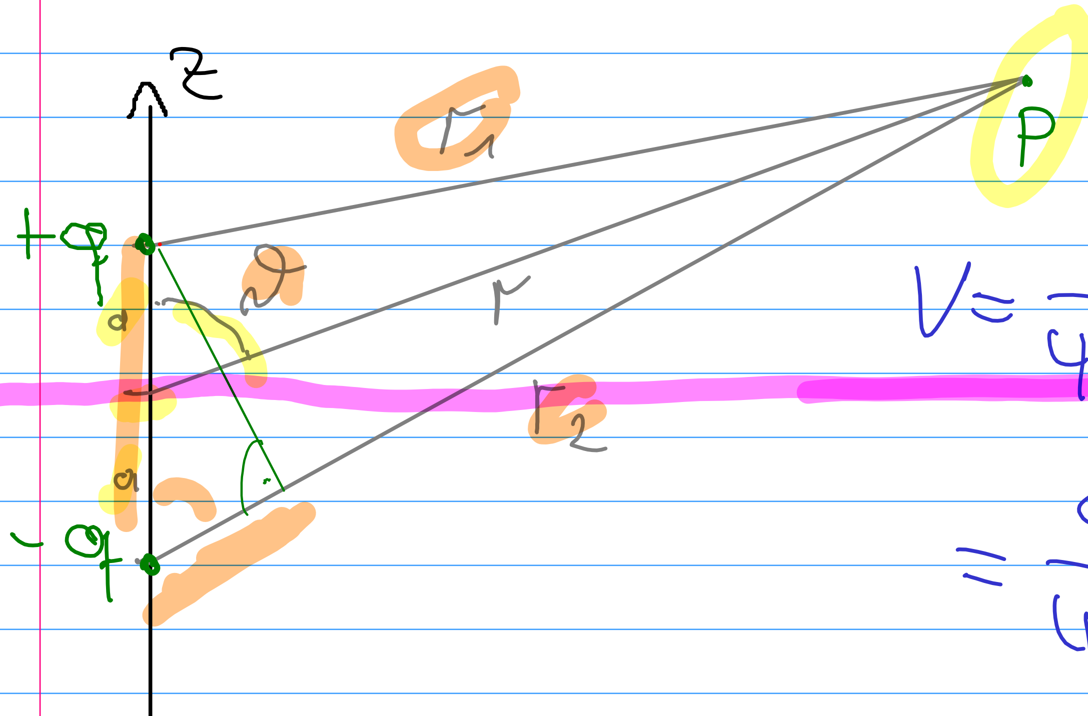
10^{-15}

$V = 1{,}7 \cdot 10^{7}\ V = 17\ MV$

$He^{++} \hat{=} 2e \Rightarrow W = 34\ MeV$

(Rückstoß ignoriert)

Elektrisches Dipolpotential



$$V=\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r_1}-\frac{q}{r_2}\right)$$

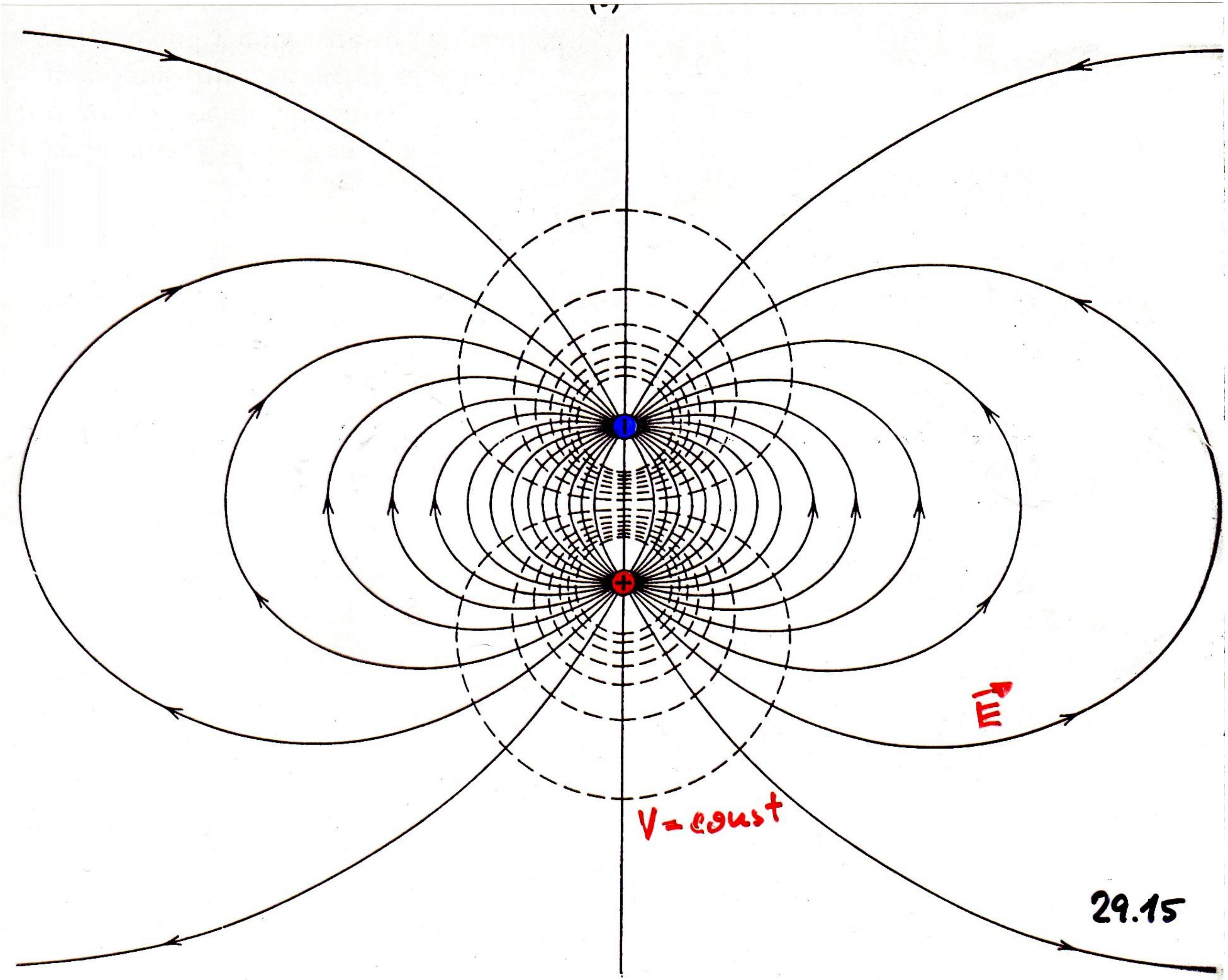
$$=\frac{q}{4\pi\varepsilon_0}\,\frac{r_2-r_1}{r_1\cdot r_2}$$

Sei $r \gg a \Rightarrow r_2-r_1 \approx 2a\cos\vartheta$

$$r_1\cdot r_2 \approx r^2$$

$$V=\frac{q}{4\pi\varepsilon_0}\,\frac{2a\cos\vartheta}{r^2}=\frac{1}{4\pi\varepsilon_0}\,\frac{p\cos\vartheta}{r^2}=\frac{\vec{p}\,\vec{r}}{r^3}\,\frac{1}{4\pi\varepsilon_0}$$

Dipol: Elektrisches Feld und Potential



$\vec{E}$ aus V ?

$$V = -\int_{\vec{r}_0}^{\vec{r}} \vec{E}(\vec{r}\,')\, d\vec{r}\,'$$

$$E_x = -\frac{\partial}{\partial x} V(x, y, z)$$

$$\vec{E} = -\left(\frac{\partial V}{\partial x}\vec{e}_x + \frac{\partial V}{\partial y}\vec{e}_y + \frac{\partial V}{\partial z}\vec{e}_z\right)$$

$$= -\vec{\nabla} V$$

Bsp: Punktladung

$$V(\vec{r}) = \frac{1}{4\pi\varepsilon_0}\frac{q}{r} = \frac{1}{4\pi\varepsilon_0} q \frac{1}{\sqrt{x^2+y^2+z^2}}$$

$$E_x = -\frac{\partial}{\partial x}(\,) = \frac{q}{4\pi\varepsilon_0}\frac{2x\cdot\frac{1}{2}}{\sqrt{x^2+y^2+z^2}^3}$$

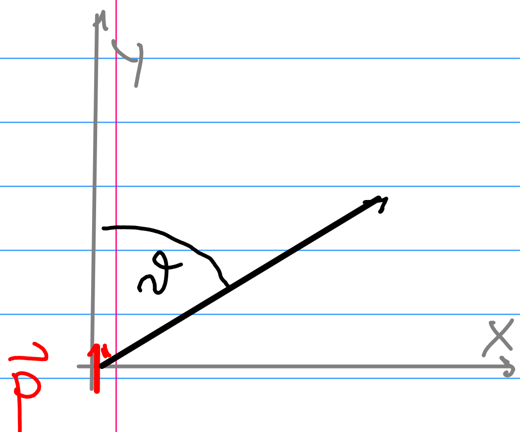
$$= \frac{q}{4\pi\varepsilon_0}\frac{x}{\sqrt{x^2+y^2+z^2}}\frac{1}{x^2+y^2+z^2}$$

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

$$\Rightarrow \vec{E} = \frac{q}{4\pi\varepsilon_0}\frac{1}{r^2}\vec{e_r}$$

Bsp. Dipol

$$V = \frac{1}{4\pi\varepsilon_0}\,\frac{p\cos\vartheta}{r^2}$$



$$r = \sqrt{x^2+y^2} \qquad \cos\vartheta = \frac{y}{\sqrt{x^2+y^2}}$$

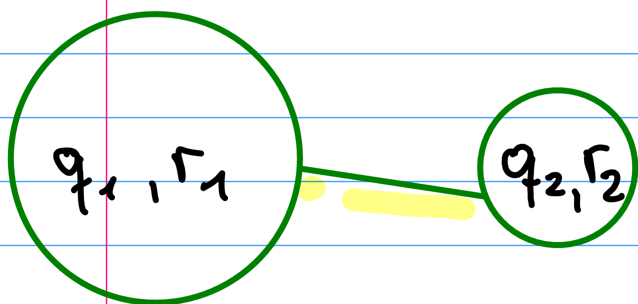
$$\Rightarrow V = \frac{p}{4\pi\varepsilon_0}\,\frac{y}{(x^2+y^2)^{3/2}}$$

$$E_y = -\frac{\partial V}{\partial y} = -\frac{p}{4\pi\varepsilon_0}\left(\frac{1}{(x^2+y^2)^{3/2}} - \frac{3}{2}\,2\,\frac{y^2}{(x^2+y^2)^{5/2}}\right)$$

$$= -\frac{p}{4\pi\varepsilon_0}\,\frac{(x^2+y^2)-3y^2}{(x^2+y^2)^{5/2}}$$

("Äquator" $y=0$: $E_y = -\dfrac{p}{4\pi\varepsilon_0}\,\dfrac{1}{x^3}$)

Spitzenwirkung



$$\frac{q_1}{r_1} = \frac{q_2}{r_2} \Rightarrow \frac{q_1}{q_2} = \frac{r_1}{r_2}$$

$$\frac{E_1}{E_2} = \frac{q_1/r_1^2}{q_2/r_2^2} = \frac{q_1}{q_2}\,\frac{r_2^2}{r_1^2} = \frac{r_2}{r_1} = \frac{E_1}{E_2}$$

$>$

Spitzenwirkung