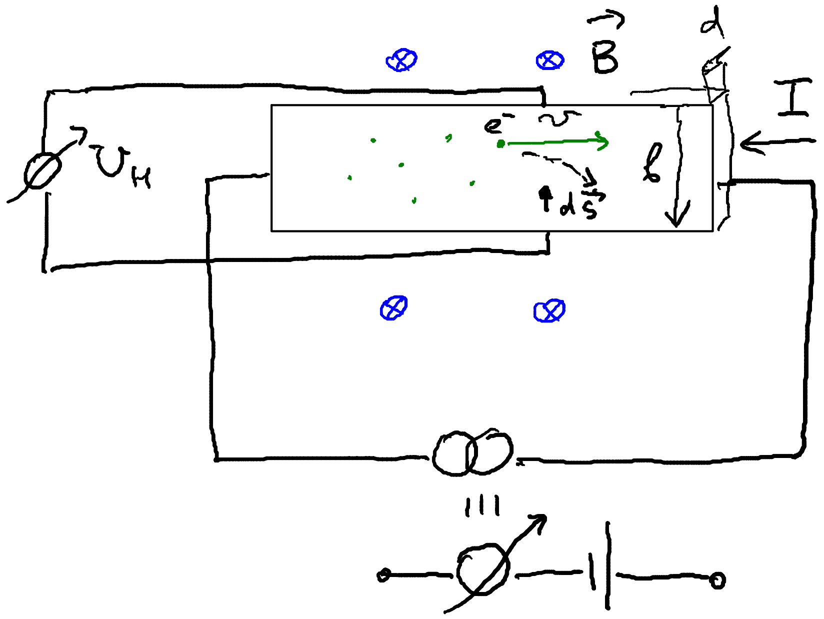
Hall-Effekt



$$\vec{F}_L = n \cdot q \cdot \left(\vec{v}_D \times \vec{B}\right)$$

$$\vec{F}_c = -F_L$$

$$\vec{F}_c = n \cdot q \cdot \underline{\underline{\vec{E}_H}}$$

$$U_H = \int \vec{E}_H \cdot d\vec{s} \quad ; \quad |\vec{U}_H| = |\vec{E}_H| \cdot b$$

Hall-Spannung

$$U_H = -\frac{(\vec{j} \times \vec{B}) \cdot \vec{b}}{n\, q}$$

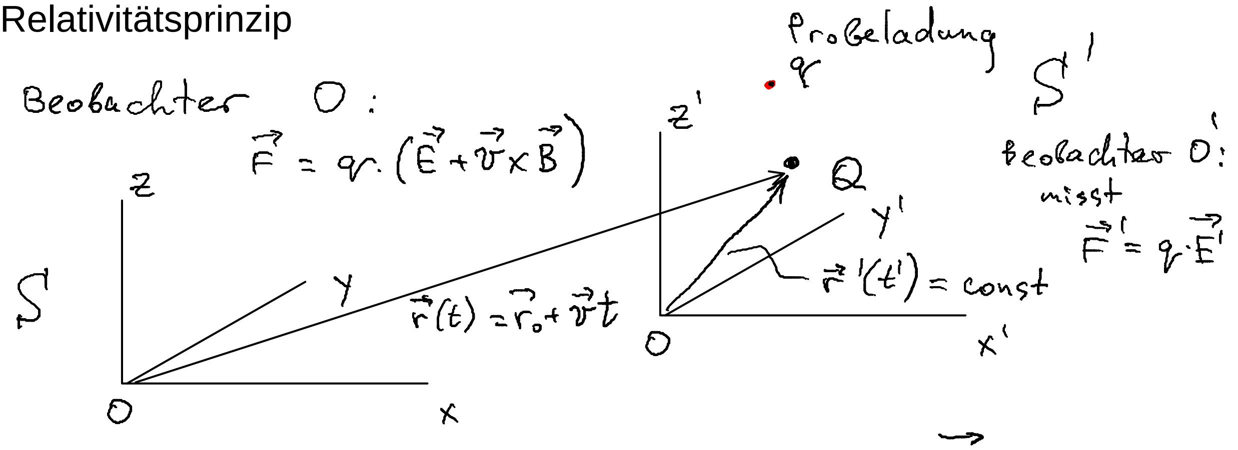
Metallen: $q = -e$

Halbleiter: $q = -e$ oder $q = +e$

$$I = j \cdot b \cdot d$$

$$U_H = -\frac{j\, B\, b}{n\, q} = -\frac{I \cdot B}{n\, q\, d}$$

Elektromagnetisches Feld und Relativitätsprinzip



$\vec{v} = \{v_x, 0, 0\}$ $\longrightarrow \vec{v}$

Strom $\vec{I} = Q \cdot \vec{v}$

Lorentz-Transformationen
(für Längen, Zeit, Geschwindigkeitenn und Kräfte)

$\underline{\underline{t=0}}$

$$\left.\begin{aligned} Q &\rightarrow \{0,0,0,0\} \\ q &\rightarrow \{x,y,z,0\} \end{aligned}\right\} \text{ in einem System } S$$

$$\left.\begin{aligned} Q &\rightarrow \{0,0,0,t'\} \\ q &\rightarrow \{x',y',z',t'\} \end{aligned}\right\} \text{ — " — System } S'$$

Längen
$$x' = \gamma(1 - v.t)$$
$$y' = y$$
$$z' = z$$

Zeit
$$t' = \gamma\left(t - \frac{v.x}{c^2}\right)$$

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}} \equiv \left(1 - \frac{v^2}{c^2}\right)^{-1/2}$$

Geschwid. $\vec{u}$
$$u'_x = \delta(u_x - v)$$
$$u'_y = \frac{\delta}{\gamma} u_y$$
$$u'_z = \frac{\delta}{\gamma} u_z$$

$$\delta = \frac{1}{1 - \frac{v.u_x}{c^2}} \equiv \left(1 - \frac{v.u_x}{c^2}\right)^{-1}$$

Kräfte $\underline{\underline{\vec{F} = \vec{F}'}}$
$$F'_x = \delta\left(F_x - \frac{v}{c^2}\vec{F}\cdot\vec{u}\right)$$
$$F'_y = \frac{\delta}{\gamma} F_y$$
$$F'_z = \frac{\delta}{\gamma} F_z$$

$$\Rightarrow \qquad F_y' = \frac{\delta}{\gamma} F_y$$

$$F_z' = \frac{\delta}{\gamma} F_z$$

$$\left.\begin{aligned} F_x &= \delta'\left(F_x' + \frac{v}{c^2}\vec{F}\cdot\vec{u}'\right) \\ F_y &= \frac{\gamma}{\delta'} F_y' \\ F_z &= \frac{\gamma}{\delta'} F_z' \end{aligned}\right\} \quad \delta' = \left(1 + \frac{v u_x'}{c^2}\right)^{-1}$$

$$t' = -\gamma v \frac{x}{c^2} \quad ; \quad r' = \left(x'^2 + y'^2 + z'^2\right)^{1/2}$$

Abstand zw. Q und q

$$\vec{F}' = \frac{qQ}{4\pi\varepsilon_0} \cdot \frac{\vec{r}'}{r'^3} \quad ; \quad \vec{u} = 0$$

$$\hookrightarrow u_x = 0$$

$$F_x = F_x' = \frac{qQ\,x'}{4\pi\varepsilon_0\, r'^3}$$

$$F_y = \gamma F_y' = \gamma \frac{qQ\cdot y'}{4\pi\varepsilon_0\, r'^3}$$

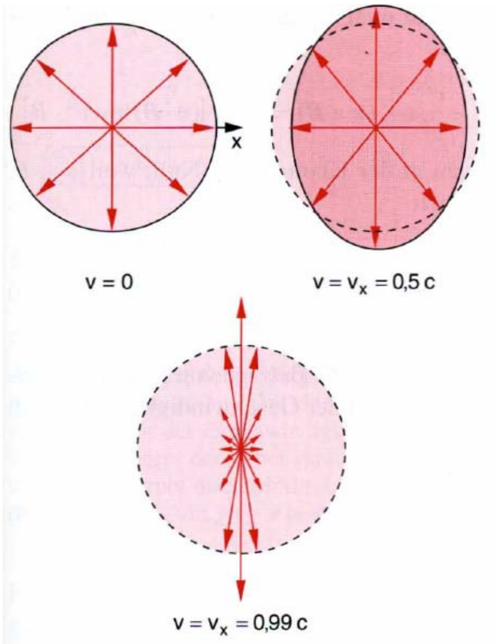
$$F_z = \gamma F_z' = \gamma \frac{qQ\,z'}{4\pi\varepsilon_0\, r'^3}$$

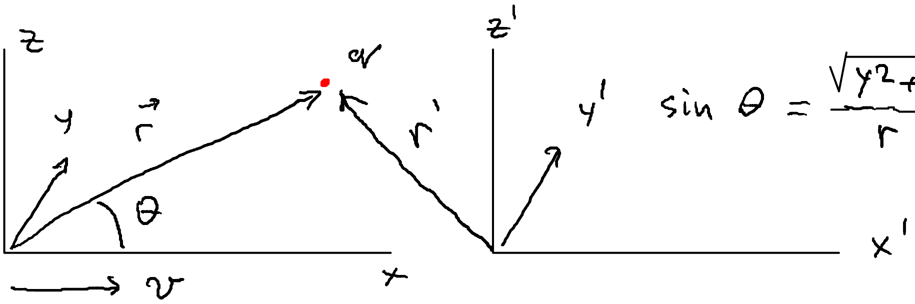
$t = 0$ gilt $\quad x' = \gamma x \; ; \; y' = y \; ; \; z' = z$

$$r' = \left(\gamma^2 x^2 + y^2 + z^2\right)^{1/2}$$

$$\vec{F}(\gamma, \vec{r}) = \frac{q\cdot Q}{4\pi\varepsilon_0} \cdot \frac{\gamma\,\vec{r}}{\left(\gamma^2 x^2 + y^2 + z^2\right)^{3/2}}$$

$$= q \cdot \vec{E}(\gamma, \vec{r})$$





$$\sin\theta = \frac{\sqrt{y^2+z^2}}{r} = \frac{\sqrt{r^2-x^2}}{r}$$

$$\vec{E} = \frac{Q}{4\pi\varepsilon_0} \cdot \frac{\gamma\,\vec{r}}{\left(\gamma^2 x^2 + y^2 + z^2\right)^{3/2}}$$

$$\vec{E} = \frac{Q\,\vec{r}}{4\pi\varepsilon_0} \cdot \frac{1}{\gamma^2\left(x^2 + \left(y^2+z^2\right)\cdot\gamma^{-2}\right)^{3/2}}$$

$$= \frac{Q\,\vec{r}}{4\pi\varepsilon_0} \cdot \frac{1 - v^2/c^2}{\left(\underbrace{x^2+y^2+z^2}_{r^2} + \left(1 - v^2/c^2\right)\left(y^2+z^2\right) - y^2 - z^2\right)^{3/2}}$$

$$= \frac{Q\,\vec{r}}{4\pi\varepsilon_0 r^3} \cdot \frac{1 - v^2/c^2}{\left[1 - v^2/c^2 \sin^2\theta\right]^{3/2}}$$