

W 35-197

Hasevögel
Relativitätstheorie
I Dr. Wisking

$$\left. \begin{aligned} x' &= \frac{1}{\kappa}(x - q t) \\ y' &= y \quad z' = z \\ t' &= \frac{1}{\kappa}\left(t - \frac{q x}{c^2}\right) \end{aligned} \right\} \begin{aligned} &\omega \sim \omega' \\ &0 \text{ } \omega' = \omega \\ &x' y' z' t' \end{aligned}$$

$$\eta_x' = \frac{\eta_x - q}{1 - \frac{q \eta_x}{c^2}}, \quad \eta_y' = \frac{\eta_y}{1 - \frac{q \eta_x}{c^2}}, \quad \eta_z' = \frac{\eta_z}{1 - \frac{q \eta_x}{c^2}}$$

$$\phi' = \frac{\phi}{\kappa} \left(1 - \frac{q \eta_x}{c^2}\right) \quad \psi' = \frac{1}{\kappa}(\psi - \beta \eta_x) \quad \eta_x' = \frac{1}{\kappa}(\eta_x - \beta \psi)$$

$$u = i c t \quad \left\{ \begin{aligned} \phi_x' &= \frac{\phi_x + i \beta \phi_u}{\kappa} & \phi_y' &= \phi_y & \phi_z' &= \phi_z & \phi_u' &= \frac{\phi_u - i \beta \phi_x}{\kappa} \end{aligned} \right.$$

$$\sin \varphi = \frac{i \beta}{\sqrt{1 - \beta^2}} \quad \cos \varphi = \frac{\beta}{\sqrt{1 - \beta^2}} \quad \mathcal{F} \varphi = i \beta$$

16. V 1911

$\Sigma \in \mathcal{W}$ und $\Sigma' \in \mathcal{W}$ Galilei-Transformationen

$$x' = x - at$$

$$y' = y$$

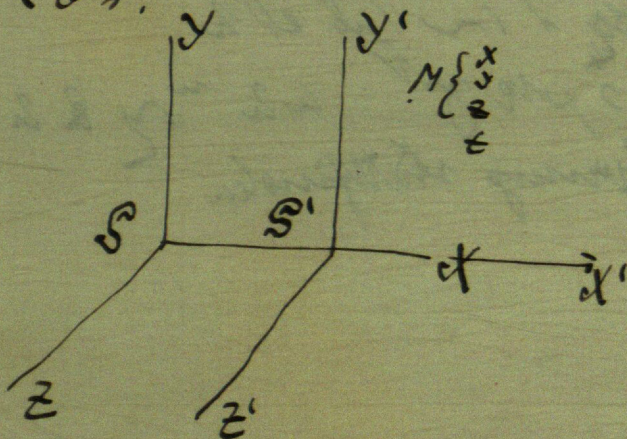
$$z' = z$$

$$t' = t$$

Isotropie $\in \mathcal{W}$ Σ Σ' Σ''

Optisches Fundamentalkörper

Σ Σ' Σ''



Σ Σ' Σ'' Σ'''

$$\frac{OM}{t} = c$$

$$c^2 = \frac{x^2 + y^2 + z^2}{t^2}$$

$$c'^2 = \frac{x'^2 + y'^2 + z'^2}{t'^2}$$

$$x^2 + y^2 + z^2 - c^2 t^2 = 0$$

Σ Σ' Σ'' Σ'''

$$x'^2 + y'^2 + z'^2 - c'^2 t'^2 = 0$$

Σ Σ' Σ'' Σ'''

$$q = \beta c$$

8. VI 1912

$$x' = \frac{1}{\kappa}(x - qt) \quad y' = y \quad z' = z \quad t' = \frac{1}{\kappa}(t - \frac{qx}{c^2})$$

$$x'' = \frac{1}{\kappa}(x' + qt') \quad y = y' \quad z = z' \quad t = \frac{1}{\kappa}(t' + \frac{qx'}{c^2})$$

Gleichzeitigkeit (definiert) Lichtsignale, D. S.
in Σ & Σ' & Σ'' .

in Σ & Σ'

$$\Delta x' = \frac{1}{\kappa} \Delta x \quad \text{für } t = \text{const}$$

$$\Delta x = \frac{1}{\kappa} \Delta x' \quad \text{" } t' = \text{const}$$

$$\Delta t' = \frac{\Delta t}{\kappa} \quad \text{w } x = \text{const}$$

$$\Delta t = \frac{\Delta t'}{\kappa} \quad \text{w } x' = \text{const.}$$

1. Grundsatz der Lorentz Transform. 2. 3. Gruppe

$$x \rightarrow x' \rightarrow x''$$

$$x'' = \frac{x' - \bar{q}t'}{\sqrt{1 - \bar{\beta}^2}} = \frac{x - \frac{q + \bar{q}}{1 + \beta\bar{\beta}}t}{\sqrt{1 - \left(\frac{\beta + \bar{\beta}}{1 + \beta\bar{\beta}}\right)^2}} = \frac{x - \bar{q}t}{\sqrt{1 - \bar{\beta}^2}}$$

$$\bar{q} = \frac{q + \bar{q}}{1 + \beta\bar{\beta}} \quad \left. \begin{array}{l} \eta; \quad \eta_x = \frac{dx}{dt} \\ \eta'; \quad \eta'_x = \frac{dx}{dt'} \end{array} \right\} \quad \begin{array}{l} x' = \eta'_x t' \quad y' = \eta'_y t' \\ x = \frac{\eta'_x + q}{\kappa} t' \end{array}$$

$$= \frac{\eta'_x + q}{\kappa} \left(t - \frac{qx}{c^2} \right) \quad \kappa^2 x = (\eta'_x + q)t - x \left(\frac{q\eta'_x}{c^2} + \beta^2 \right)$$

$$x = \frac{\eta'_x + q}{1 + \frac{q\eta'_x}{c^2}} t \quad y = \eta'_y \frac{t - \frac{qx}{c^2}}{\kappa} = \frac{1}{\kappa} \left(\eta'_y t - \frac{q\eta'_y}{c^2} x \right)$$

$$= \frac{\eta'_y}{\kappa} \left(t - \frac{q\eta'_y}{c^2(1 + \frac{q\eta'_x}{c^2})} (\eta'_x + q)t \right) = \frac{\eta'_y t}{\kappa(1 + \frac{q\eta'_x}{c^2})} \left\{ 1 + \frac{q\eta'_x}{c^2} - \right.$$

$$\left. \frac{q\eta'_x}{c^2} - \beta^2 \right\} \quad \text{d. h. } y = \frac{\eta'_y \sqrt{1 - \beta^2}}{1 + \frac{q\eta'_x}{c^2}} t$$

$$z = \frac{\eta'_z \sqrt{1 - \beta^2}}{1 + \frac{q\eta'_x}{c^2}} t$$

$$u_x = \frac{u'_x + g}{1 + \frac{g u'_x}{c^2}}$$

$$u'_x = \frac{u_x - g}{1 - \frac{g u_x}{c^2}}$$

$$u_y = \frac{u'_y \frac{c}{k}}{1 + \frac{g u'_x}{c^2}}$$

$$u'_y = \frac{u_y \frac{c}{k}}{1 - \frac{g u_x}{c^2}}$$

$$u_z = \frac{u'_z \frac{c}{k}}{1 + \frac{g u'_x}{c^2}}$$

$$u'_z = \frac{u_z \frac{c}{k}}{1 - \frac{g u_x}{c^2}}$$

u $u'_x = c$ $u'_y = u'_z = 0$

$$u_x = \frac{c+g}{1+\frac{g}{c}} = c \quad \text{wird } u'_x = c \text{ in } u'_x = c \text{ eingesetzt}$$

$c = \frac{c}{1+\frac{g}{c}}$

wenn $g = c$ u. $u'_x = c$ $1 = \frac{c}{1+\frac{c}{c}}$

$$u_x = \frac{u'_x + c}{1 + \frac{u'_x}{c}} = c$$

wenn $u'_y = c$ $u'_x = u'_z = 0$

$$u_x = g \quad u_y = c\sqrt{1-\beta^2} \quad u_z = 0 \quad u_x^2 + u_y^2 = c^2$$

Wir bilden δ -Invariante & Lorentz Transform.

$$x'^2 + y'^2 + z'^2 - c^2 t'^2 = y^2 + z^2 + \frac{1}{k^2} (x^2 - 2gx + g^2 t^2 - c^2 t^2 - 2\frac{g}{c^2} x t + \frac{g^2}{c^4} t^2)$$

$$= x^2 + y^2 + z^2 - c^2 t^2$$

Parabel

10. VII 1912

$$\Delta \varphi - \frac{1}{c^2} \frac{\partial^2 \varphi}{\partial t^2} = 0$$

$$\varphi = f(lx + my + nz - ct)$$

Choosen $lx + my + nz - ct =$

$$l \frac{x' + \frac{g t'}{k}}{\sqrt{1-\beta^2}} + m y' + n z' - c \frac{t' + \frac{g x'}{c^2}}{\sqrt{1-\beta^2}}$$

$$= x' \frac{l-\beta}{\sqrt{1-\beta^2}} + m y' + n z' - c t' \frac{1-\beta l}{\sqrt{1-\beta^2}}$$

$$= \frac{1-\beta l}{\sqrt{1-\beta^2}} \left\{ x' \frac{l-\beta}{1-\beta l} + y' m \frac{\sqrt{1-\beta^2}}{1-\beta l} + z' n \frac{\sqrt{1-\beta^2}}{1-\beta l} - c t' \right\}$$

$$= \frac{1-\beta l}{\sqrt{1-\beta^2}} \{ lx' + my' + nz' - ct' \} = \varphi$$

u. v. l. s. x. d. h. v.

2. en $\varphi = f(lx + my + nz - ct) \log 2 \phi$ in z en

$$L_e = \Delta\varphi \neq -\frac{1}{c^2} \frac{d\varphi}{dt} = 0 \quad \text{and therefore}$$

$$I_5 = \Delta g - \frac{1}{c^2} \frac{\partial^2 g}{\partial t^2} = 0 \quad \text{invariant} \sim H \in \text{Lorentz Transf.}$$

$$\frac{\partial \varphi}{\partial x} = \frac{\partial \varphi}{\partial x'} \frac{\partial x'}{\partial x} + \frac{\partial \varphi}{\partial y'} \frac{\partial y'}{\partial x} + \dots + \frac{\partial \varphi}{\partial t'} \frac{\partial t'}{\partial x}$$

$$\frac{\partial \varphi}{\partial x} = \frac{\partial \varphi}{\partial x'} \frac{1}{\sqrt{1-\beta^2}} - \frac{\partial \varphi}{\partial t'} \frac{\beta}{c \sqrt{1-\beta^2}} = \frac{1}{\sqrt{1-\beta^2}} \left(\frac{\partial}{\partial x'} - \frac{\beta}{c} \frac{\partial}{\partial t'} \right) \varphi$$

$$\frac{\partial \varphi}{\partial y} = \frac{\partial \varphi}{\partial y'}, \quad \frac{\partial \varphi}{\partial t} = \frac{\partial \varphi}{\partial t'}$$

$$\begin{aligned} \frac{\partial \varphi}{\partial t} &= \frac{\partial \varphi}{\partial x'} \frac{\partial x'}{\partial t} + \frac{\partial \varphi}{\partial t'} \frac{\partial t'}{\partial t} = \frac{\partial \varphi}{\partial x'} \frac{-v}{\sqrt{1-\beta^2}} + \frac{\partial \varphi}{\partial t'} \frac{1}{\sqrt{1-\beta^2}} \\ &= \frac{1}{\sqrt{1-\beta^2}} \left(-v \frac{\partial}{\partial x'} + \frac{\partial}{\partial t'} \right) \varphi \end{aligned}$$

$$\cancel{4} - \frac{1}{c^2} \frac{\partial^2 \phi}{\partial t^2} = \frac{\partial^2 \phi}{\partial x^2} - \frac{1}{c^2} \frac{\partial^2 \phi}{\partial t^2} = \frac{1}{1-\beta^2} \left(\frac{\partial^2 \phi}{\partial x'^2} - \frac{2\beta}{c} \frac{\partial^2 \phi}{\partial x' \partial t'} + \frac{\beta^2}{c^2} \frac{\partial^2 \phi}{\partial t'^2} \right)$$

$$= \frac{\partial^2 \varphi}{\partial x'^2} - \frac{1}{c^2} \frac{\partial^2 \varphi}{\partial t'^2}$$

Daher $\Delta \varphi - \frac{1}{c^2} \frac{\partial^2 \varphi}{\partial t^2} = \Delta' \varphi - \frac{1}{c^2} \frac{\partial^2 \varphi}{\partial t'^2}$

$$\varphi = \sin 2\pi \nu \left(\frac{l x + m y + n z}{c} - t \right)$$

[illegible]

$$\phi = \sin \pi v \frac{1-\beta^2}{\sqrt{1-\beta^2}} \left(\frac{c^2 y'^2 + u^2 z'^2}{c} - t'^2 \right)$$

$$= \sin \frac{\pi}{n} v' \left(\frac{e'x + u'y' + u'z'}{e} - \delta' \right)$$

$$v' = v \frac{1-\beta^2}{\sqrt{1-\beta^2}}$$

$$c' = \frac{c - \beta}{1 - \beta c} \quad \sin' = \sin \frac{\sqrt{1 - \beta^2}}{1 - \beta c} \quad n' = n \frac{\sqrt{1 - \beta^2}}{1 - \beta c} \quad \text{shrinkage}$$

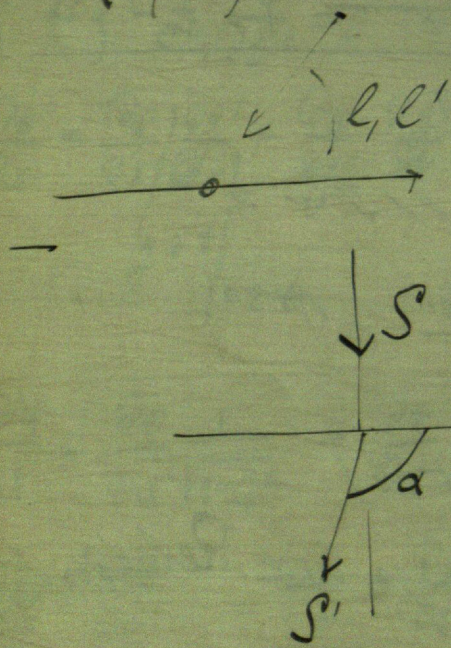
$$l = \frac{l' + \beta}{1 + \beta c'} \quad m = m' \frac{\sqrt{1 - \beta^2}}{1 + \beta c'} \quad \gamma = \gamma' \frac{1 + \beta c'}{\sqrt{1 - \beta^2}}$$

Dopplereffekt u. e. alten Theorie

$$x = x' + vt' \quad t = t' \quad \sin 2\pi \nu \left(\frac{x' + vt'}{c} - t' \right) = \sin 2\pi \nu \left(\frac{x'}{c} - t' \right)$$

$$= \sin 2\pi r \left[\frac{lx+my+nz}{c} - t(1-\beta l) \right] = \underbrace{\sin 2\pi r(1-\beta l)}_{\sin 2\pi r'} \left[\dots \right]$$

$$r' = r(1-\beta l)$$



11. III 1912

$$l=0$$

$$l' = -\beta$$

$$\cos(\varphi - \alpha) = l' = -\beta$$

$$\oint \mathbf{E} = \text{int } \mathbf{A} \quad \oint = -\text{grad } \varphi - \frac{1}{c} \mathbf{A}$$

$$\Delta \varphi = -\frac{1}{c^2} \frac{\partial^2 \varphi}{\partial t^2} = -4\pi g \quad \Delta \mathbf{A} - \frac{1}{c^2} \frac{\partial^2 \mathbf{A}}{\partial t^2} = -\frac{4\pi g \mathbf{A}}{c}$$

$$\frac{\partial \varphi}{\partial t} + \text{div}(\mathbf{S} \eta) = 0$$

$$\frac{\partial \varphi'}{\partial t'} + \text{div}'(\mathbf{S}' \eta') = 0$$

$$c^2 \mathbf{S}' \cdot \mathbf{S} = \dots \quad \frac{1}{k} \left(\frac{\partial}{\partial t'} - \vartheta \frac{\partial}{\partial x'} \right) \mathbf{S} + \frac{1}{k} \left(\frac{\partial}{\partial x'} - \vartheta \frac{\partial}{\partial t'} \right) (\dots)$$

$$-\left(\vartheta \frac{\partial \mathbf{S}' + \vartheta}{1 + \vartheta^2} \eta_x \right) + \frac{\partial}{\partial y'} (\mathbf{S}' \eta_y) + \frac{\partial}{\partial z'} (\mathbf{S}' \eta_z) = 0$$

$$\frac{1}{k} \frac{\partial}{\partial t'} (\mathbf{S}' (1 - \vartheta \frac{\partial \eta_x}{\partial z'})) + \frac{1}{k} \frac{\partial}{\partial x'} (\mathbf{S}' (\eta_x - \vartheta)) + \frac{\partial}{\partial y'} (\mathbf{S}' \eta_y) + \frac{\partial}{\partial z'} (\mathbf{S}' \eta_z) = 0$$

$$\dots \quad \frac{1}{k} \frac{\partial}{\partial x'} [\mathbf{S}' \eta_x' (1 - \vartheta \frac{\partial \eta_x}{\partial z'})] + \frac{1}{k} \frac{\partial}{\partial y'} [\mathbf{S}' (1 - \vartheta \frac{\partial \eta_x}{\partial z'})] + \dots$$

$$\mathbf{S}' = \frac{\mathbf{S}}{k} \left(1 - \vartheta \frac{\partial \eta_x}{\partial z'} \right) \text{ u c c o n n a n t u n c y}$$

$$\frac{\partial \mathbf{S}'}{\partial t'} + \frac{\partial}{\partial x'} (\mathbf{S}' \eta_x') + \frac{\partial}{\partial y'} (\mathbf{S}' \eta_y') + \frac{\partial}{\partial z'} (\mathbf{S}' \eta_z') = 0$$

$$\mathbf{S}' = \text{const u n c c o n n a n t u n c y}$$

$$\dots \text{ u n c c o n n a n t u n c y}$$

$$\text{u n c c o n n a n t u n c y}$$

$$\text{u n c c o n n a n t u n c y} \quad \mathbf{S} = \frac{\mathbf{S}'}{k} \left(1 + \vartheta \frac{\partial \eta_x}{\partial z'} \right)$$

$$\mathbf{S}' - \eta_x' = 0 \quad \text{u n c c o n n a n t u n c y} \quad c' = \int \mathbf{S}' d\tau'$$

$$\text{u n c c o n n a n t u n c y} \quad c = \int \mathbf{S} d\tau$$

$$\text{u n c c o n n a n t u n c y} \quad dt = \text{const u n c c o n n a n t u n c y} \quad dx = \frac{dx'}{k} \quad d\tau = d\tau' : k$$

$$a^2 \rho' = \frac{\rho}{k} \left(1 - \frac{q^2}{c^2} \right) = \rho \cdot k$$

$$\nabla^2 \psi \sim \Delta' \psi - \frac{1}{\epsilon^2} \psi'' = -4\pi g'$$

$$\Delta' u_x - \frac{1}{c^2} \ddot{u}_x' = - \frac{4\pi \rho' u_x'}{c}$$

$$u^{\alpha} \Delta^{\alpha} = \Delta'^{\alpha} \quad \mathcal{R}:$$

$$\Delta \psi' - \frac{1}{c^2} \ddot{\psi}' = -4\pi \frac{\rho}{u} \left(1 - \frac{v^2}{c^2}\right)$$

$$\Delta \varphi'_x - \frac{1}{c^2} \ddot{\varphi}'_x = - \frac{4\pi q}{\kappa} \left(1 - \frac{q \cdot x}{c^2}\right) \frac{y_x - q}{1 - \frac{q y_x}{c^2}}$$

$$\Delta \psi_y' - \frac{1}{c^2} \ddot{\psi}_y' = -\frac{4\pi}{c} \frac{S}{\kappa} \left(1 - \frac{q_{yx}}{c^2}\right) \frac{\kappa \psi_y}{1 - \frac{q_{yx}}{c^2}} = -\frac{4\pi}{c} S \psi_y$$

$$\alpha_g' = \alpha_g \quad \alpha_z' = \alpha_z$$

$$1 \psi_k' - \frac{1}{c^2} \psi_k'' = -\frac{4\pi^2}{5} \frac{1}{h} (\psi_k - q) \left| \frac{q}{c} \right|$$

$$\Delta \phi' - \frac{1}{c^2} \ddot{\phi}' = -4\pi \frac{g}{\kappa} \left(1 - \frac{g v_x}{c^2} \right)$$

$$\Delta(\vec{v}' + \beta \vec{v}'_{\parallel}) - \frac{1}{c} \frac{\partial}{\partial t} (\vec{v}' + \beta \vec{v}'_{\parallel}) = -\frac{4\pi \rho}{\kappa} (1 - \beta^2) = -\frac{4\pi \rho}{\kappa}$$

$\log p(1) = \log 0.02$

$$\text{or } v = \frac{v' + \beta c x'}{k}$$

$$Z_{\bar{S}} = \frac{1}{\alpha_x} \sqrt{2} \sqrt{C P_{1, \bar{S}}} = \frac{1}{C} \frac{1}{\alpha_x} \sqrt{2}$$

$$\Delta(\phi_x' + \beta\phi) - \frac{1}{c^2} \frac{\partial^2}{\partial t^2} (\phi_x' + \beta\phi) = -\frac{4\pi\epsilon}{k} \left(\frac{\rho^2 \phi_x}{c^3} + \frac{\phi_x}{c} \right)$$

$$= \frac{4\pi\epsilon_0}{c^4} \frac{m_x}{c} \left(1 - \frac{v^2}{c^2}\right) = \frac{4\pi\epsilon_0}{c} m_x \kappa \quad c^2 \epsilon_0 g c \kappa$$

$$1/\bar{S} / \alpha_{st} \quad \text{OR} \quad \alpha_{st} = \frac{\alpha_{st}' + 30}{K}$$

12. Ⅳ 19次

S. ~~W.~~

→ P1 9

$$1 \rightarrow S'' \xrightarrow{\quad} S''$$

8

51

96

$$\mathcal{S} \rightarrow \mathcal{S}^n$$

$$\begin{array}{r} 9+9 \\ \hline 1+99 \\ \hline 02 \end{array}$$

$$S'' = \frac{S}{\sqrt{1 - \frac{(a+b)^2}{(2+\beta)^2}}}$$

221

$$\mathcal{P}'' = \frac{\mathcal{P}}{\sqrt{1-\beta^2}} \left(1 - \frac{\bar{q}q}{c^2} \right)$$

$$y = \text{rot } u \quad \phi = -\text{grad } v - \frac{1}{c} u' \quad u, v (S, \eta)$$

$$u' v' \quad y' = \text{rot}' u' \quad \phi' = -\text{grad}' u' - \frac{1}{c} \frac{\partial u'}{\partial t'}$$

$$\text{rot}' y' = \frac{1}{c} \left(\frac{\partial \phi'}{\partial t'} + \phi' \omega' \right) \quad \text{rot}' \phi' = -\frac{1}{c} \frac{\partial y'}{\partial t'}$$

$$y'_x = \frac{\partial y'_z}{\partial y'} - \frac{\partial y'_y}{\partial z'} = y_x$$

$$y'_{yy} = \frac{\partial y'_x}{\partial y'} - \frac{\partial y'_z}{\partial x'} = \frac{\partial}{\partial z} \frac{y_x - \beta v}{k} - \frac{1}{k} \left(\frac{\partial}{\partial x} + \frac{q}{c} \frac{\partial}{\partial t} \right) u_z$$

$$= \frac{1}{k} \left\{ \frac{\partial y_x}{\partial z} - \frac{\partial y_z}{\partial x} - \beta \frac{\partial v}{\partial z} - \frac{q}{c^2} \frac{\partial y_z}{\partial t} \right\} = \frac{1}{k} (y_y + \beta \phi_z)$$

$$\begin{aligned} y'_x &= y_x \\ y'_y &= \frac{1}{k} (y_y + \beta \phi_z) \\ y'_z &= \frac{1}{k} (y_z - \beta \phi_y) \end{aligned} \quad \begin{aligned} &\text{C. v. d. } \phi' \\ \phi'_x &= -\frac{\partial v'}{\partial x'} - \frac{1}{c} \frac{\partial y'_x}{\partial t'} \\ &= -\frac{1}{k} \left(\frac{\partial}{\partial x} + \frac{q}{c} \frac{\partial}{\partial t} \right) \frac{y_x - \beta v}{k} - \frac{1}{c} \left(\frac{\partial}{\partial t} + \frac{q}{c} \frac{\partial}{\partial x} \right) \frac{y_x - \beta v}{k} \\ &= -\frac{1}{k^2} \frac{\partial v}{\partial x} + \frac{\beta q}{c k^2} \frac{\partial v}{\partial t} + \frac{\partial y_x}{\partial t} \left(\frac{\beta^2}{c k^2} - \frac{1}{c k^2} \right) \\ &\quad - \frac{1}{k^2} \frac{\beta}{c} \frac{\partial v}{\partial t} + \frac{1}{k^2} \frac{\beta}{c} \frac{\partial v}{\partial t} + \frac{\beta}{k^2} \frac{\partial y_x}{\partial x} - \frac{q}{c k^2} \frac{\partial y_x}{\partial x} \end{aligned}$$

$$= -\frac{\partial v}{\partial x} \frac{1-\beta^2}{k} - \frac{\partial y_x}{\partial t} \frac{1-\beta^2}{c k^2} = -\frac{\partial v}{\partial x} - \frac{1}{c} \frac{\partial y_x}{\partial t} = \phi_x$$

$$\phi'_x = \phi_x \quad \phi'_y = \frac{1}{k} (\phi_y - \beta y_z) \quad \phi'_z = \frac{1}{k} (\phi_z + \beta y_y)$$

$$\omega \quad y'_y = 0 \quad \text{in } \phi'_y = 0 \quad \text{in } \phi'_z = 0$$

$$\text{in } y'_z = 0 \quad \text{in Ruhesystem } \underline{\text{in } \phi'_z = 0}$$

$$\text{C. v. d. } \phi'_x = 0 \quad \text{in } \phi'_y = 0 \quad \text{in } \phi'_z = 0$$

$$x' = \frac{1}{k} y'_x t'^2 \quad \text{in } \phi'_x = 0 \quad \text{in } \phi'_y = 0 \quad \text{in } \phi'_z = 0$$

$$x = \frac{1}{k} y'_x t'^2 + q t' = \frac{1}{k} y'_x \left(\frac{t - \frac{q x}{c}}{k} \right)^2 + q \frac{t - \frac{q x}{c}}{k}$$

$$e^2 - x^2 = 1/k \cdot \text{aus } y'_x \text{ und } t'$$

$$x = \frac{c^2 k}{\beta^2 y'_x} \left(1 + \frac{y'_x \beta t}{c k} \right) + \frac{c^2 k}{\beta^2 y'_x} \sqrt{1 + \frac{2 y'_x \beta k t}{c}}$$

$$\text{2. } \phi'_y = 0 \quad \text{in } \phi'_z = 0 \quad \text{in } \phi'_x = 0$$

13. II. 1912

$$\text{C. v. d. } \phi'_x = 0 \quad \text{in } \phi'_y = 0 \quad \text{in } \phi'_z = 0$$

$$\sqrt{1 + \frac{y'_x \beta k t}{c}} = \frac{1}{2} \left(\frac{y'_x \beta k t}{c} \right)^2 \quad \text{in } \phi'_x = 0 \quad \text{in } \phi'_y = 0 \quad \text{in } \phi'_z = 0$$

$$x = \frac{c'x}{\beta' b_x'} \left\{ \frac{b_x' \beta' t}{c k} \beta^2 + \frac{1}{2} \frac{b_x'^2 \beta^2 k^2 t^2}{c^2} \right\} = q t + \frac{1}{2} b_x' k^2 t^2$$

$$\left. b_x^+ = b_x' t^3 \right\} \text{при } x = y - z = y = \frac{b_x'}{2} t'^2$$

$$y = \frac{h_0}{2} \left(\frac{t - \frac{9x}{c^2}}{u} \right)^2 \quad x = 9t$$

$$g = \frac{b_y'}{2} \frac{[t(1 - \frac{g^2}{c^2})]^2}{x^2} = \frac{b_y'}{2} t^2 \kappa^2 \quad b_y^+ = b_y' \kappa^2$$

$$b_y^+ = b_y^k r$$

$$C_2 = C_2 K^2$$

$\text{len}^m \subset \text{len}^w$, e.g. $\text{len}^m = \text{len}^w$

$$m \frac{d^2 x'}{dt'^2} = e \mathcal{E}' \quad m \frac{dx}{dt} = e \mathcal{E}$$

$$m \frac{dx}{k^3} = c \, dx$$

$$m \dot{y} = 2 \dot{\phi}$$

$$m \frac{dy}{dt} = e \frac{1}{k} (E_y - \beta E_z)$$

$$u_{b_2'} = \ell_{b_2'}$$

$$m \frac{b_z}{a_z} = e \frac{1}{k} (g_z + \beta g_y)$$

$e^2, \omega_2 = 1 \sim \omega^2 e^2 \text{ due to } \omega$

$$k^2 = 1 - \frac{q^2}{c^2} \quad \text{in } q \ll c \quad \text{in } k \approx 1$$

$$m b_x = e \mathcal{L}_x \quad m b_y = e \left(\mathcal{L}_y - \frac{x'}{c} \mathcal{L}_z \right) \quad m b_z = e \left(\mathcal{L}_z + \frac{y'}{c} \mathcal{L}_y \right)$$

$y \sim \text{let } \sqrt{1/d} \sim \sqrt{1/d} \sim \sqrt{1/d} \sim \sqrt{1/d}$

1 ~ re w^o L2 L2 zt:

$m \cdot b = e \left(\frac{1}{c} + \frac{1}{c} [m \cdot g] \right) \in \mathbb{R}^6 \rightarrow e \cdot b \cdot h \cdot \sim \sim$
 1. ρ pseudomom. f. $\sim$ Hypothese. $\sim$ Lorentz $\sim$ c 2

∞ Hyp. v. Sh.

$C = \frac{1}{2} \gamma_2 \in K \neq 1. \quad C g \quad g = g + \frac{1}{2} [v, g] e^{-\gamma_2 v}$

$$f_x = \mathcal{L}_x \quad f_y = \mathcal{L}_y - \beta \mathcal{L}_z \quad f_z = \mathcal{L}_z + \beta \mathcal{L}_y$$

$$m \frac{h_x}{\kappa^3} = c f_x \quad m \frac{h_y}{\kappa} = c f_y \quad m \frac{h_z}{\kappa} = c f_z$$

и по сеемъ, въ нѣмъ

17^{te}. av. 3 f. 50 C. Lige transmutabile, impi-

tridactyla Mass

$$m_l = \frac{m}{(1-\beta^2)^{3/2}} \quad m_{tr} = \frac{m}{(1-\beta^2)^{1/2}}$$

experimentell "Haber, Loewy & Shraiman 1952.

$c = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$, ρ d.

$$p'_x = \rho' \left[\epsilon'_x + \frac{1}{c} (v'_y g'_z - v'_z g'_y) \right] =$$

$$= \frac{\rho}{\kappa} \left(1 - \frac{v^2}{c^2} \right) \epsilon_x + \frac{1}{c} \rho v_y \frac{g_z}{\kappa} - \frac{1}{c} \rho v_z \frac{g_y}{\kappa} + \beta \frac{\rho}{\kappa} \epsilon_z$$

$$= \frac{\rho}{\kappa} \left\{ \epsilon_x + \frac{1}{c} (v_y g_z - v_z g_y) \right\} - \frac{\rho}{\kappa} \frac{\beta}{c} (\epsilon_x v_x + \epsilon_y v_y + \epsilon_z v_z)$$

$$\rho v \epsilon = \eta \rho$$

$$p'_x = \frac{p_x - \frac{\beta}{c} \eta \rho}{\kappa}$$

$$p'_y = p_y$$

$$p'_z = p_z$$

$$c = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \quad (v' \rho') = \frac{(\eta \rho)}{\kappa} - \frac{\beta \rho}{\kappa} \frac{p_x}{\kappa}$$

$c \gamma \rho = \rho \beta$.

$$x' = \frac{x - vt}{\kappa} \quad y' = y \quad z' = z \quad t' = \frac{t - \frac{\beta x}{c}}{\kappa}$$

$$g'_x = \frac{g_x - \frac{v}{c} g_t}{\kappa} \quad g'_y = g_y \quad g'_z = g_z \quad g' = \frac{g - \frac{\beta}{c} (p_x)}{\kappa}$$

$$u'_x = \frac{u_x - \frac{v}{c}}{\kappa} \quad u'_y = u_y \quad u'_z = u_z \quad \frac{v'}{c} = \frac{\frac{v}{c} - \frac{\beta u_x}{c}}{\kappa}$$

$$p'_x = \frac{p_x - \frac{\beta}{c} p_t}{\kappa} \quad p'_y = p_y \quad p'_z = p_z \quad (p' \rho') = \frac{(\rho \rho)}{\kappa} - \frac{\beta}{\kappa} \frac{p_x}{\kappa}$$

Wiederholung des Relativitätsprinzips.
Lorentz u. Einstein u. d. h. v.

Wiechart & c Relativitätsprinzips.
Lorentz u. d. h. v. Einstein u. d. h. v.

18. VI

$$c \times 10 \sim c \gamma \sim \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \times c \gamma \sim \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \times c \gamma$$

$$c = 1 \quad \gamma = \beta \quad \text{etc.}$$

$$x' = \frac{x - \beta t}{\kappa} \quad y = y' \quad z = z' \quad t' = \frac{t - \frac{\beta x}{c}}{\kappa}$$

$$g'_x = \frac{g_x - \frac{\beta}{c} g_t}{\kappa} \quad \dots \quad g' = \frac{g - \frac{\beta}{c} p_x}{\kappa}$$

$$u'_x = \frac{u_x - \frac{\beta v}{c}}{\kappa} \quad \dots \quad p' = \frac{p - \frac{\beta}{c} p_x}{\kappa}$$

$$p'_x = \frac{p_x - \frac{\beta}{c} (p_t)}{\kappa} \quad \dots \quad (p' \rho') = \frac{(\rho \rho) - \frac{\beta}{c} p_x}{\kappa}$$

Wiederholung des Relativitätsprinzips.

$$x'^2 + y'^2 + z'^2 - c^2 t'^2 = x^2 + y^2 + z^2 - c^2 t^2$$

Minkowski $x \sim u = icl = ict$

$$u' = icl' \quad x'^2 + y'^2 + z'^2 + u'^2 = x^2 + y^2 + z^2 + u^2$$

$C \supset \circ$ in $V \sim$ Drehung $\circ$ $P \circ$ $xyzu$ $S/\sim$

$$x' = \frac{x + i\beta u}{\kappa} \quad y' = y \quad z' = z \quad u' = \frac{u - i\beta x}{\kappa}$$

$$s'_{ix} = \frac{s_{ix} + i\beta(i s)}{\kappa} \quad \text{,,} \quad \text{,,} \quad i s' = \frac{i s - i\beta(s u)}{\kappa}$$

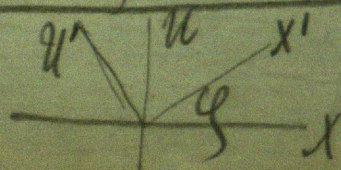
$$u'_{ix} = \frac{u_{ix} + i\beta(i u)}{\kappa} \quad \text{,,} \quad \text{,,} \quad i u' = \frac{i u - i\beta u_x}{\kappa}$$

$$p'_x = \frac{p_x + i\beta(i p)}{\kappa} \quad \text{,,} \quad \text{,,} \quad i(p' p) = \frac{i(p p) - i\beta p_x}{\kappa}$$

Drehung $\sim$ (xu) Ebene CS $\cos \varphi = \frac{1}{\sqrt{1-\beta^2}}$

$$\sin \varphi = \frac{i\beta}{\sqrt{1-\beta^2}} \quad \underline{\underline{\tan \varphi = i\beta}}$$

$$x' = x \cos \varphi + u \sin \varphi \quad u' = -x \sin \varphi + u \cos \varphi$$



$\sim$ eq $z \sim$ uv $\rightarrow$ $Ma \varphi$ u $phys.$ $- \varphi \in cl$

$$e^{i\varphi} = e^{i\varphi} \quad q = -ict p \varphi$$

$$q_1 = -ict p \varphi_1 \quad \left. \begin{array}{l} q_2 = -ict p \varphi_2 \end{array} \right\} e^{i\varphi} = e^{i\varphi_1 + i\varphi_2}$$

$$e^{i\varphi} = e^{i\varphi_1 + i\varphi_2} \quad q = -ict p (\varphi_1 + \varphi_2)$$

$$= -ict p \varphi_1 - ict p \varphi_2 = \frac{q_1 + q_2}{1 - \tan \varphi_1 \tan \varphi_2} = \frac{q_1 + q_2}{1 + \frac{q_1 q_2}{c^2}} \quad \text{ist } \varphi \text{ phys.}$$

f. 4. Ma $z/\sim$ $Mink.$ 1 $Welt$.

$$\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2} - \frac{1}{c^2} \frac{\partial^2}{\partial t^2} = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial u^2} = \square t$$

$e^{\sim} = \frac{1}{\sqrt{1-\beta^2}}$ $\sim$ $z/\sim$ 1 $\sim$ 18 Ma f

$\square$ $operator$ $\square$ all in eq $\circ$ $P \circ$ $invariant$

e g $z/\sim$ φ $\sim$ 4 Ma $z/\sim$ Cl $\{s'_{ix}, \dots, i s'\}$

$$\Phi'_x = \frac{\Phi_x + i\beta \Phi_u}{\kappa} \quad \Phi'_y = \Phi_y \quad \Phi'_z = \Phi_z \quad \Phi'_u = \frac{\Phi_u - i\beta \Phi_x}{\kappa}$$

f. 2 Ma $z/\sim$ $P \circ$ Cl $\sim$ $\circ$ $Binavektoren$.

2. inhomog. $\mathcal{O}$ $x' = \alpha_1 x + \alpha_2 y + \alpha_3 z$
 $y' = \alpha_1' x + \alpha_2' y + \alpha_3' z$

$P = \{p_x, p_y, p_z, i\varphi\}$ Viererstrom
 Φ Viererpotential $\Phi_x = A_x$ $\Phi_u = i\varphi$
 F Viererkraft $F_u = i(\rho u)$

$\sim$ allgemeine Lorentztransformation von
 $-u' \leq z \leq u$

$$\begin{cases} x' = a_{11}x + a_{12}y + a_{13}z + a_{14}u \\ y' = a_{21}x + \dots + a_{24}u \\ z' = a_{31}x + \dots + a_{34}u \\ u' = a_{41}x + \dots + a_{44}u \end{cases} \quad \text{Lorentztransf.}$$

$x'^2 + y'^2 + z'^2 + u'^2 = x^2 + y^2 + z^2 + u^2$

$a_{11}^2 + a_{21}^2 + a_{31}^2 + a_{41}^2 = 1$

$a_{12}^2 + a_{22}^2 + a_{32}^2 + a_{42}^2 = 1$

$a_{11}a_{22} + a_{21}a_{12} + a_{31}a_{22} + a_{41}a_{22} = 0$ $\} 6$

2. inhomog. $\mathcal{O}$

19. VI 1912

2. inhomog. $\mathcal{O}$

$x = a_{11}x' + a_{21}y' + a_{31}z' + a_{41}u'$

$y = a_{12}x' + a_{22}y' + a_{32}z' + a_{42}u'$

$z = a_{13}x' + \dots$

$u = a_{14}x' + a_{24}y' + a_{34}z' + a_{44}u'$

	x'	y'	z'	u'
x	a_{11}	a_{21}	a_{31}	a_{41}
y	a_{12}	a_{22}	a_{32}	a_{42}
z	a_{13}	a_{23}	a_{33}	a_{43}
u	a_{14}	a_{24}	a_{34}	a_{44}

$$\Delta = \begin{vmatrix} a_{11} & a_{21} & a_{31} & a_{41} \\ a_{12} & a_{22} & a_{32} & a_{42} \\ a_{13} & a_{23} & a_{33} & a_{43} \\ a_{14} & a_{24} & a_{34} & a_{44} \end{vmatrix}$$

$$\Delta^2 = \begin{vmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{vmatrix} = 1$$

$\Delta = +1$

2. inhomog. $\mathcal{O}$

$x = x' \quad y = y' \quad z = z' \quad u = u'$

$$\Delta = \frac{\partial(x'y'z'u)}{\partial(xyzu)} = 1 \quad \text{c} \quad \partial_1 \partial_2 \partial_3 \partial_4$$

- also eqn - Lorentz Transformation

h p die vicy, h c y well

a_{14} imaginär a_{44} reell 70°

$a_{44} > 0 \sim \text{WLF} \sim \text{the } \sigma \sim \text{the } \sigma \sim \text{the } \sigma$

~ Viarektur ~ C - 7 196 492 1100

$$\Pi \quad \Pi_x' = a_{11}\Pi_x + a_{12}\Pi_y + a_{13}\Pi_z + a_{14}\Pi_u$$

$$\text{cut } y = \frac{40}{e} \log f = 2.2744 \approx 22.74\%$$

С 1891 = электродинамика - 1892, 1893, 1894, 1895

4.2.2. Lorentz-Transf. ggr

	x'	y'	z'	u'
x	$\frac{1}{K}$	0	0	$-\frac{i\beta}{K}$
y	0	1	0	0
z	0	0	1	0
u	$\frac{i\beta}{K}$	0	0	$\frac{1}{K}$

$$x' = \frac{x + i\beta u}{k} \quad y' = y \quad z' = z$$

$$u' = \frac{u - i\beta x}{k}$$

082-543032629

	x'	y'	z'	u'
x	C_{11}	C_{12}	C_{13}	0
y	C_{21}	C_{22}	C_{23}	0
z	C_{31}	C_{32}	C_{33}	0
u	0	0	0	1

4 m² Vektoralgebra

Skalar $\phi = \pi_x \phi_x + \pi_y \phi_y + \pi_z \phi_z + \pi_u \phi_u \in \mathbb{C}^2$ -wert

$$e \text{ of } h \circ \psi = \pi_x \phi_x + \pi_y \phi_y + \pi_z \phi_z + \pi_u \phi_u$$

$$|\pi| = \sqrt{\pi_x^2 + \pi_y^2 + \pi_z^2 + \pi_u^2}$$

a flux in $\vec{B}$ $\perp$ a $\pi\phi = 0$

$$\text{Div } \vec{F} = \frac{\partial F_x}{\partial x} + \frac{\partial F_y}{\partial y} + \frac{\partial F_z}{\partial z} + \frac{\partial F_u}{\partial u} = \frac{\partial F_x'}{\partial x'} + \frac{\partial F_y'}{\partial y'} + \dots$$

clearly $\frac{\partial}{\partial x} = a_{11} \frac{\partial}{\partial x} + a_{12} \frac{\partial}{\partial y} + \dots$

Cpl 20, Div - Diverskames

$$\mathcal{P} = \{g_{xx}, g_{yy}, g_{zz}, ip\} \quad \frac{1}{c} \frac{\partial \mathcal{P}}{\partial t} \quad c=1$$

$$\text{Die } P = \frac{\partial \varphi(x)}{\partial x} + \frac{\partial \varphi(y)}{\partial y} + \pi \frac{\partial \varphi}{\partial u} = \text{div}(\varphi \eta) + \frac{\partial \varphi}{\partial t}$$

Div P = 0

$\Phi = \{ \varphi_x, \varphi_y, \varphi_z, i\varphi \}$

$\text{Div } \Phi = \text{div } \vec{A} + \frac{1}{c} \dot{\varphi} = 0$

Div \Phi = 0

$\square \Pi = \{ \square \Pi_x, \square \Pi_y, \square \Pi_z, \square \Pi_u \}$

2. 1) $\partial \Pi_x \in \square \sim \partial \varphi_x$

$\square \Phi = \frac{\partial^2 \varphi_x}{\partial x^2} - \frac{\partial^2 \varphi_x}{\partial y^2} + \frac{\partial^2 \varphi_x}{\partial z^2} + \frac{\partial^2 \varphi_x}{\partial u^2}$

$= \Delta \varphi_x - \frac{1}{c^2} \ddot{\varphi} = -4\pi \frac{\rho \varphi_x}{c} = -4\pi P_x$

$\square \Phi_y = -4\pi P_y \quad \square \Phi_z = -4\pi P_z$

$\square \Phi_u = i \{ \Delta \varphi - \frac{1}{c^2} \ddot{\varphi} \} = i(-4\pi \rho) = -4\pi P_u$

es: $\square \Phi = -4\pi P$

10. 11. 1912

2. 1) $\partial \Pi_x \in \square \sim \partial \varphi_x$

$\frac{\partial \Phi_x}{\partial y} - \frac{\partial \Phi_y}{\partial x}$	$\frac{\partial \Phi_u}{\partial x} - \frac{\partial \Phi_x}{\partial u}$
$\frac{\partial \Phi_x}{\partial z} - \frac{\partial \Phi_z}{\partial x}$	$\frac{\partial \Phi_u}{\partial y} - \frac{\partial \Phi_y}{\partial u}$
$\frac{\partial \Phi_x}{\partial u} - \frac{\partial \Phi_u}{\partial x}$	$\frac{\partial \Phi_u}{\partial z} - \frac{\partial \Phi_z}{\partial u}$

$\frac{\partial \Phi_x}{\partial y} - \frac{\partial \Phi_y}{\partial x} = \frac{\partial \varphi_x}{\partial y} - \frac{\partial \varphi_y}{\partial x} = \mathcal{G}_{yx}$

$\frac{\partial \Phi_x}{\partial z} - \frac{\partial \Phi_z}{\partial x} = \mathcal{G}_{zx}$

$\frac{\partial \Phi_x}{\partial u} - \frac{\partial \Phi_u}{\partial x} = \mathcal{G}_{xu}$

$\frac{\partial \Phi_u}{\partial x} - \frac{\partial \Phi_x}{\partial u} = \frac{\partial i\varphi}{\partial x} - \frac{\partial \varphi_x}{\partial i\varphi} = i \{ \frac{\partial \varphi}{\partial x} + \frac{1}{c} \frac{\partial \varphi_x}{\partial t} \} = -i\mathcal{G}_x$

$\frac{\partial \Phi_u}{\partial y} - \frac{\partial \Phi_y}{\partial u} = -i\mathcal{G}_y$

$\frac{\partial \Phi_u}{\partial z} - \frac{\partial \Phi_z}{\partial u} = -i\mathcal{G}_z$

Schurvektor $\mathcal{M} = \text{Rat } \Phi$

$\mathcal{M} \{ \mathcal{M}_{yz} = \mathcal{G}_{yx}, \mathcal{M}_{zx} = \mathcal{G}_{zy}, \mathcal{M}_{xy} = \mathcal{G}_{xz} \}$

$\mathcal{M}_{xu} = -i\mathcal{G}_x, \mathcal{M}_{yu} = -i\mathcal{G}_y, \mathcal{M}_{zu} = -i\mathcal{G}_z$

$\mathcal{M}_{ik} = -\mathcal{M}_{ki}$

2. 3. 12. 1912. 1. 1. 1913. 1. 1. 1914.

$$[\pi, \pi] = \{ f_{\pi}(u, x), f_{\pi}(u, y), f_{\pi}(u, z) \}$$

$24 \text{ } \partial^{\alpha} \bar{\psi} \gamma_{\mu} \psi = 0$

$1 \times y z \perp y \quad 1 \perp z \quad y \perp z$

$$\begin{matrix} \phi & \phi_x & \phi_y & \phi_z & \phi_{xx} & \phi_{yy} & \phi_{zz} \\ \psi & \psi_x & \psi_y & \psi_z & \psi_{xx} & \psi_{yy} & \psi_{zz} \end{matrix} \quad \left. \begin{matrix} \\ \\ \\ \\ \\ \\ \end{matrix} \right\} \phi \psi = 0$$

C has 2 subgroups x, yz, u and $\bar{x}\bar{y}\bar{z}\bar{u}$

$\bar{x}\bar{y} - y\bar{x} = a_{xy}$

$$w_{xy} = x\bar{y} - y\bar{x}$$

$$\alpha_{yz} = y\bar{z} - z\bar{y}$$

$$a_{zx} = z\bar{x} - x\bar{z}$$

$$\sigma_{x\bar{x}} = x\bar{x} - n\bar{x}^2$$

$$a_{ji} = y_i \bar{u} - u_i \bar{y}$$

$$A_{zu} = z\bar{u} - u\bar{z}$$

Ch 9 13420

$e^{100} c_2 \approx 10^6$

2nd day of life

06052261142

—

accusator

$$|u|^2 = \alpha_x^2 + \alpha_y^2 + \alpha_z^2 + \alpha_u^2 + \alpha_v^2 + \alpha_w^2$$

Les "J"-Invariante 14^{me} et 20^{me}

$$u_{ik} = -u_{ki}$$

cal 26 $u_{xy} u_{zu} + u_{yz} u_{xu} + u_{zx} u_{yu} = 0$

in 2 e 4 6 8 10 12, 15 17

2 p 67^e / a 3. v.

8/12¹⁰ in lat 24 N lon 27 W 5 g. h.

EBD: 1794-1821

$$\frac{1}{u}, \frac{4}{u}, \frac{3}{u}, \frac{5}{u}, \frac{4}{u}, \frac{3}{u} \} 6 \text{ a } 17 \text{ gph}$$

f; 29 I P. n r d < l z c v m e z e z

6 e v the an 1 h am c; 6 5 & h.

27.6 / Schnurvektoren nicht vgl. $\mathbb{R}$ identifizieren

Sommerfeld 6. 6. 2017

9 e 1.6.

exfa $\rho_{\text{Eröpfung}}$ i^* ~ 0.6:

$$u_x = u_{34}$$

$$u^x y^z = u^x u^z$$

$$u_x = a_y u$$

$$\alpha_{\lambda\mu}^* = \alpha_{\mu\lambda}$$

$$U_{yu}^x = U_{zx}^x$$

$$u_{zu}^* = u_{x\delta}$$

$$\text{in } \mathbb{C}^2 \text{ h } \alpha^x \in \perp \gamma \alpha$$

$$\text{in } \mathbb{C}^2 \text{ h } \alpha^x \in \perp \gamma \alpha$$

$$\alpha^x \gamma^x \bar{\alpha}^x \bar{\gamma}^x = \alpha^x \gamma^x \bar{\alpha}^x \bar{\gamma}^x = \alpha^x \gamma^x \bar{\alpha}^x \bar{\gamma}^x = \alpha^x \gamma^x \bar{\alpha}^x \bar{\gamma}^x$$

$$\alpha^x \gamma^x = \alpha^x \gamma^x + \gamma^x \gamma^x + \bar{\alpha}^x \bar{\gamma}^x + \bar{\alpha}^x \bar{\gamma}^x = 0 \quad \left. \begin{array}{l} \bar{\alpha}^x \bar{\gamma}^x \\ \alpha^x \gamma^x \end{array} \right\} \text{ in } \mathbb{C}^2 \text{ h}$$

$$\alpha^x \gamma^x = 0$$

$$\bar{\alpha}^x \bar{\gamma}^x = \bar{\alpha}^x \bar{\gamma}^x + \bar{\gamma}^x \bar{\gamma}^x + \alpha^x \alpha^x + \alpha^x \alpha^x = 0$$

$$\text{in } \mathbb{C}^2 \text{ h } \alpha^x \gamma^x : \alpha^x \gamma^x : \dots \alpha^x \gamma^x = \alpha^x \gamma^x : \alpha^x \gamma^x : \dots$$

$$\alpha = [\alpha^x \bar{\alpha}^x] \quad \text{21. II. 1912} \quad \alpha^x = [\alpha^x \bar{\alpha}^x]$$

$$\alpha^x \gamma^x = \gamma^x \bar{\gamma}^x - \bar{\gamma}^x \bar{\gamma}^x = \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x = 0$$

$$\alpha^x \gamma^x = \gamma^x \bar{\gamma}^x - \bar{\gamma}^x \bar{\gamma}^x = \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x = 0$$

$$\alpha^x \gamma^x = \gamma^x \bar{\gamma}^x - \bar{\gamma}^x \bar{\gamma}^x = \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x = 0$$

$$\alpha^x \gamma^x = \gamma^x \bar{\gamma}^x - \bar{\gamma}^x \bar{\gamma}^x = \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x = 0$$

$$\alpha^x \gamma^x = \gamma^x \bar{\gamma}^x - \bar{\gamma}^x \bar{\gamma}^x = \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x = 0$$

$$\alpha^x \gamma^x = \gamma^x \bar{\gamma}^x - \bar{\gamma}^x \bar{\gamma}^x = \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x = 0$$

$$\alpha^x \gamma^x = \gamma^x \bar{\gamma}^x - \bar{\gamma}^x \bar{\gamma}^x = \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x = 0$$

$$\alpha^x \gamma^x = \gamma^x \bar{\gamma}^x - \bar{\gamma}^x \bar{\gamma}^x = \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x + \alpha^x \gamma^x \alpha^x \gamma^x = 0$$

$$\alpha^x \gamma^x$$

$$\alpha^x \gamma^x (\alpha^x \gamma^x) = (\alpha^x \gamma^x) = \dots = 0 \quad \alpha^x \gamma^x \alpha^x \gamma^x$$

$$\alpha^x \gamma^x : \alpha^x \gamma^x : \alpha^x \gamma^x : \alpha^x \gamma^x : \alpha^x \gamma^x : \alpha^x \gamma^x : \alpha^x \gamma^x : \alpha^x \gamma^x : \dots$$

$$\text{in } \mathbb{C}^2 \text{ h } \alpha^x \gamma^x \text{ is a Sechseckvektor:$$

$$(\alpha \gamma) = \alpha^x \gamma^x + \alpha^x \gamma^x + \dots \alpha^x \gamma^x$$

$$(\alpha \alpha^x) = \alpha^x \gamma^x + \alpha^x \gamma^x + \dots \alpha^x \gamma^x$$

$$= \alpha^x \gamma^x + \alpha^x \gamma^x + \alpha^x \gamma^x + \dots = 0$$

$$\text{in } \mathbb{C}^2 \text{ h } (\alpha) = (\alpha^x) = 1$$

$$\text{Sechseckvektor eingeführt } \alpha = \mathcal{S} \alpha + \mathcal{S}^x \alpha^x$$

$$\alpha \in \mathbb{C}^2 \text{ h}$$

$$|\alpha|^2 = \mathcal{S}^2 \alpha^2 + \mathcal{S}^x \alpha^x + 2 \mathcal{S} \mathcal{S}^x (\alpha \alpha^x) = \mathcal{S}^2 + \mathcal{S}^x$$

$$\text{dual of } \alpha^* = \mathcal{S}^* \alpha + \mathcal{S}^x \alpha^x$$

$$\alpha^*_{xy} = \mathcal{S}^* \alpha_{xy} + \mathcal{S}^x \alpha^x_{xy} = \mathcal{S}^* \alpha^*_{zu} + \mathcal{S}^x \alpha^x_{zu} = \alpha^*_{zu}$$

c A 3D vector in $\mathbb{R}^3$ with $|c| = 1$
 $c^T c = 1$

Sechseckter ~ $\sim \sim \sim \sim \sim \sim$
 26er Schema

2D Lorentz-T.

	x	y	z	u		∂_{y^2}	∂_{tx}	∂_{xy}	∂_{xu}	∂_{yu}	∂_{zu}
x'	$\frac{1}{\kappa}$	0	0	$\frac{i\beta}{\kappa}$	∂_{y^2}	1	0	0	0	0	0
y'	0	1	0	0	∂_{tx}	0	$\frac{1}{\kappa}$	0	0	0	$\frac{i\beta}{\kappa}$
z'	0	0	1	0	∂_{xy}	0	0	$\frac{1}{\kappa}$	0	$-\frac{i\beta}{\kappa}$	0
u'	$\frac{i\beta}{\kappa}$	0	0	$\frac{1}{\kappa}$	∂_{xu}	0	0	0	1	0	0
					∂_{yu}	0	0	$\frac{i\beta}{\kappa}$	0	$\frac{1}{\kappa}$	0
					∂_{zu}	0	$-\frac{i\beta}{\kappa}$	0	0	0	$\frac{1}{\kappa}$

$\text{Rot } \Phi = M$ $M_{yz} = \partial_{yz}$ $M_{zu} = -i\partial_z$

2D ∂_{y^2} and ∂_{tx} are not for ∂_{xy}

$\text{Rot } \Phi = [\nabla \Phi]$ $\nabla = \left\{ \frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}, \frac{\partial}{\partial u} \right\}$

no ∂_{y^2} and ∂_{tx}

$M_{yz} = \partial_{yz}$ $M_{zx} = \frac{1}{\kappa} \partial_{tx} + \frac{i\beta}{\kappa} \partial_{zu}$

$M_{xy} = \frac{1}{\kappa} \partial_{xy} - \frac{i\beta}{\kappa} \partial_{yu}$

$M_{xu} = \partial_{xu}$ $M_{yu} = \frac{i\beta}{\kappa} \partial_{xy} + \frac{1}{\kappa} \partial_{yu}$ $M_{zu} = -\frac{i\beta}{\kappa} \partial_{xy} + \frac{1}{\kappa} \partial_{xu}$

$\partial_{x^2} = \partial_{xx}$

$\partial_{y^2} = \frac{1}{\kappa} \partial_{yy} + \frac{\beta}{\kappa} \partial_z$

$\partial_{z^2} = \partial_{zz} - \frac{\beta}{\kappa} \partial_y$

no ∂_{y^2} and ∂_{tx} are not for ∂_{xy} and ∂_{xu}

the ∂_{y^2} and ∂_{tx} are not for ∂_{xy} and ∂_{xu}

$\partial_{y^2} = \frac{1}{\kappa} \partial_{yy} + \frac{\beta}{\kappa} \partial_z$

$[\Phi] = \sim 4 \partial_{xy}$

$[\Phi]_u = \partial_x \partial_{xu} + \partial_y \partial_{yu} + \partial_z \partial_{zu} + \partial_u \partial_{uu}$

$[\Phi]_x = \partial_y \partial_{xy} + \partial_z \partial_{xz} + \partial_u \partial_{xu}$

$$[\Phi \kappa]_y = \Phi_x \kappa_{yx} + \Phi_z \kappa_{yz} + \Phi_u \kappa_{yu}$$

$$\pi \phi^0 = ie \int_{-\infty}^{+\infty} \frac{d\tau}{R^2} \eta = -ie \int \frac{d\tau \eta}{(\tau - \bar{\tau})(R\eta)}$$

$$\int \frac{f(z)}{(z-\xi)} dz = 2\pi i f(\xi)$$

Beilage z. W 35-197

$$\Rightarrow \frac{1}{2} \cdot \frac{2\pi i}{2} \left(\frac{\eta}{(R\eta)} \right) = \frac{e\pi \eta}{(R\eta)}$$

$$\boxed{\phi^0 = \frac{e\eta}{(R\eta)}}$$

$$\eta \left\{ \frac{\frac{dx}{du}}{\sqrt{\left(\frac{dx}{du}\right)^2 + 1}}, \frac{\frac{dy}{du}}{\sqrt{\dots}}, \frac{\frac{dz}{du}}{\sqrt{\dots}}, \frac{1}{\sqrt{\dots}} \right\} \quad \frac{dx}{du} = \frac{dx}{dl} = -i\beta$$

$$\phi_x^0 = \frac{e \frac{dx}{du}}{(R\eta) \sqrt{\dots}}$$

$$\underbrace{(x-x_0) \frac{dx}{d\tau} + (y-y_0) \frac{dy}{d\tau} + \dots + (u-u_0) \frac{du}{d\tau}}_{(\eta \eta) \frac{dl}{d\tau}}$$

$$\eta = \left\{ \frac{dx}{d\tau}, \frac{dy}{d\tau}, \dots \right\}$$

$$u - u_0 =$$

$$R\eta = -i\eta_r \frac{du}{d\tau} + (u - u_0) \frac{du}{d\tau}$$

$$u = il \quad dl = -idu$$

$$= -i \frac{du}{d\tau} [\eta_r + (l - l_0)]$$

$$l - l_0 = r$$

$$du = i dl$$

$$= -i \frac{du}{d\tau} [\eta_r + r] = \frac{dl}{d\tau} [\eta_r + r]$$

$$\phi = \frac{e \eta \frac{d\tau}{d\ell}}{[\eta_r + r]}$$

$$\eta \frac{d\tau}{d\ell}$$

$$\frac{d\tau}{d\ell} = \frac{1}{\cos \alpha}$$

$$\eta = \left\{ \frac{dx}{du}, \frac{dy}{du}, \dots \right\}$$

$$\frac{d\tau}{d\ell} \triangle dl \eta$$

$$d\sigma = dl \sqrt{1+q^2}$$

$$\frac{d\sigma}{d\ell} = \sqrt{1+q^2}$$

$$\phi^0 = \frac{e \sqrt{1+q^2}}{[r + \eta_r] (l - l_0)}$$

$$\eta_x = \frac{-i\eta_r}{\sqrt{q^2+1}}$$

$$\eta_x = \frac{dx}{du} \frac{du}{d\tau}$$

$$\sqrt{\frac{dx^2}{du^2} + \frac{dy^2}{du^2} + \frac{dz^2}{du^2} + 1}$$

$$\frac{d\tau}{d\sigma} \triangle - i dl \eta \quad \frac{du}{d\tau} = \frac{+i}{\sqrt{1+q^2}}$$

$$d\sigma = i \sqrt{1+q^2} du$$

$$\int dx dy dz \cos(nu) = \int \frac{\frac{\partial F}{\partial u}}{\sqrt{\left(\frac{\partial F}{\partial x}\right)^2 + \left(\frac{\partial F}{\partial y}\right)^2 + \left(\frac{\partial F}{\partial z}\right)^2}} du = \int \frac{du}{\sqrt{x^2 + y^2 + z^2 + u^2}} = \int \frac{u}{R}$$

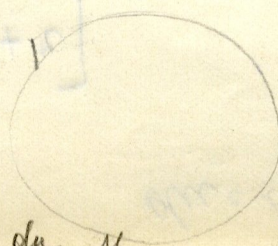
$$F = \int x^2 \sin \vartheta \sin \varphi \, d\vartheta \, d\varphi \, \frac{\sqrt{R^2 - (x^2 + y^2 + z^2)}}{R}$$

$$\begin{cases} x^2 = r^2 \sin^2 \vartheta \cos^2 \varphi \sin^2 \varphi \\ y^2 = r^2 \sin^2 \vartheta \sin^2 \varphi \sin^2 \varphi \\ z^2 = r^2 \cos^2 \vartheta \end{cases} \quad \left. \begin{aligned} & x^2 (\sin^2 \vartheta \sin^2 \varphi + \cos^2 \vartheta) \\ & y^2 \sin^2 \vartheta \sin^2 \varphi \\ & z^2 \cos^2 \vartheta \end{aligned} \right\} r^2 \left\{ \sin^2 \vartheta \sin^2 \varphi + \cos^2 \vartheta \right\}$$

$$r^2 \{ 1 - \sin^2 \vartheta \cos^2 \varphi \}$$

$$r^2 \{ \sin^2 \vartheta + \sin^2 \vartheta \cos^2 \varphi + \cos^2 \vartheta \}$$

$$\int x^2 \sin \vartheta \, d\vartheta \, d\varphi \, \frac{\sqrt{R^2 - r^2 (1 - \sin^2 \vartheta \cos^2 \varphi)}}{R}$$



$$q = f(u)$$

$$\begin{aligned} df &= q \, du \cos(nu) \\ Q &= \int q \, du \cos(nu) \end{aligned}$$

$$\begin{aligned} du &= R \, d\varphi \\ q &= 4\pi R^2 \\ u^2 &= R^2 - u^2 \end{aligned}$$

$$df = q \frac{du}{\sin(nu)}$$

$$f = \int \frac{q(u) \, du}{\sin(nu)}$$

$$\begin{aligned} q &= 4\pi R^2 \\ u^2 &= R^2 - u^2 \end{aligned}$$

$$\sin(nu) = \frac{u}{R}$$

$$\cos(nu) = \frac{u}{R} \quad \sin(nu) = \frac{\sqrt{R^2 - u^2}}{R}$$

$$f = \int \frac{q \, du}{\sqrt{R^2 - u^2}} R = 4\pi R \int \frac{R^2 - u^2}{\sqrt{R^2 - u^2}} \, du = 4\pi R \int \sqrt{R^2 - u^2} \, du$$

$$= 4\pi R \left[\frac{u}{2} \sqrt{R^2 - u^2} + \frac{R^2}{2} \arcsin \frac{u}{R} \right] = 2\pi R^3 \left[\arcsin 1 - \arcsin -1 \right]$$

$$2\pi R^3$$

$$\frac{\pi}{2} - \frac{3\pi}{2} = -\pi$$

$$u = i l$$

$$du = i dl$$

$$\pi \Phi_0 = \iiint_{-\infty}^{+\infty} d\tau du \frac{P}{R^2} = \int d\tau \int_{-\infty}^{+\infty} du \frac{P}{R^2}$$

Beilage z. W35-197

wenn $u = -\infty$

$$l = \frac{u}{i} = +i\infty$$

$$= \int d\tau \int i du \frac{i P}{R^2}$$

$$\pi \Phi = \iiint dx dy dz du \frac{P}{R^2}$$

$$= \int dS \int ds \frac{P}{R^2} = i \int \frac{dS}{R^2} \int d\tau P$$

$$ds = \sqrt{\left(\frac{dx}{du}\right)^2 + \dots + du^2} \quad \tau = -i s \quad s = -\infty$$

$$\tau = +i\infty$$

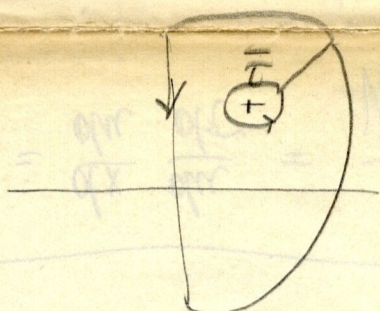
$$\pi \Phi = \int d\tau \int_{-i\infty}^{+\infty} du \frac{P}{R^2} = \int dS \int_{-\infty}^{+\infty} ds \frac{P}{R^2} \quad ds = i d\tau$$

$$= i \int dS \int d\tau \frac{P}{R^2} = - \int dS \oint \frac{d\tau}{R^2}$$

$$\pi \Phi = - \oint_{+i\infty}^{-i\infty} \frac{d\tau}{R^2}$$

$$R^2 = x^2 + (x-x_0)^2 + (y-y_0)^2 + \dots + (u-u_0)^2$$

$$\eta = \left\{ \frac{\partial x}{\partial u}, \frac{\partial y}{\partial u}, \frac{\partial z}{\partial u}, \frac{1}{\sqrt{\dots}} \right\}$$



$$/(l-l_0) = r \quad R^2 = 0 \quad \tau = \bar{\tau}$$

$$ds = \sqrt{(dx)^2 - du^2}$$

$$s = \int \sqrt{(dx)^2 - (du)^2}$$

$$R^2(\tau) = R^2(\bar{\tau}) + (\tau - \bar{\tau}) \frac{\partial R^2}{\partial \tau} + \frac{(\tau - \bar{\tau})^2}{2!} \frac{\partial^2 R^2}{\partial \tau^2} + \dots$$

$$\pi \Phi = i \int dS \int_{+i\infty}^{-i\infty} d\tau \frac{P}{R^2} = i \int dS P \int_{+i\infty}^{-i\infty} \frac{d\tau}{R^2} = \boxed{i e \int_{+i\infty}^{-i\infty} \frac{d\tau}{R^2} \eta}$$

$$\left| \int dS P \right| = e \quad \int dS P = e \eta \quad R^2 = (\tau - \bar{\tau})^2 R \frac{dR}{d\tau}$$

$$\frac{d(R^2)}{d\tau} = 2(x-x_0) \frac{dx}{d\tau} + \dots + (u-u_0) \frac{du}{d\tau} = \frac{du}{d\tau} \left\{ (x-x_0) \frac{dx}{du} + \dots + (u-u_0) \right\}$$

$$\frac{d\tau}{du} = \frac{1}{\sqrt{\dots}}$$

$$R^2 = (\tau - \bar{\tau}) (R \eta) + \dots$$

$$\Phi^0 = \frac{e\eta}{(R\eta)}$$

$$\eta(R\eta) = R \frac{d\ell}{d\tau} [\eta_r + r]$$

$$\Phi^0 = \frac{e\eta \frac{d\tau}{d\ell}}{[r + \eta r]} = \frac{e\eta \sqrt{1-q^2}}{[r + \eta r]}$$

$$\eta_x = \frac{-i m_x}{\sqrt{1+q^2}}$$

$$\Phi_x = \frac{-i e \eta_x}{[r + \eta r]} / (e - r)$$

$$\Phi = \frac{e\eta}{r[1+\eta r]} \frac{d\ell}{d\tau}$$

$$\eta_x = \frac{dx}{d\tau} = \frac{dx}{d\ell} \frac{d\ell}{d\tau}$$

$$\eta_x = \frac{dx}{du} \frac{du}{d\tau} = \frac{\frac{dx}{du}}{\sqrt{\left(\frac{dx}{du}\right)^2 + 1}}$$

$$\frac{du}{d\tau} = \frac{i}{\sqrt{1+q^2}} = \frac{i}{\sqrt{\dots}}$$

$$\frac{du}{dt} \frac{dt}{d\tau} = \frac{d\ell}{d\tau}$$

$$\tau = -ids$$

$$\frac{du}{d\tau} = i \frac{du}{ds} = \frac{i}{\sqrt{\dots}}$$

$$\frac{d\tau}{d\ell} \frac{d\ell}{dt} = \frac{d\tau}{dt}$$

$$d\tau = d\ell \sqrt{1+q^2}$$

$$\frac{dx}{ds} = \frac{dx}{dt} \frac{dt}{ds}$$

$$\frac{dt}{ds} = \sqrt{\dots}$$

$$dt = ds \sqrt{\frac{de}{du}}$$

$$ds = \sqrt{dx^2 + dy^2 + dz^2 + du^2}$$

$$\frac{ds}{du} = \sqrt{\left(\frac{dx}{du}\right)^2 + \dots + 1}$$

$$\frac{du}{ds} = \frac{1}{\sqrt{\left(\frac{dx}{du}\right)^2 + \dots + 1}}$$

$$\frac{d\tau}{d\ell} = \sqrt{1-q^2}$$

$$d\ell = d\tau \sqrt{1-q^2}$$