

Bild - 001

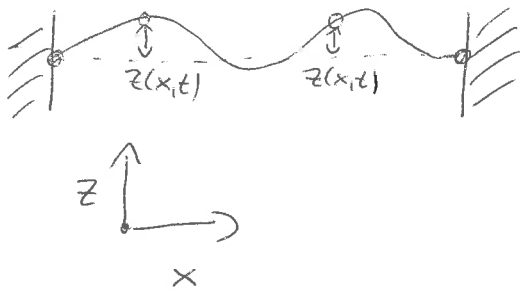


Bild - 002

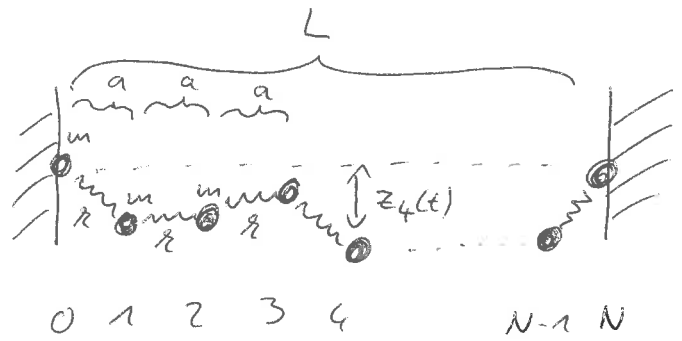


Bild - 003

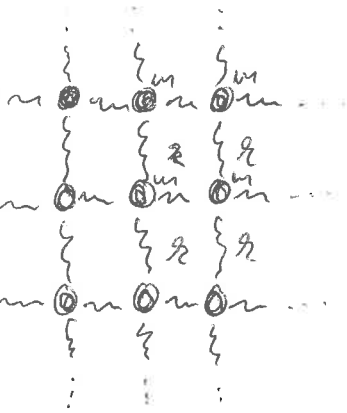
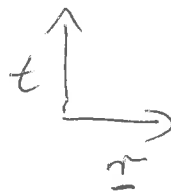


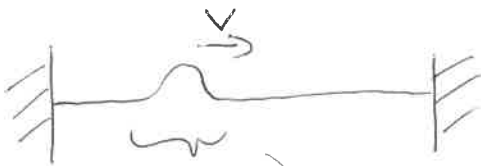
Bild - 004



Schwingungen
des em Felds
 \Rightarrow dort befinden
sich Photonen

Bild - 005

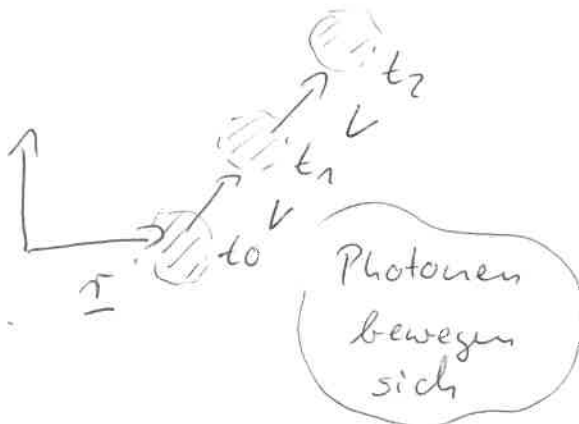
Saite:



ein "Teilchen" bewegt
sich mit v nach
rechts

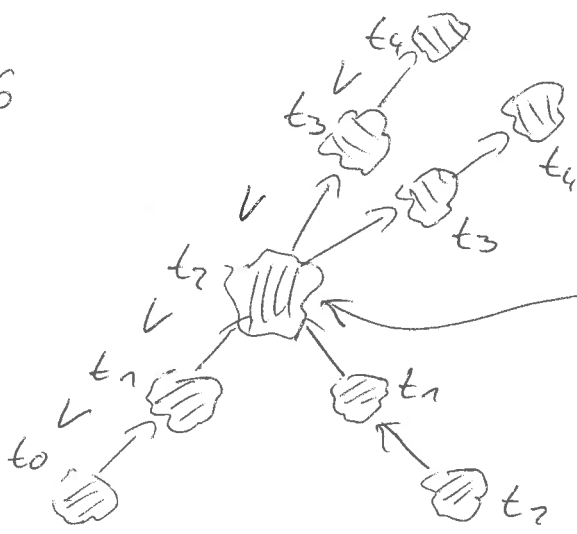
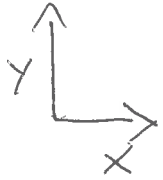
em Feld:

(analog z.B. t
Elektronen-Feld)



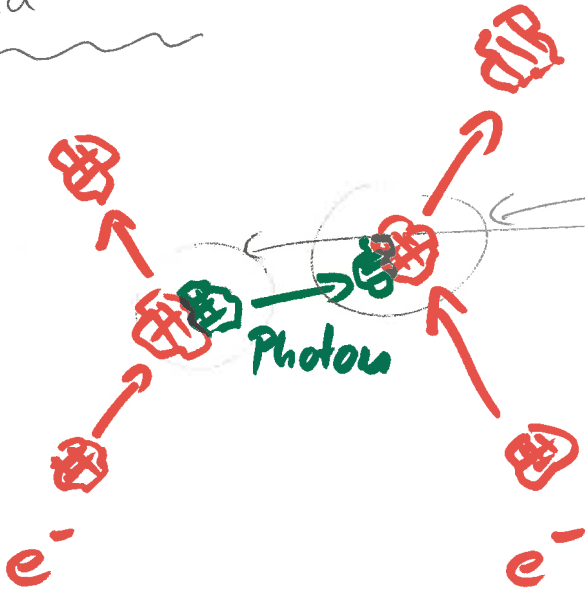
Photonen
bewegen
sich

Bild - 006



Streuung
gleichartiger
Teilchen

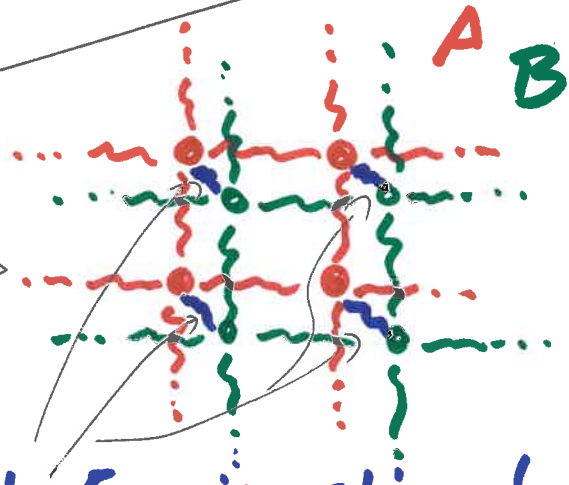
Bild - 007



Energie wird
von e^- -Feld auf
Photon-Feld übertragen
bzw. umgekehrt

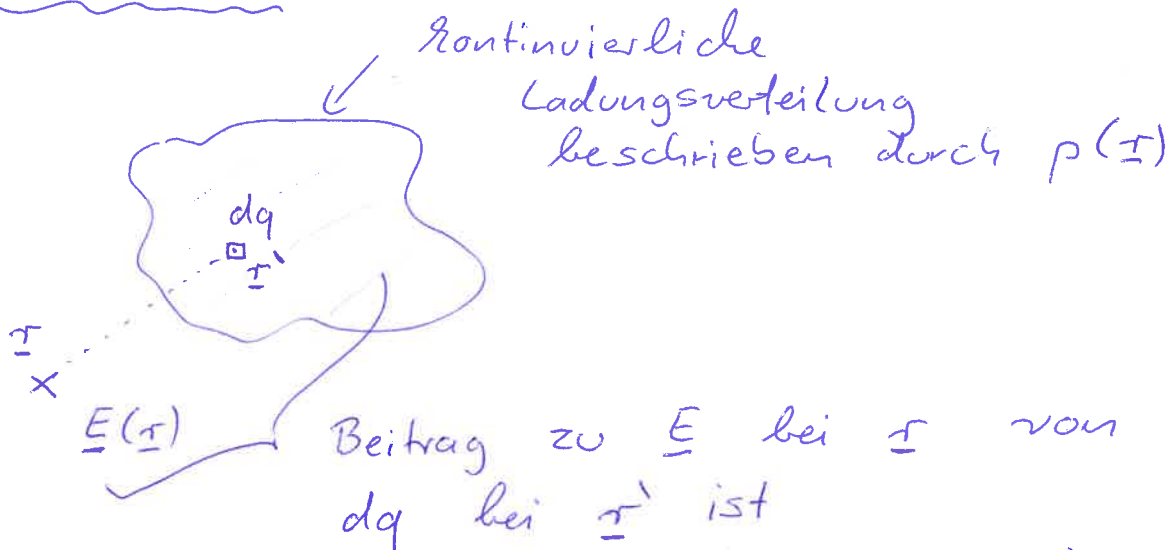
Kraftübertragung zwischen zwei
Elektronen via Photonaustausch

mechanisches
anschauliches
Bild:



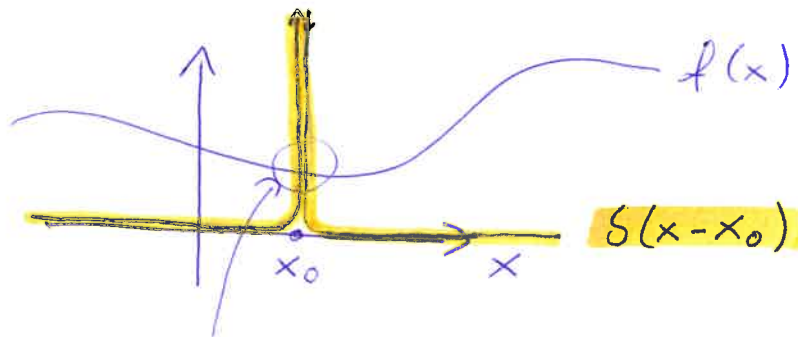
ermöglicht Energieaustausch
zwischen **Feld A** und **Feld B**

Bild - 008



$$d\underline{E}(\underline{r}) = \frac{dq}{|\underline{r} - \underline{r}'|^2} \frac{\underline{r} - \underline{r}'}{|\underline{r} - \underline{r}'|}$$

Bild - 009



Nur Funktionswert $f(x_0)$
bei Integral $\int_{-\infty}^{+\infty} dx \delta(x-x_0) f(x)$
von Bedeutung $= f(x_0)$

Bild - 010 (Gauß)

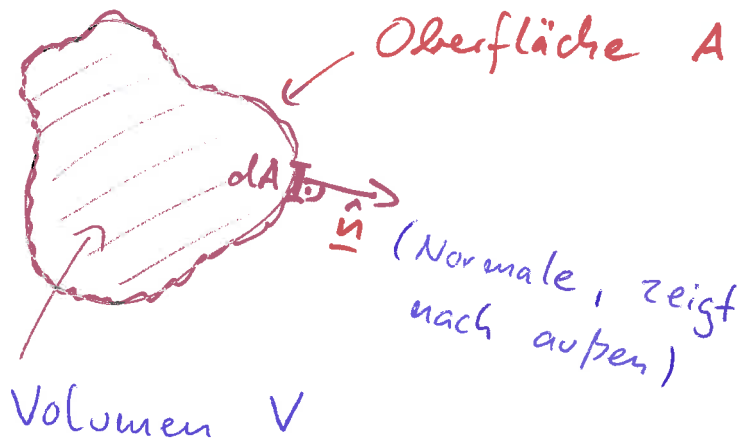
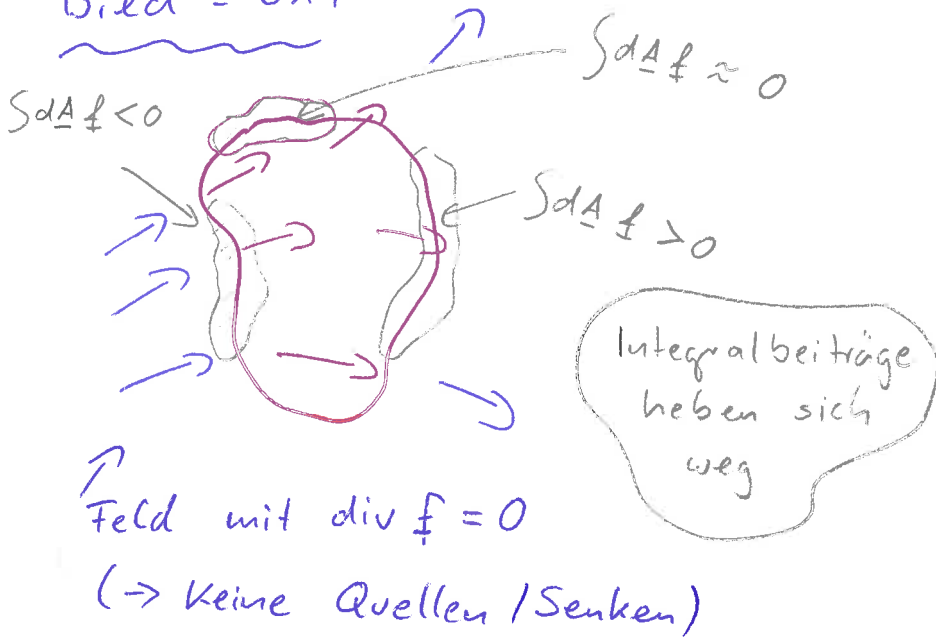
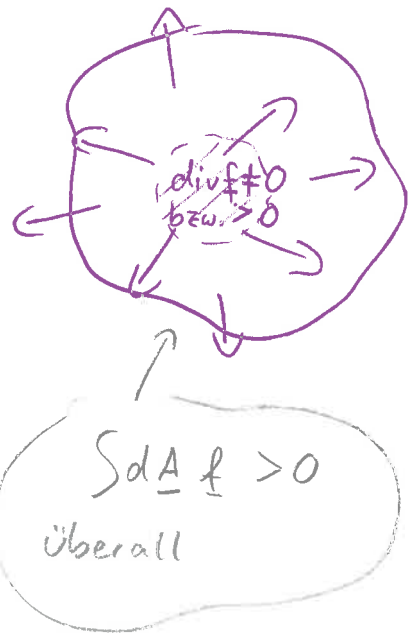


Bild - 011



$$\int_V dV \nabla \cdot \underline{f} = \oint_A dA \underline{f} = 0$$



$$\int_V dV \nabla \cdot \underline{f} = \oint_A dA \underline{f} > 0$$

Bild - 012

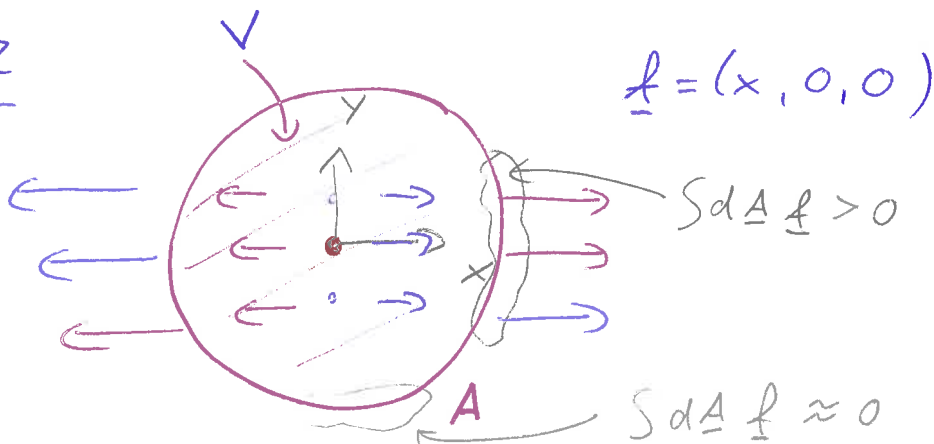
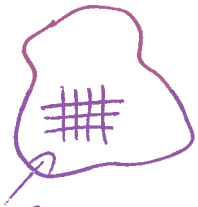
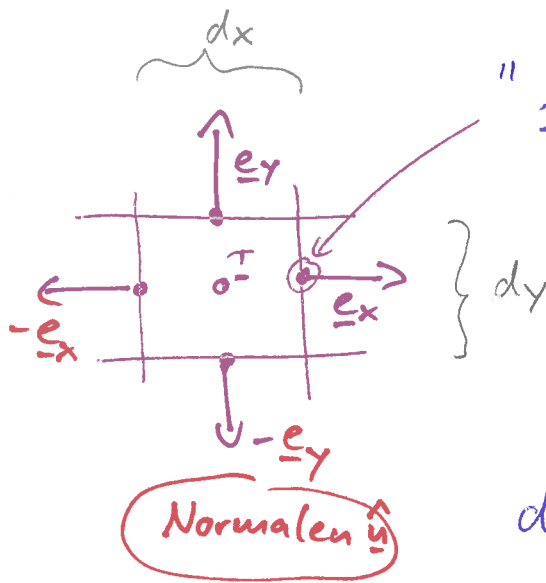


Bild - 013

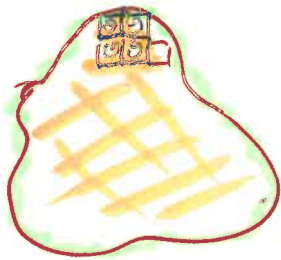


kleine Quadrate



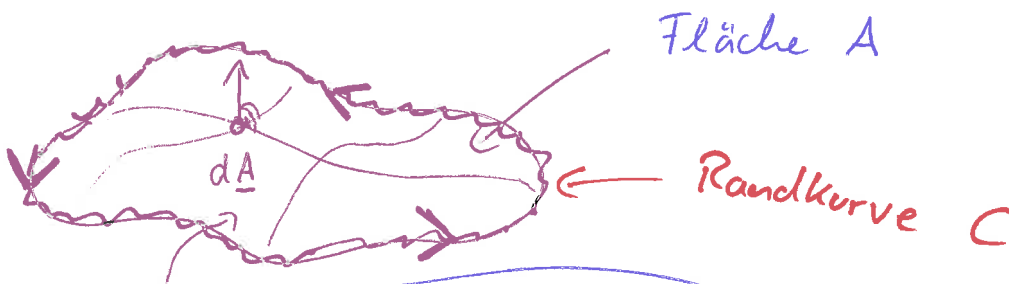
" $f(x + e_x \frac{dx}{2})$ " etc.

$$d\underline{A} = dx dy \hat{n}$$



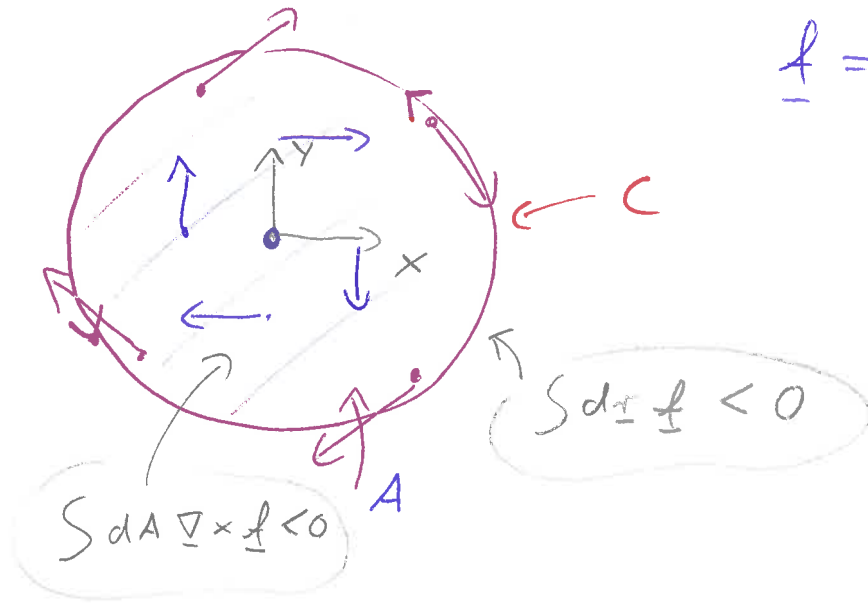
- infinitesimale innere Flächenstücke, treten doppelt mit entgegengesetzten Vorzeichen auf
- infinitesimale äußere Flächenstücke, treten einfach auf

Bild - 014 (Stokes)



Normale, Orientierung über Umlaufsinus der Randkurve und "Rechte-Hand-Regel"

Bild - 015



$$\underline{f} = (+y, -x, 0)$$

Bild - 016

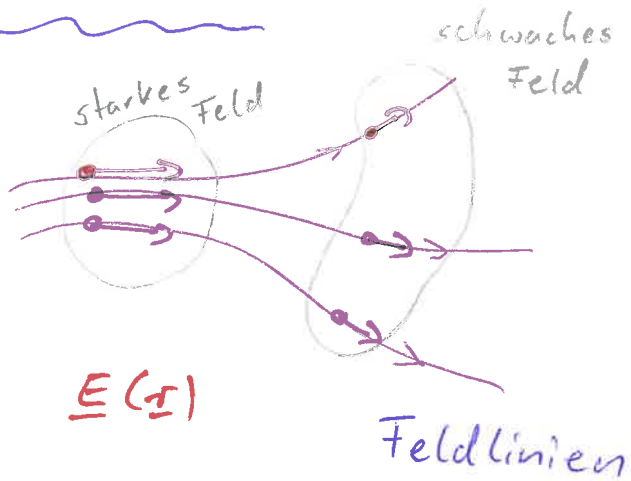


Bild - 017

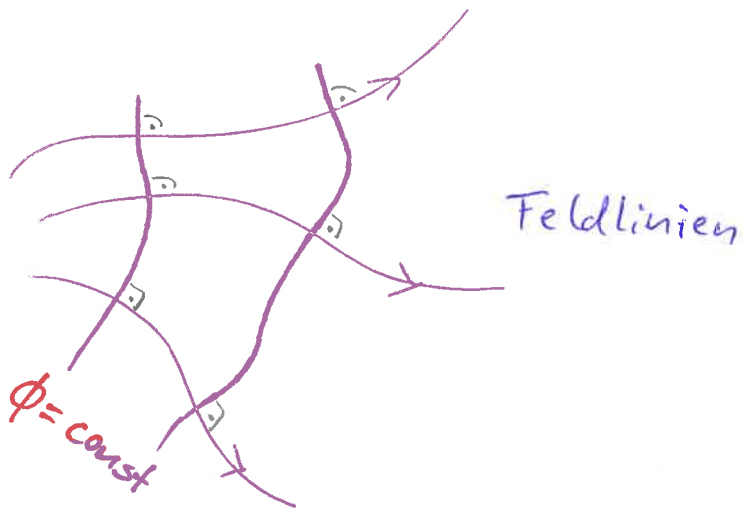


Bild - 019

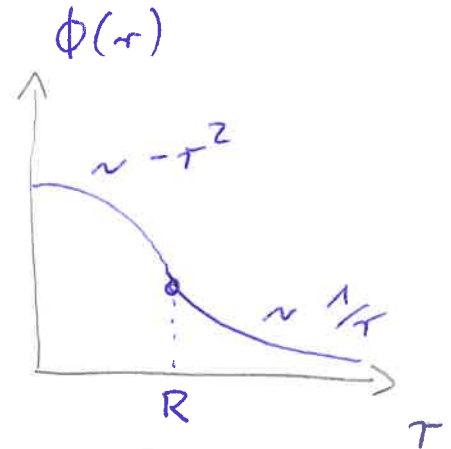
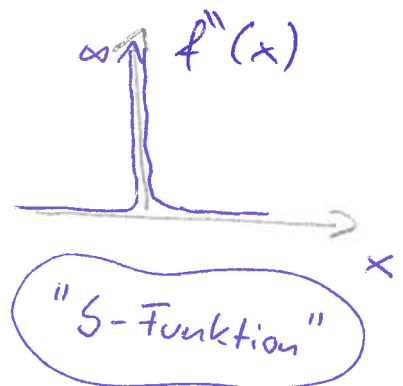
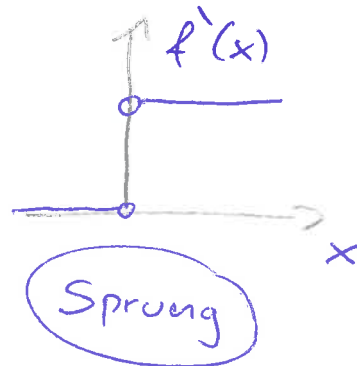
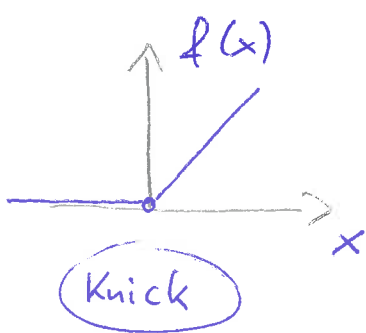


Bild - 018

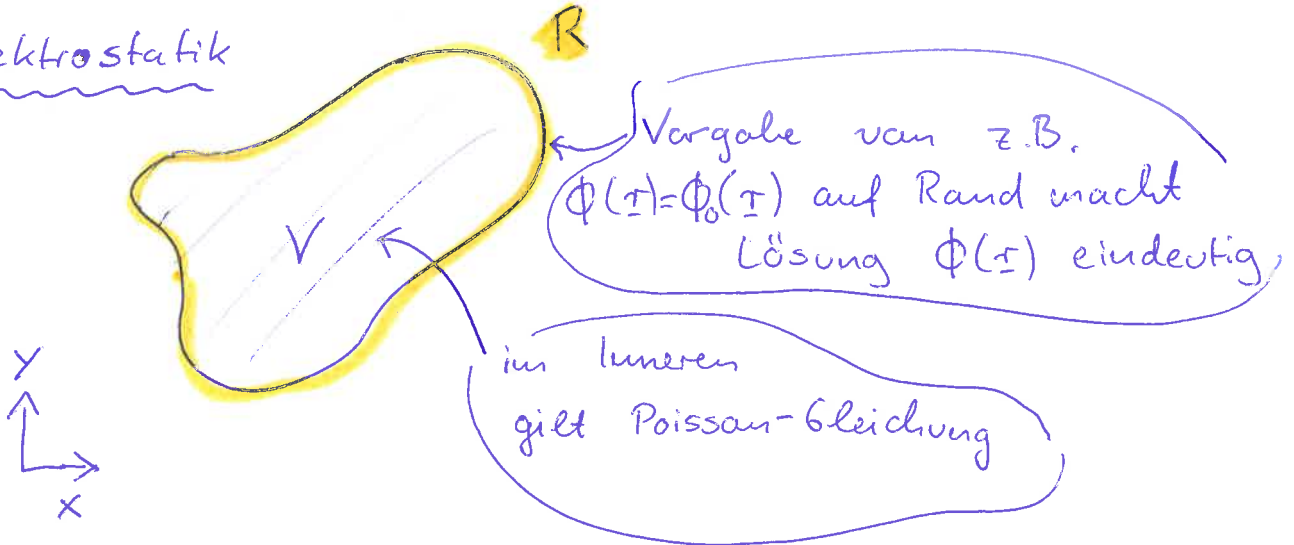


$$f(x) = \begin{cases} x & \text{falls } x > 0 \\ 0 & \text{" } x \leq 0 \end{cases} \Rightarrow f'(x) = \theta(x) \quad (\text{Heaviside-Funktion})$$

$$f''(x) = \delta(x) \quad (\delta\text{-Funktion})$$

Bild - 020

Elektrostatik



Mechanik

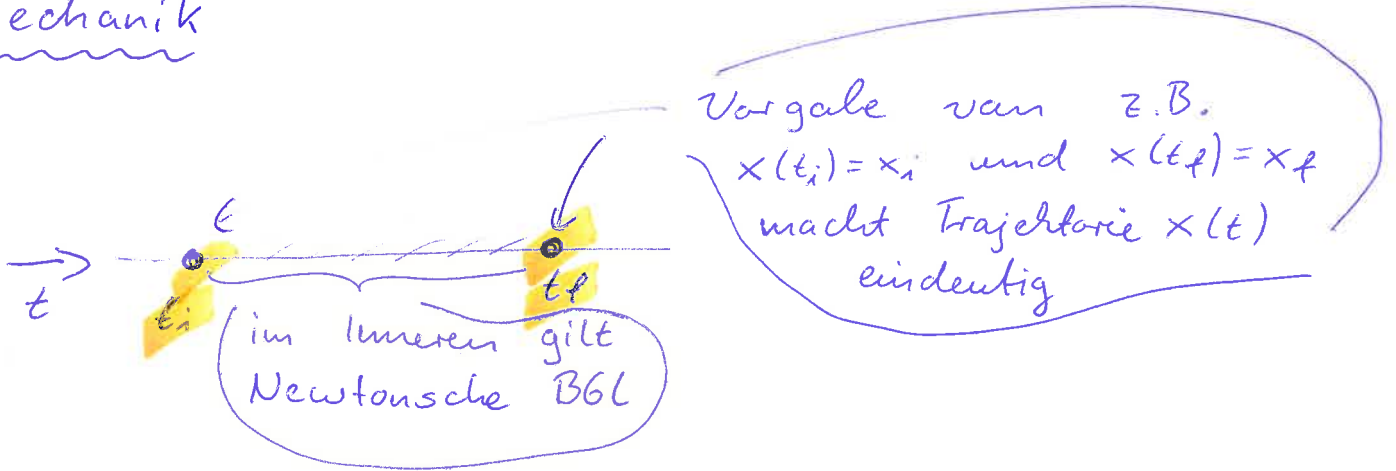


Bild - 021

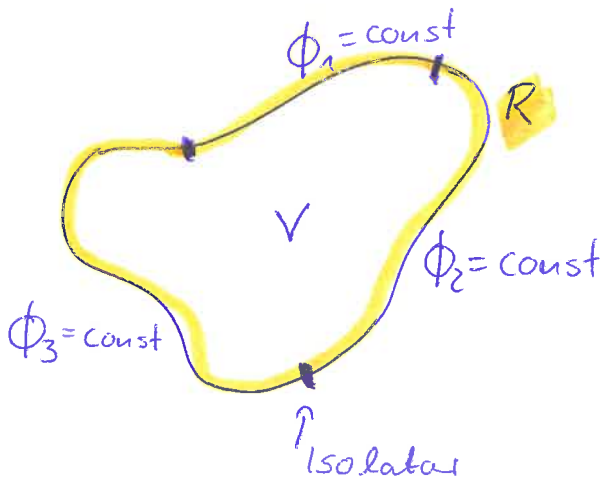


Bild - 022

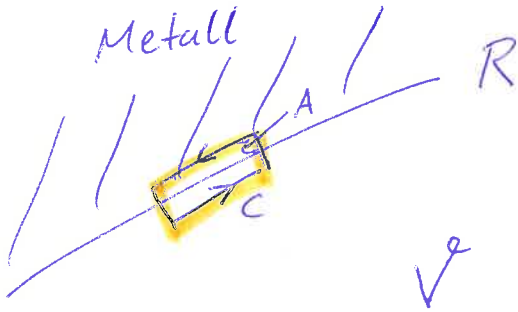


Bild - 023

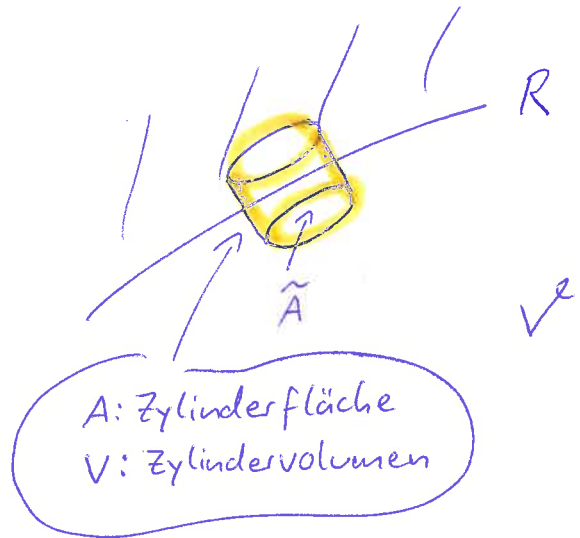


Bild - 024

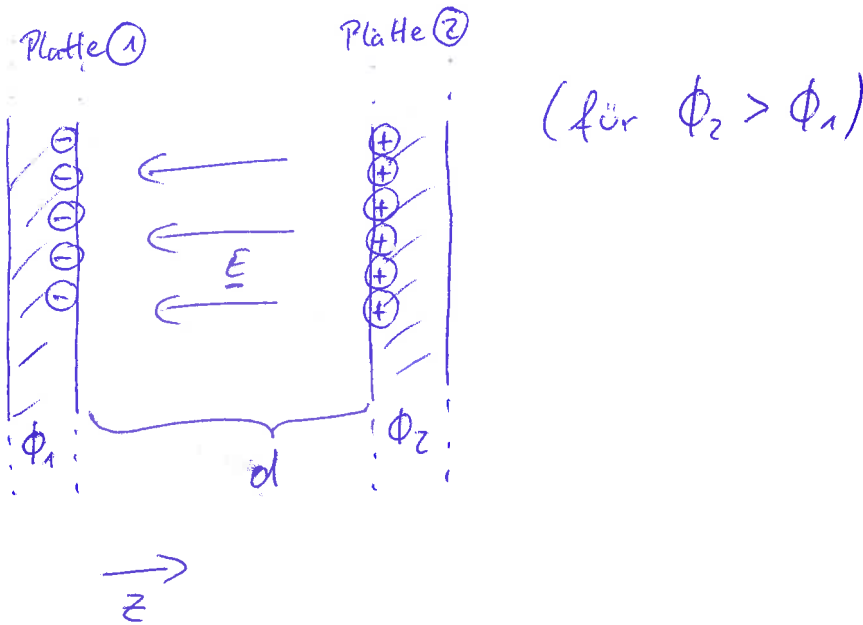


Bild - 025

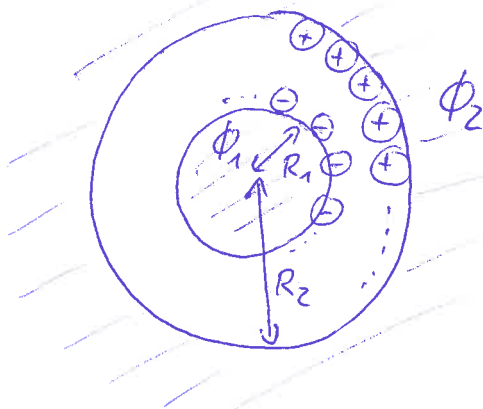


Bild - 026

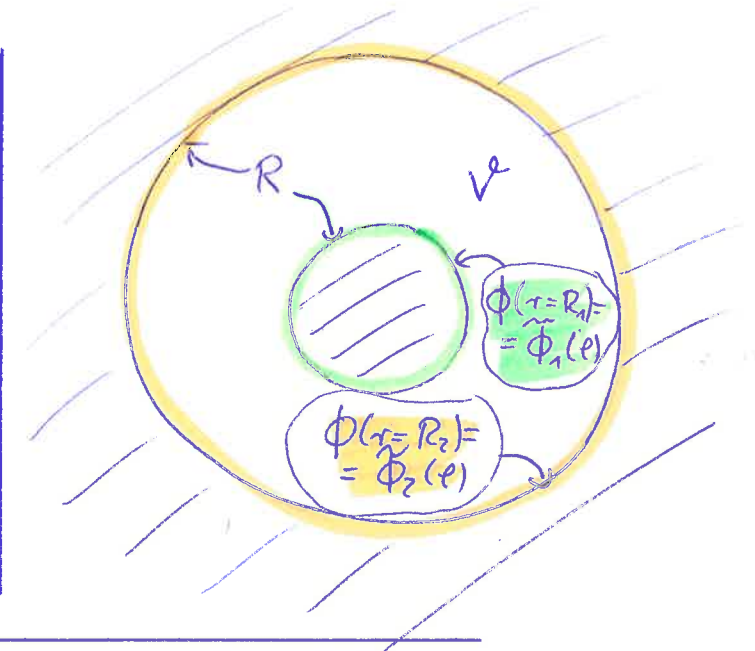
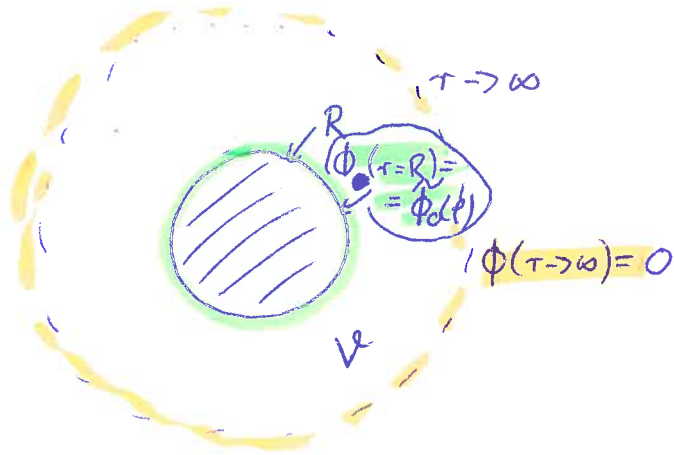


Bild - 027

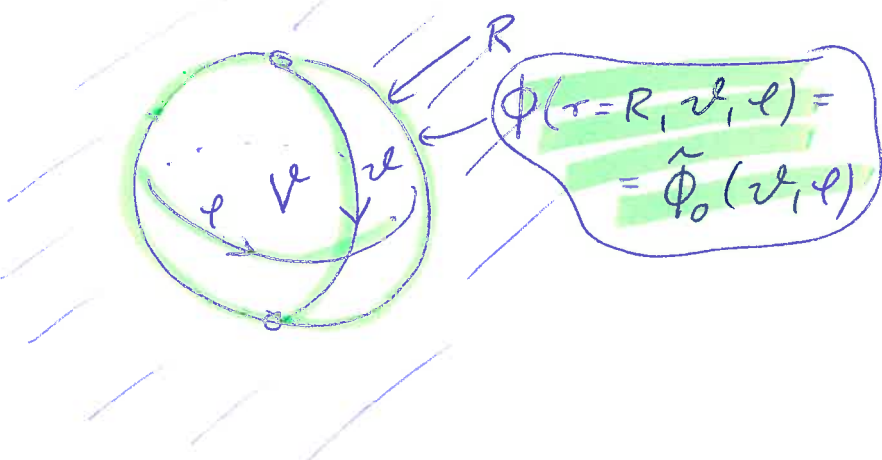
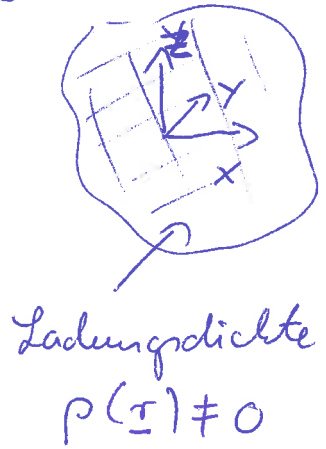
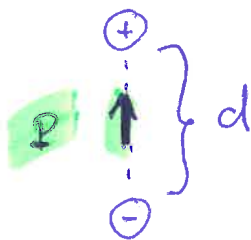


Bild - 028



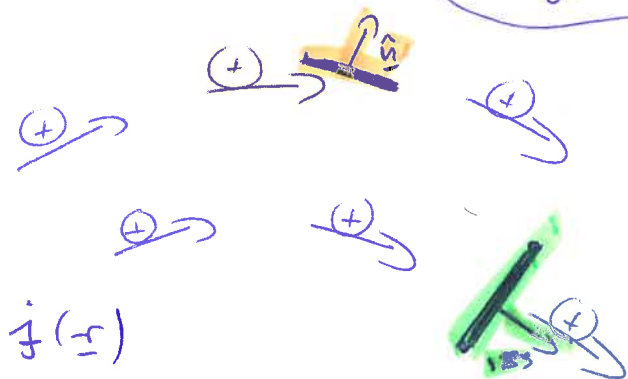
• $\phi(\underline{r}) = ?$
 (weit entfernt von Ladungen)

Bild - 029



Dipolmoment zeigt
von ~~negativen~~ negativen zu
positiven Ladungen

Bild - 030

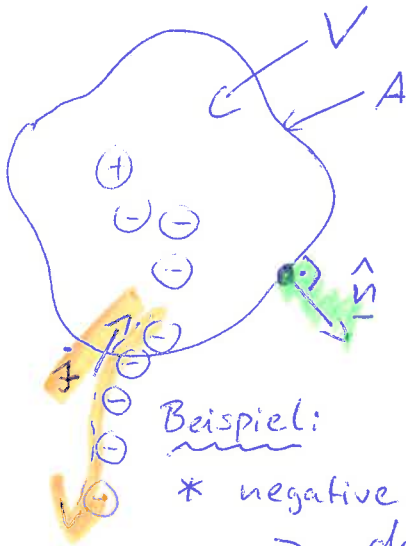


kleines Strom
durch Fläche, da näherungsweise
 $\hat{j} \perp \hat{n}$

$$dI = dA \hat{j}$$

großer Strom
durch Fläche, da $\hat{j} \parallel \hat{n}$

Bild - 031



Beispiel:

* negative Ladungen verlassen V
 $\rightarrow \frac{dq}{dt} > 0$

* negative Ladungen
 $\rightarrow \vec{j}$ ist Ladungsbewegung entgegengerichtet
 $\rightarrow \int \underbrace{dA \vec{j}}_{< 0} < 0$

beide Größen addiert
ergeben 0 laut Skript
... stimmt zumindest bzgl.
des Vorzeichens

Bild - 032

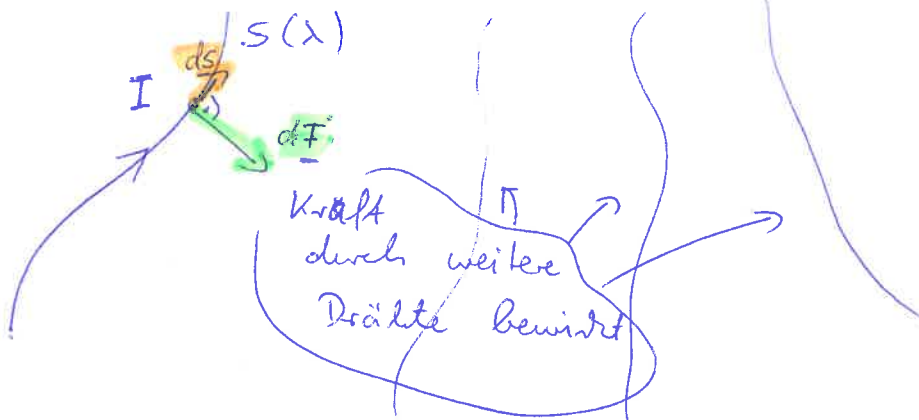


Bild - 033

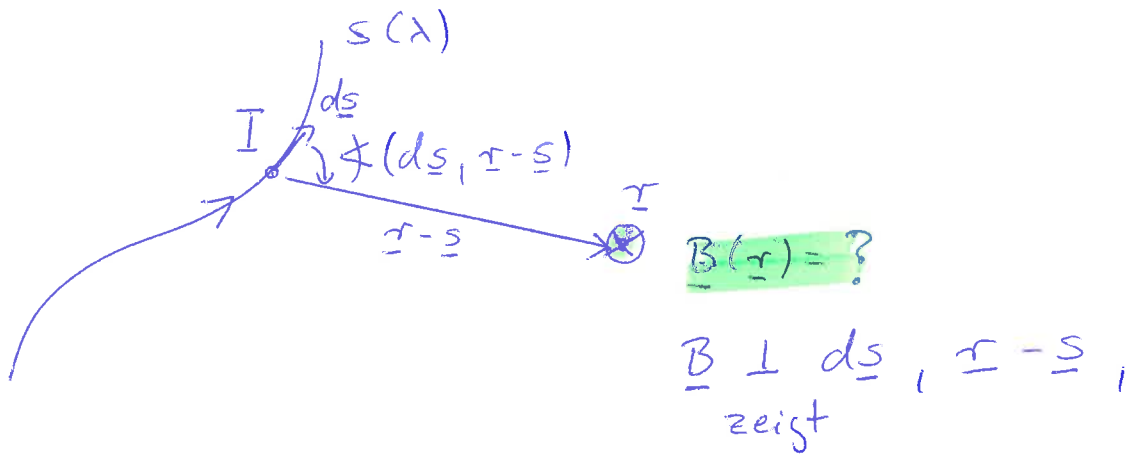


Bild - 034

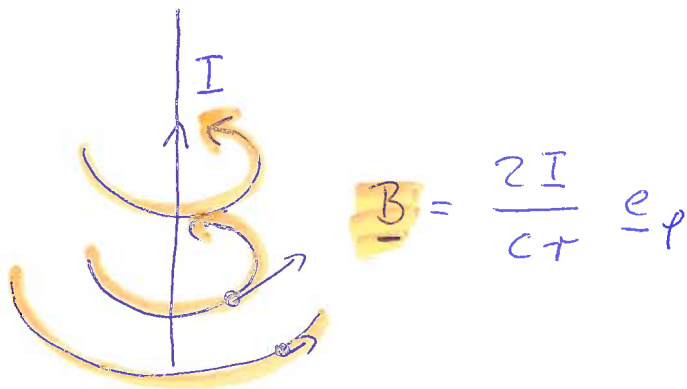


Bild - 035

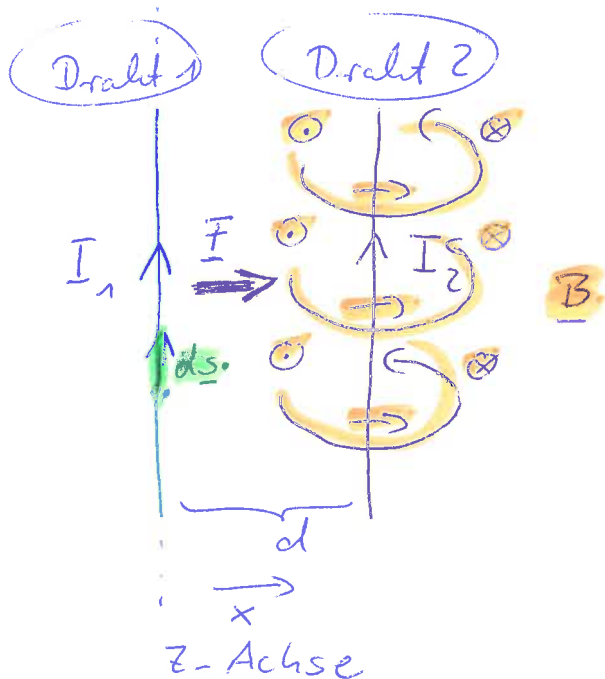
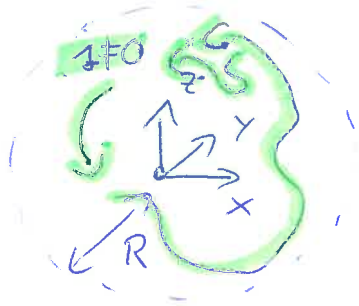
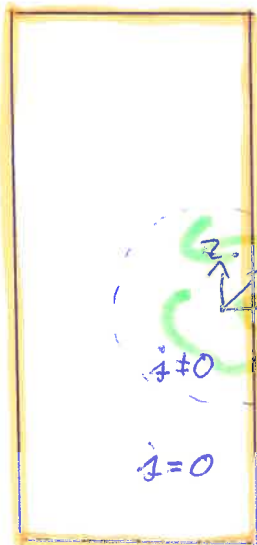


Bild - 036



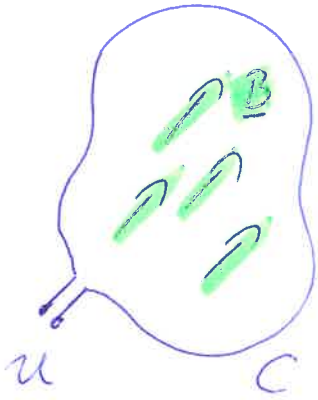
$$\begin{aligned} & \times \underline{A}(\underline{z}) = ? \\ & (|\underline{z}| \gg R) \end{aligned}$$

Bild - 037



A bzw. V

Bild - 038

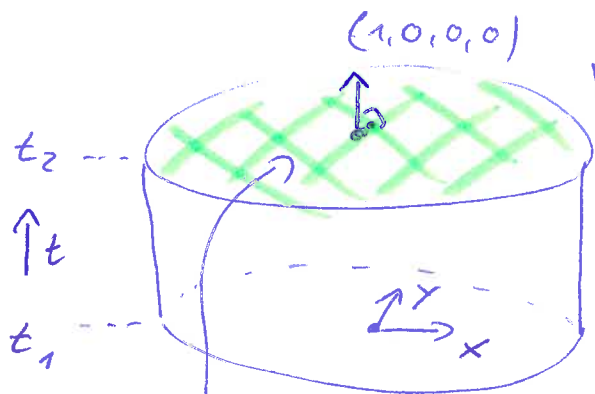


Leiterschleife

\underline{B} -Feld

Verändert sich magnetischer Fluss durch Leiterschleife (z.B. \underline{B} wird stärker), wird Spannung u induziert

Bild - 039



V : Zylinder in Raumzeit mit unendlichem Radius

z.B. Beitrag $\int d^3x T^{00} |_{t=t_2}$

kein Beitrag vom Zylindermantel, da $T_{\mu\nu} = 0$ im Unendlichen

Bild - 040

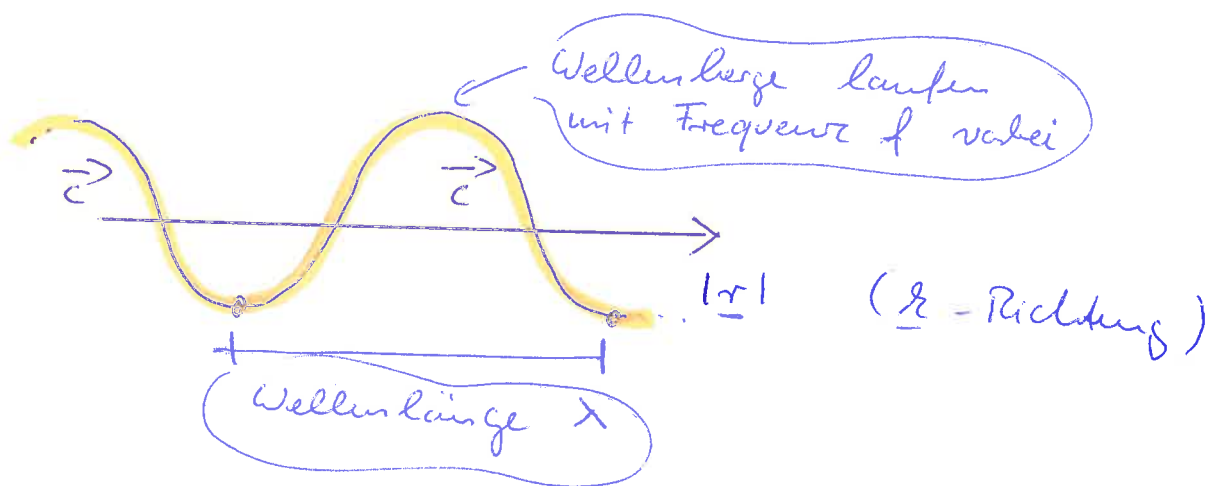
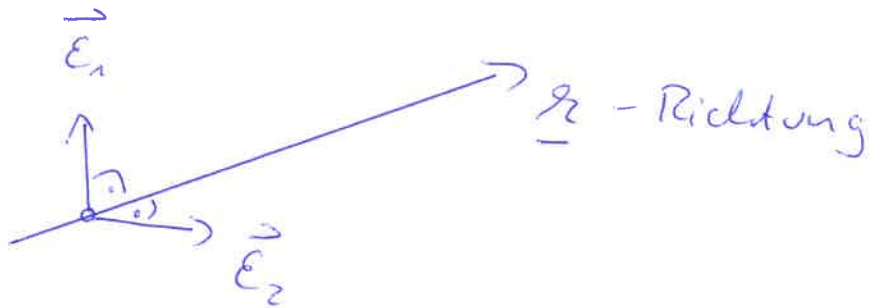


Bild - 041

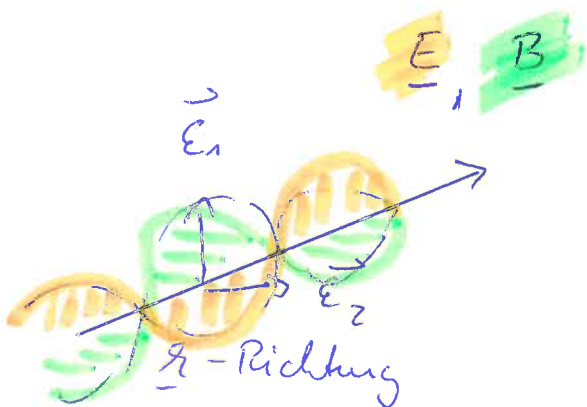
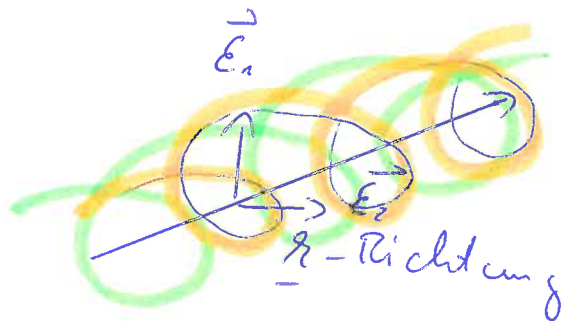
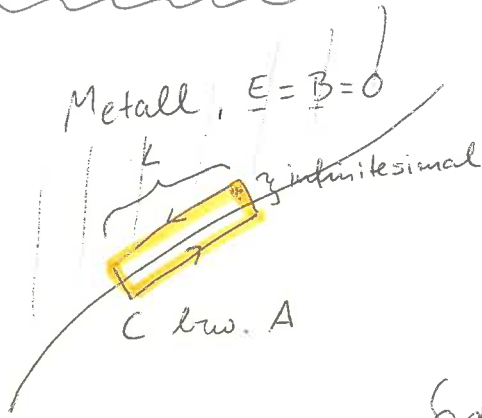


Bild - 042



\vec{E}_1, \vec{B} Schraubenlinien
um $\frac{\pi}{2}$ relativ
verdreht

Bild - 043



$$\underline{E}_{\parallel}$$

$$\int_C dA \nabla \times \underline{E} + \int_A dA \frac{\dot{B}}{c} = 0$$

$$\int_C d\tau \underline{E}_{\parallel}$$

$$L \cdot (E_{\parallel, \text{au\ss}erhalb} - E_{\parallel, \text{innerhalb}})$$

$$\Rightarrow \underline{E}_{\parallel, \text{au\ss}erhalb} = 0$$

$$\underline{B}_{\perp}$$

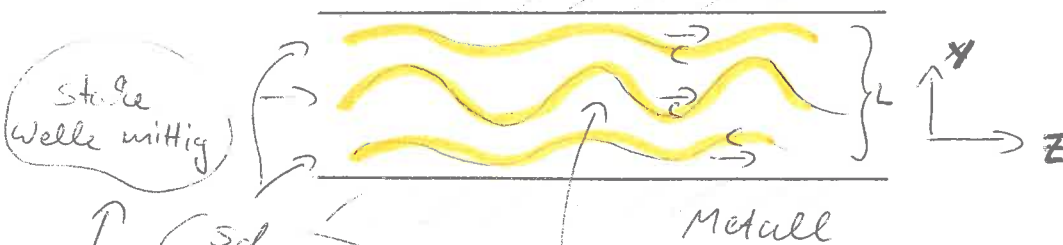
analog ...



$$\dots \Rightarrow \underline{B}_{\perp, \text{au\ss}erhalb} = 0$$

Bild - 044

einfaches Beispiel: $l=0, m=1$



starke Welle mittig

Schwache Welle weiter au\ss

da $E_x \sim \sin(\frac{\pi x}{L})$

\underline{E} zeigt immer in x-Richtung, d.h. $E_y = E_z = 0$

Bild - 045

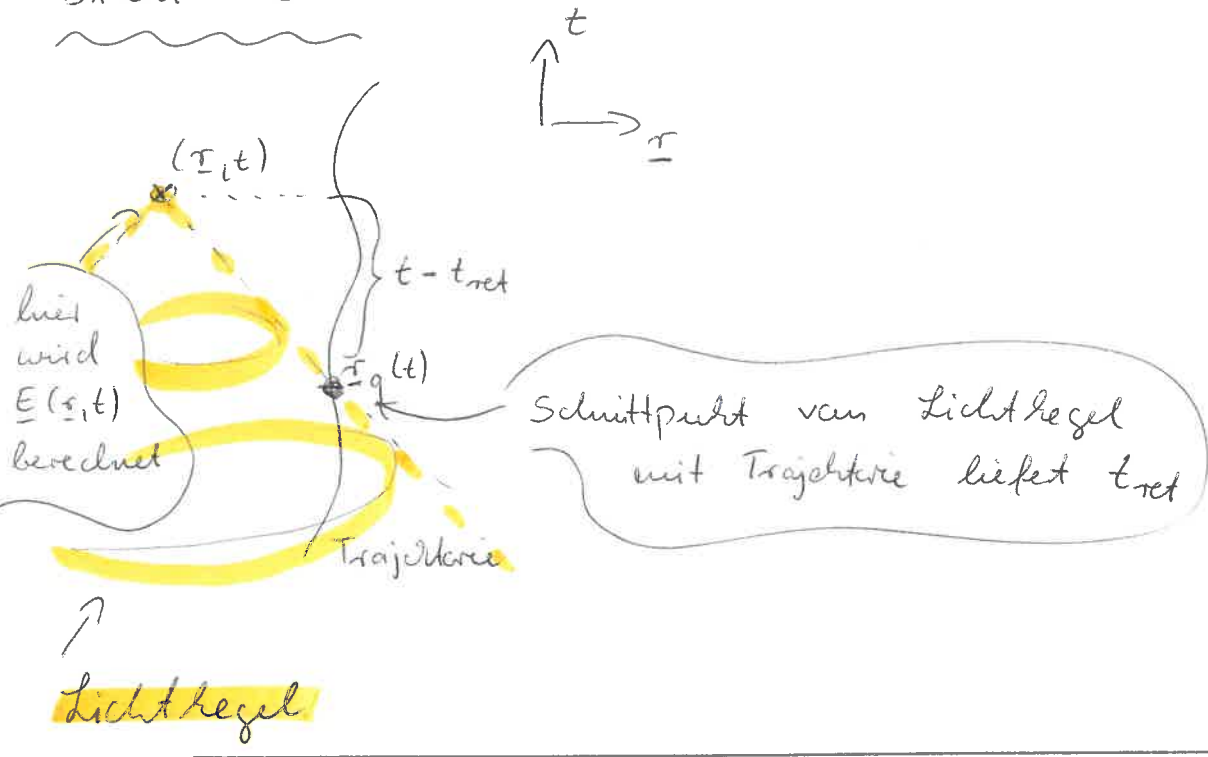


Bild - 046

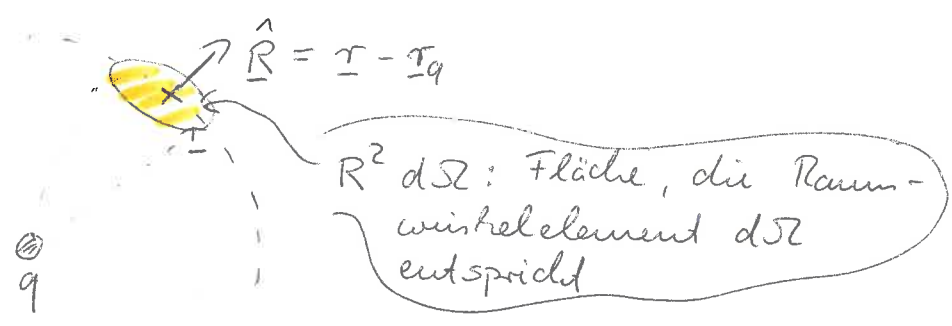
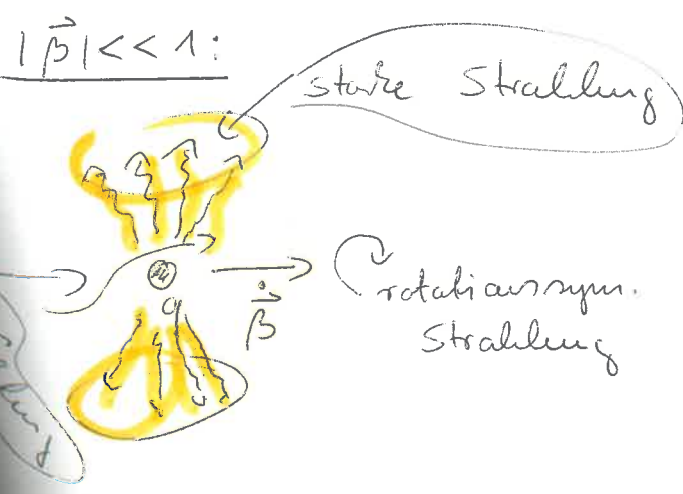


Bild - 047



$\vec{\beta} \parallel \dot{\vec{\beta}}, |\vec{\beta}| \approx c$

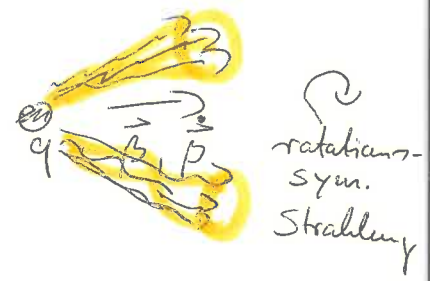
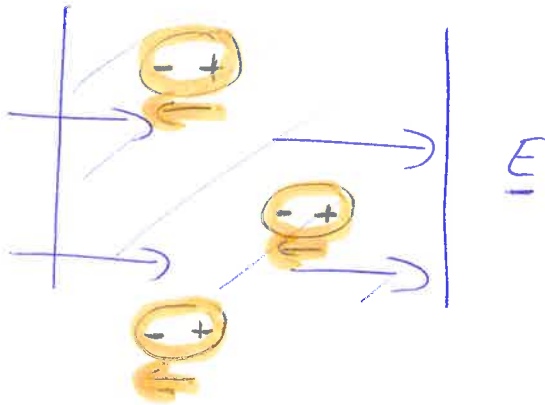


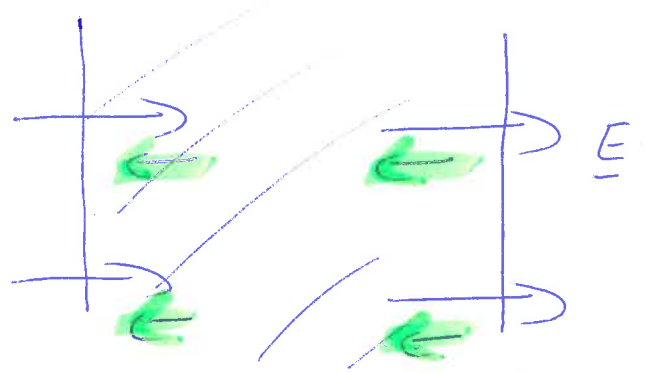
Bild - 048

Materie



mikroskopisch: Polarisation der Atome, entsprechende Gegenfelder im Bereich der Atomzentren

Materie



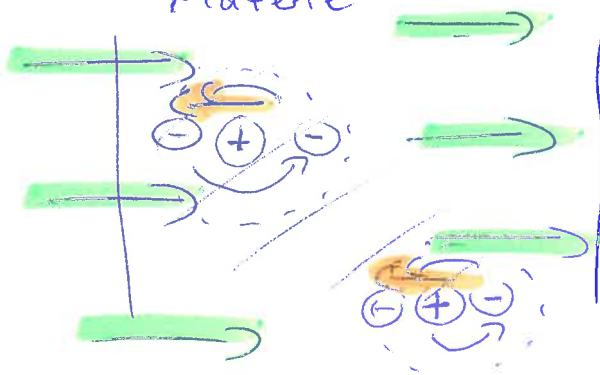
makroskopisch: Mittelung über einige Atomabstände liefert konstantes Gegenfeld



einfacher zu berechnen und i.d.R. ausreichend

Bild - 049

Materie



externes Feld

E_{ext} (z.B. Kondensator)

Polarisation führt zu Korrekturfeldern

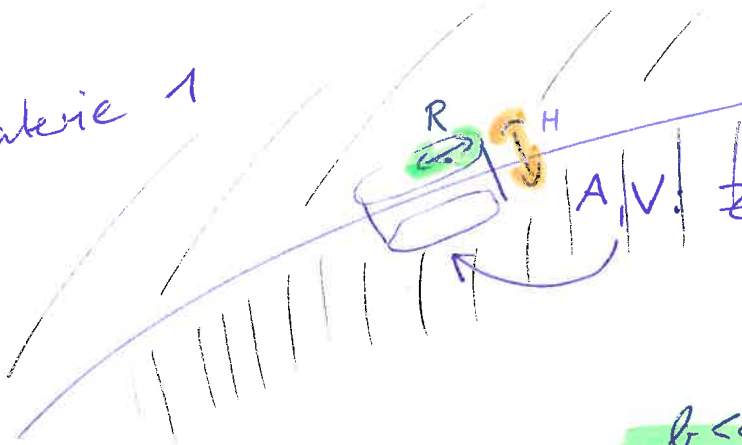
E_{ind}, B_{ind}

Atomkerne +

Elektronen ... komplizierte, stark variierende Felder $\{E_0, B_0 = ?\}$ (unbekannt, uninteressant)

Bild - 050

Materie 1



Zylinder, Höhe H ,
Radius R

$H \approx b$ ("Mittelungslänge")

$b \ll R \ll \lambda$

("Längenskala des
Physik-Problems")

Materie 2

Bild - 051

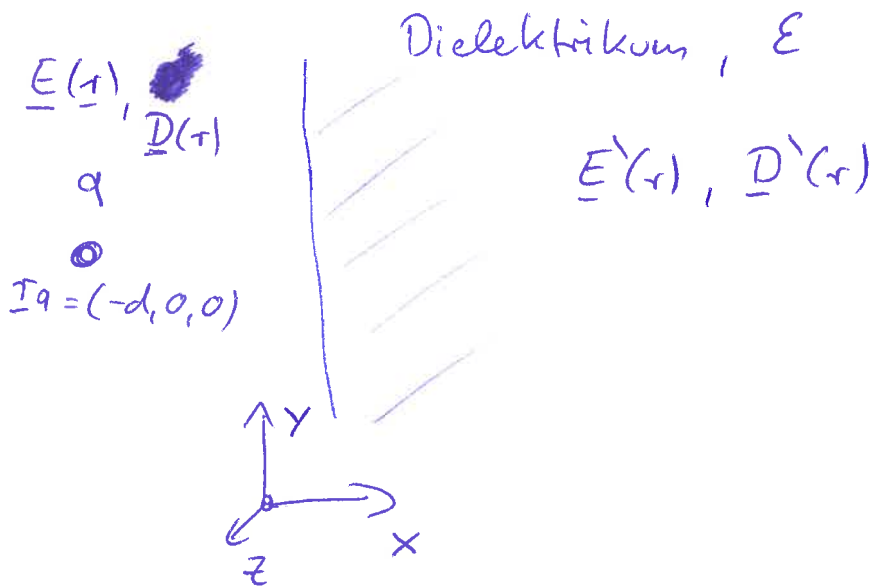


Bild - 052

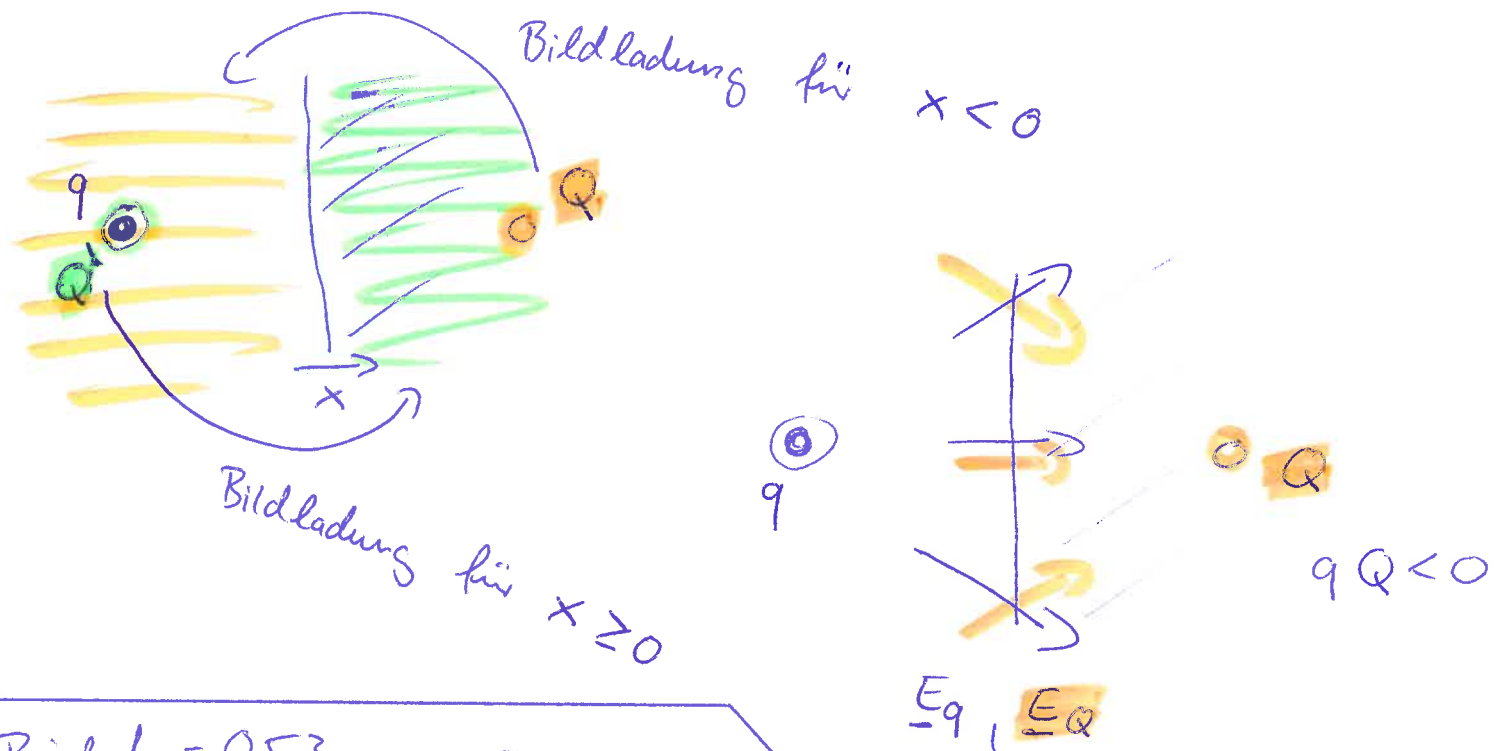


Bild - 053

