$\boxed{S\emptyset 1}$

$$S = \{x \in M \mid \tau(x) = 0\}, \quad h : S \times S \to \mathbb{L} \otimes \mathbb{L}$$

$$q \in S : \|q\| = \sqrt{h(q,q)} \in \mathbb{L}$$

EGYS. V. : $\frac{S}{L}$ ELEME :

$$h : \frac{S}{\mathbb{L}} \times \frac{S}{\mathbb{L}} \to \mathbb{R} \qquad n \in \frac{S}{L} : \|n\| \in \mathbb{R}$$

PL. $\|n\| = 1$

$$h : S \times \frac{S}{\mathbb{L} \otimes \mathbb{L}} \to \mathbb{R} \equiv h \in \mathrm{Lin}\left(\frac{S}{\mathbb{L} \otimes \mathbb{L}}, S^*\right)$$

$$S^* \equiv \frac{S}{\mathbb{L} \otimes \mathbb{L}} \qquad M^* \quad M$$

SØ2

$\Pi_u = \mathbb{1} - u \otimes \tau : M \to S$, EZZEL

$b_u(x, y) = b(\Pi_u(x), \Pi_u(y))$

Π_u FÖLÖTT VAN A $\underset{\cdot}{\Pi}_u : \underset{\cdot}{M} \to \underset{\cdot}{S}_u$,

$\tau : M \to T$ FÖLÖTT | $\underset{\cdot}{x} \mapsto \underset{\cdot}{x} + T_u$

VAN $\underset{\cdot}{\tau} : \underset{\cdot}{M} \to \underset{\cdot}{T}$,

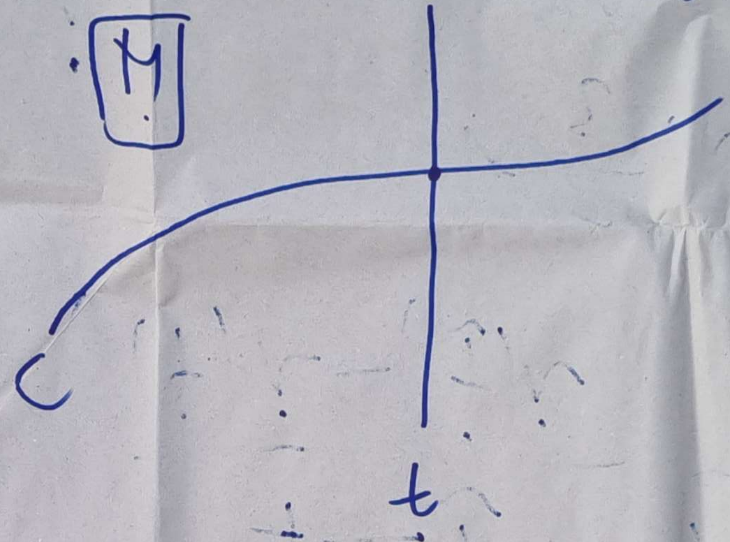
$\underset{\cdot}{x} \mapsto \underset{\cdot}{x} + S$

$\underset{\cdot}{\tau}(\underset{\cdot}{y}) - \underset{\cdot}{\tau}(\underset{\cdot}{x}) = \tau(\underset{\cdot}{y} - \underset{\cdot}{x})$

$\boxed{503}$

VIL.V. PÁR. AZ ABSZ. 1-VEL.

$t \mapsto t \cap C$ $\boxed{M}$



VIL.V. FV

„ELÉG SIMA" $\gamma : T \to M$, MELYRE

$\tau(\gamma(t)) = t$

VIL.V. $\Leftrightarrow$ VIL.V. FV

$\boxed{504}$

$\dot{\gamma}(t) \overset{?}{\in} V(1)$ $\dot{\gamma}(t) : \mathbb{T} \to \mathbb{M}$, $\boxed{\gamma : \mathbb{T} \to \mathbb{M}}$

$\tau(\dot{\gamma}(t)) \overset{?}{=} 1$ $\dot{\gamma}(t) \in \frac{\mathbb{M}}{\mathbb{T}}$

$$\tau\left(\lim_{\tilde{t}\to t} \frac{\gamma(\tilde{t})-\gamma(t)}{\tilde{t}-t}\right) = \lim_{\tilde{t}\to t} \tau\left(\frac{\gamma(\tilde{t})-\gamma(t)}{\tilde{t}-t}\right) =$$

$$= \lim_{\tilde{t}\to t}\left[\frac{\tau(\gamma(\tilde{t})-\gamma(t))}{\tilde{t}-t}\right] = \lim_{\tilde{t}\to t} \frac{\tau(\gamma(\tilde{t}))-\tau(\gamma(t))}{\tilde{t}-t} =$$

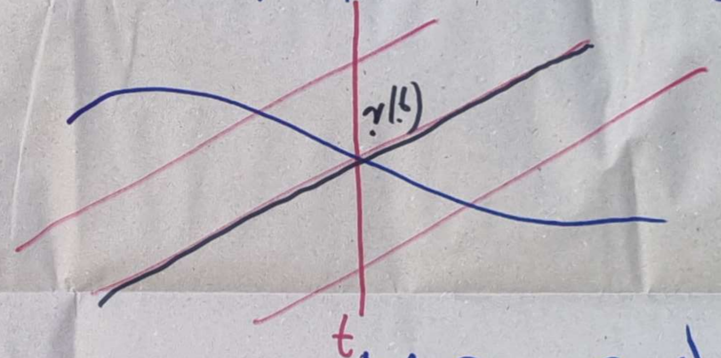
$$= \lim_{\tilde{t}\to t} \frac{\tilde{t}-t}{\tilde{t}-t} = \lim_{\tilde{t}\to t} 1 = 1 \text{ : OK.}$$

505

$\dot{r}(t) \in \frac{S}{T \otimes T}$: AZ ABSZ. GY. TÉRSZERŰ

VAN Ø A. GY., VAN NAGYSÁGA,

2 SZÖGE



TEH. R-BEN u-MOZGÁS EGY

$\dot{r}$-HEZ: $T \to S_u$, $t \mapsto \dot{r}_u(t) :=$

$:= \Pi_u(\dot{r}(t)) = \dot{r}(t) + \overline{}_u$

$\boxed{\text{u-REL. SEB.: } \dot{r}_u(t) := \Pi_u(\dot{r}(t)) = \dot{r}(t) - u}$

TEH. VV: $v_{u'u} = u' - u$

$$\ddot{\vec{v}}_u(t) = \ddot{\vec{a}}(t) \in \frac{S}{T\otimes T}$$ RELGY. = = ABSZ.GY.

TÖMEG PONT

$$M = \frac{T}{L\otimes L} \quad (" t = 1", " t = 1")$$

=: PLANCK-ÁLL.

SZOKÁSOS: N.-EGY.

(REL) = LENDÜLET = TÖMEG × RELS

IDŐDERIVÁLTJA $\stackrel{!}{=}$ RELERŐ

S07)

KEZ. → ÁBR. $\dot{A}$ ~ $\dot{x}$: ÁBR. L.,

$$(x : T \to M)\ 2\ A+VN\ \underbrace{(\sim \dot{x})}_{\sim \ddot{x}} = f(x, \dot{x})$$

2.-RENDŰ K. DE., PL. KEZD. „HELY",
t_0-KOR $x(t_0)$, $\dot{x}(t_0)$ „SEB."

HA $M \times V(1)$ ÉRTÉKŰ: 1-RENDŰ
(FEJL. TÉR)

EGY MO.: FOLYAMAT

$$f : M \times V(1) \to \frac{S}{\text{IL}\otimes\text{L}\otimes\text{T}} \equiv \frac{S^*}{T}$$

508

mv ~~A~~ imp. $\dot{A}$ vektorpot

$p := mv + A$

(q, p)

$(x, \dot{x})$ $t \mapsto (x(t), \dot{x}(t))$

REL. N.-EQ.: $\in M \times V(1) \leftarrow (x, \dot{x})$

$(\dot{x}, v)$

u-REL. LENDÜLET =

TÖMEG $\cdot$ x u-REL. S., $m\Pi_u(\dot{x}) = \Pi_u(m\dot{x})$

CamScannerrel szkennelve

$\boxed{509}$ $\left(\Pi_u(m\dot{x})\right)^{\cdot} = \Pi_u(m\ddot{x}) = m\ddot{x}$

REL. N. - EGY.: $(q : T \to S_u)$?

$(m\dot{q})^{\cdot}(t) = f_u(t, q(t), \dot{q}(t))$

$f_u : T \times S_u \times \frac{S}{T} \rightarrowtail \frac{S^*}{T}$ $\boxed{f_u(t, q, \dot{q}) = f(t \cap q, u + \dot{q}}$

$f(x, \dot{x}) = f_u(\tau(x), \Pi_u(x), v_{\dot{x}u})$

5.10)

ABSZ. LEND. := TÖMEG × ABSZ. S $\quad m\dot{x}$

AMIVEL $(\text{ABSZ. L.})^{\dot{}} =$ TÖMEG × A. GY.

$(m\dot{x})^{\dot{}} = m\ddot{x}$

$\Rightarrow$

$(\text{ABSZ. N.-E.})_1$: $(\text{ABSZ. L.})^{\dot{}} \overset{!}{=}$ ABSZ. ERŐ

$(\text{ABSZ. N.-E.})_2$: TÖMEG × A. GY. $\overset{!}{=}$ ABSZ. ERŐ

S11

U.-REL. L.: TÖM. × U-R. SEB.

MELY ABSZ. L. U-TERSZ. KOMP. $m v_{\dot{x} u}$

ÉS $\left(\text{U-REL. L.}\right)^{\cdot} = \text{TÖM} \times \Pi_u (m \ddot{x})$
U-REL. GY.

$\Rightarrow$ $\left(\text{REL. N.-E.}\right)_1$: $\left(\text{U-REL. L.}\right)^{\cdot} \overset{!}{=} \text{U-REL. ERŐ}$

$\left(\text{REL. N.-E.}\right)_2$: TÖMEG × U-REL. GY. $\overset{!}{=}$ U-REL. ERŐ

S12

POT-OS ERŐK: $K : M \to M^*$,

POT.

$(M \to M^*)$

MEZŐERŐSSÉG

KOTENZOR

$F := D \wedge K = D \otimes K - DK =$

„TÉRERŐSSÉG TENZOR"

$= (DK)^* - DK$

D JOBBRÓL HAT:

$(DK)_{ij} = D_j K_i =$

$= K_i \overleftarrow{D}_j$

S13 RÖGZ. $\underset{\cdot}{x}$, $\underset{\cdot}{\tilde{x}}$; $\Delta \underset{\cdot}{x} := \underset{\cdot}{\tilde{x}} - \underset{\cdot}{x}$:

$$K(\underset{\cdot}{\tilde{x}}) - K(\underset{\cdot}{x}) = \Delta K = (DK)\,\Delta \underset{\cdot}{x} + \underbrace{\text{ordo}(\Delta \underset{\cdot}{x})}_{\text{HIBA}}$$

$$(\Delta K)_i = (DK)_{ij} (\Delta \underset{\cdot}{x})^j + \ldots$$

$$F_{ij} = D_i K_j - D_j K_i = \boxed{\partial_j K_i = K_i \overleftarrow{\partial}_j}$$

$$= \overrightarrow{D}_i K_j - K_i \overleftarrow{D}_j$$

CamScannerrel szkennelve

5.14)

$$f(x, \dot{x}) = i^{*} F(x)\, \dot{x} \qquad i : S \to M$$

$$i^{*} : M^{*} \to S^{*}$$

$$K \underset{u}{\prec} (-V_u, A) - V \wedge L$$

$$F \underset{u}{\prec} \begin{pmatrix} 0 & -i^{*} E u \\ i^{*} E u & i^{*} E i \end{pmatrix} = \begin{pmatrix} 0 & -E_u \\ E_u & B \end{pmatrix} =$$

(8.67)

$$= \begin{pmatrix} 0 & \nabla V_u + D_u A \\ -\nabla V_u - D_u A & \nabla \wedge A \end{pmatrix}$$

5|5|

$(10.1)-(10.2)$:

$$D_u f[\underset{\cdot}{x}] := u^*\left(Df[\underset{\cdot}{x}]\right) = \left(Df[\underset{\cdot}{x}]\right)u$$

$$\nabla f[\underset{\cdot}{x}] := i^*\left(Df[\underset{\cdot}{x}]\right) = \left(Df[\underset{\cdot}{x}]\right)i =$$

$$= \left(Df[\underset{\cdot}{x}]\right)\Big|_S$$

$i^*F(\underset{\cdot}{x})\underset{\cdot}{x} =$

$$\underbrace{i^*F(\underset{\cdot}{x})u}_{\text{BAL ALSÓ EM}} + i^*F(\underset{\cdot}{x})\underbrace{(\underset{\cdot}{x}-m)}_{\text{ABSZ. TERSZ.}} = i(\underset{\cdot}{x}-y$$

$\underset{B}{i^*F(x)i}$,

516

$i^{*}F(\dot{x})\,\dot{x}$ SZETHAS. ALAKJA

$E_u + B\,v_{\dot{x}u}$, LORENTZ-ERŐ!!

HA

K ABSZ. IDŐSZERŰ :

$K \prec_u (-V_u, A)$ -BAN $A=0$

AZAZ $V : M \rightarrowtail T^{*}$, $V_u = 0$

PL. SEB.-FLEN ERŐRE $K = -V\tau$ (RUG., GRAV.)

CamScannerrel szkennelve

S17)

VAN SEB.-FLEN ERŐ

VAN CSAK IDŐTŐL F. ERŐ

VAN ÁLL. ERŐ

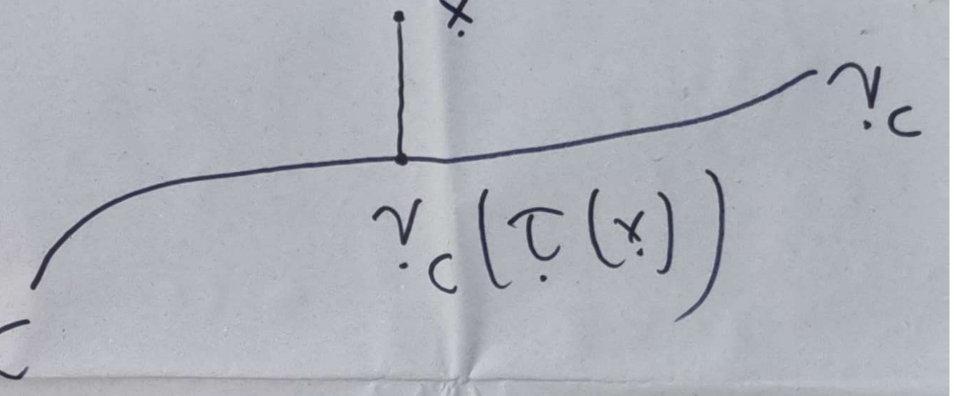
„SZTATIKUS" ERŐ: CSAK u-SZTAT. VAN!

$\exists\, u_s \in V(1)$, MELLYEL $f(x, \dot{x}) = f(x + t u_s, \dot{x})$

$f_u(t, q, \dot{q})$ CSAK $u = u_s$ ESETÉN t-FLEN! $\forall t \in T$

S18)

„CENTRÁLIS" ERŐ:



EGY $a : \mathbb{L} \to \dfrac{\mathbb{R}}{\mathbb{L}\otimes\mathbb{L}\otimes\mathbb{T}}$

-VAL $f(x, \dot{x}) = a\left(\left|x - \dot{r}_c(\dot{\tau}(x))\right|\right)\left(x - \dot{r}_c(\dot{\tau}(x))\right),$

$\left[\ \underline{f}(\underline{r}) = a(r)\,\underline{r}\ \right]$

HA EZ AC

u_c-JŰ TEH. VV:

„ u_c – SZTATIKUS

ÉS ABSZ. SK. POT.-OS

PL. RUGAL-
MAS: $a =$
ÁLL.

$\boxed{519}$ MÁSIK PL.: GRAV.:

$$f(\underset{\cdot}{x}, \dot{\underset{\cdot}{x}}) = \frac{-\gamma m_c m}{|\underset{\cdot}{x} - \underset{\cdot}{r}_c(\tau(\underset{\cdot}{x}))|^3} \left(\underset{\cdot}{x} - \underset{\cdot}{r}_c(\tau(\underset{\cdot}{x}))\right)$$

NEWTON: IDŐ × TÉR

---

u-MOZG. EN. $\frac{m}{2} |v_{\dot{\underset{\cdot}{x}}} u|^2 \in \mathbb{T}^*$

NEM LEHET KOV. u-IDŐSZ:K.

$$\left(\frac{m}{2} |v_{\dot{\underset{\cdot}{x}}} u|^2\right)^{\cdot} = \underbrace{f(\underset{\cdot}{x}, \dot{\underset{\cdot}{x}})\, v_{\dot{\underset{\cdot}{x}}} u}_{\text{REL. TELJ.}} \in \mathbb{T}^* \otimes \mathbb{T}^*$$

$\boxed{520}$

$$\bar{f} : (x, \dot{x}) \mapsto f(\dot{x}, \dot{x}) \left(\mathbb{1} - \dot{x} \otimes \tau \right) \qquad (\dot{X})^{\cdot} \equiv$$

$$\underset{u}{\prec} \left(-f(\dot{x}, \dot{x})\, v_{\dot{x}u} \,,\; f(\dot{x}, \dot{\gamma}) \right)$$

---

u-MOZG.EN. : KOTENZOR IDŐ-IDŐSZ. R.:

$$\frac{m}{2} b_{\dot{x}} \underset{u}{\prec} \begin{pmatrix} \frac{m}{2} v_{\dot{x}u}^{2} & -\frac{m}{2} v_{\dot{x}u} \\ -\frac{m}{2} v_{\dot{x}u} & \frac{m}{2} h \end{pmatrix}$$

$$\left(\frac{m}{2} h_{\dot{x}} \right)^{\cdot} \stackrel{!}{=}$$

$\boxed{S21}$ $\overset{!}{=} N_{\dot{x}}\, f(x, \dot{x})$, AHOL

$N_{\dot{x}} = -\frac{1}{2}\left(\tau \otimes \Pi^{*}_{\dot{x}}\right)^{S_{1,3}}$ ← SZIMMETRIZÁLT AZ 1. ÉS 3. VÁLTOZÓBAN, AZAZ

$$(N_{\dot{x}})^{k}_{ij} = -\frac{1}{2}\left((\Pi_{\dot{x}})^{k}{}_{i}\, \tau_j + (\Pi_{\dot{x}})^{k}{}_{j}\, \tau_i \right)$$

$$\begin{pmatrix} \frac{m}{2} v_{\dot{x}u}^{2} & -\frac{m}{2} v_{\dot{x}u} \\ -\frac{m}{2} v_{\dot{x}u} & \frac{m}{2} h \end{pmatrix}^{\bullet} \overset{!}{=} \begin{pmatrix} f(x, \dot{x})\, v_{\dot{x}u} & -\frac{1}{2} f(x, \dot{x}) \\ -\frac{1}{2} f(x, \dot{x}) & 0 \end{pmatrix}$$

MOZG. EN. – LEND. – TÖMEG KOTENZOR