gravitace

$$g_{mn} \to \nabla_n \to R_{mn}{}^k{}_l$$

$$S_{GR}[g] = \frac{1}{2\varkappa}\int_\Omega (R - 2\Lambda)\, g^{\frac{1}{2}}$$

$$S = S_{GR} + S_{ost.}(\dots, g)$$

$$\frac{\delta S}{\delta g} = 0 \qquad \frac{2}{g^{\frac{1}{2}}}\frac{\delta S_{GR}}{\delta g^{-1}} = -\frac{1}{\varkappa}\left(Ric - \frac{1}{2}R g + \Lambda g\right)$$

$$Ric - \frac{1}{2}R g + \Lambda g = \varkappa T \qquad \nabla_m T^{mn} = 0$$

$$T = -\frac{2}{g^{\frac{1}{2}}}\frac{\delta S_{ost}}{\delta g^{-1}}$$

$$g \to g + \delta g \qquad \delta g_{mn} = \nabla_{(m}\xi_{n)} \qquad \delta S_{GR} = \int \frac{\delta S}{\delta g}\, \delta g$$

Skal. pole

$$\phi(x) \qquad d_n\phi$$

$$S_{SP}[\phi, g] = -\frac{1}{2}\int_\Omega \left(d_m\phi\, g^{mn} d_n\phi + m^2\phi^2\right) g^{\frac{1}{2}}$$

$$S_{SPI}[\phi, g] = -\int_\Omega U(\phi)\, g^{\frac{1}{2}}$$

$$S[\phi, g] = -\frac{\xi}{2}\int_\Omega R\phi^2 g^{\frac{1}{2}}$$

$$\frac{\delta S_{SP}}{\delta\phi} = -g^{\frac{1}{2}}\left[-\Box + m^2\right]\phi \qquad \Box = \nabla_m g^{mn}\nabla_n$$

$$\frac{1}{g^{\frac{1}{2}}}\frac{\delta S_{ost}}{\delta\phi} = J \qquad \left[-\Box + m^2\right]\phi = J$$

$$T_{SP} = d\phi\, d\phi - \frac{1}{2} g \left(d\phi \cdot g^{-1} \cdot d\phi + m^2\phi^2\right)$$

Kalibrační a látková pole

$\mathcal{G}M$ lokální kal. grupa

$\mathfrak{g}M$ lokální kal. algebra

$C_{\mu\nu}{}^{\kappa}$ $\quad k_{\alpha\beta}$

D kalibrační pole

kov. der. na $\mathfrak{g}M$ $\quad Dc = 0$

AM asoc. vekt. bundle

$T_{\alpha}{}^{A}{}_{B}$ $\quad t_m{}^A{}_B = m^\alpha t_\alpha{}^A{}_B$

H_{AB} metr. (sk. součin)

$t_m{}^+ = -t_m$

Φ^A látkové pole $\in$ Sect AM

gravitace

$$g_{\underline{mn}} \to \nabla_{\underline{n}} \to R_{\underline{mn}}{}^{\underline{k}}{}_{\underline{l}}$$

$$S_{GR}[g] = \frac{1}{2\varkappa}\int_{\Omega} (R - 2\Lambda)\, g^{\frac{1}{2}}$$

$$S = S_{GR} + S_{ost.}(\ldots\ldots, g)$$

$$\frac{\delta S}{\delta g} = 0 \qquad \frac{2}{g^{\frac{1}{2}}}\frac{\delta S_{GR}}{\delta g^{-1}} = -\frac{1}{\varkappa}\left(Ric - \frac{1}{2}Rg + \Lambda g\right)$$

$$Ric - \frac{1}{2}Rg + \Lambda g = \varkappa T \qquad \nabla_m T^{mn} = 0$$

$$T = -\frac{2}{g^{\frac{1}{2}}}\frac{\delta S_{ost}}{\delta g^{-1}}$$

$$g \to g + \delta g \qquad \delta g_{\underline{mn}} = \nabla_{(m}\xi_{n)} \qquad \delta S_{GR} = \int \frac{\delta S_{GR}}{\delta g}\delta g$$

Skal. pole

$\phi(x)$ $\quad$ $d_{\underline{m}}\phi$

$$S_{SP}[\phi, g] = -\frac{1}{2}\int_{\Omega} \left(d_{\underline{m}}\phi\, g^{mn}\, d_{\underline{n}}\phi + m^2\phi^2\right) g^{\frac{1}{2}}$$

$$S_{SPI}[\phi, g] = -\int_{\Omega} U(\phi)\, g^{\frac{1}{2}}$$

$$S[\phi, g] = -\frac{\xi}{2}\int_{\Omega} R\,\phi^2\, g^{\frac{1}{2}}$$

$$\frac{\delta S_{SP}}{\delta \phi} = -g^{\frac{1}{2}}\left[-\underbrace{\Box}_{\nabla_{\underline{m}}\, g^{mn}\, \nabla_{\underline{n}}} + m^2\right]\phi$$

$$\frac{1}{g^{\frac{1}{2}}}\frac{\delta S_{int}}{\delta \phi} = J \qquad \left[-\Box + m^2\right]\phi = J$$

$$T_{SP} = d\phi\, d\phi - \frac{1}{2} g\left(d\phi \cdot g^{-1} \cdot d\phi + m^2\phi^2\right)$$

Kalibrační a látková pole

$\mathcal{G}M$ lokální kal. grupa

$\mathfrak{g}M$ lokální kal. algebra

$c_{\underline{\mu\nu}}{}^{\underline{\kappa}}$ $k_{\underline{\alpha\beta}}$

D kalibrační pole

kov. der. na $\mathfrak{g}M$ $Dc = 0$

AM asoc. vekt. bundle

$T_{h}{}^{\underline{A}}{}_{\underline{B}}$ $t_m{}^{\underline{A}}{}_{\underline{B}} = m^{\alpha} t_{\underline{\alpha}}{}^{\underline{A}}{}_{\underline{B}}$

$H_{\underline{AB}}$ metr. (sk. součin)

$t_m^{\dagger} = -t_m$

$\Phi^{\underline{A}}$ látkové pole $\in \mathrm{Sect}\,AM$

kalibrační pole

trivializace E^{M}_{A} ∂

$$D_{\underline{m}} m^{\alpha} = \partial_{\underline{m}} m^{\alpha} + [A_{\underline{m}}, m]^{\alpha}$$

$$A^{\alpha}_{\underline{m}} \qquad F^{\alpha}_{\underline{mn}} = \partial_{\underline{m}} \wedge A^{\alpha}_{\underline{n}} + [A_{\underline{m}}, A_{\underline{n}}]^{\alpha}$$

$$D_{\underline{m}} \wedge D_{\underline{n}} m^{\alpha} = [F_{\underline{mn}}, m]^{\alpha}$$

$$S_{KP}[D, g] = -\frac{1}{4}\varepsilon_{KP} \int F^{\alpha}_{\underline{mn}} F^{\beta}_{\underline{kl}} k_{\alpha\beta} g^{mk} g^{nl} g^{\frac{1}{2}}$$

δS $\qquad D \wedge \delta A \quad F$

$$\frac{\delta S_{KP}}{\delta D^{\alpha}_{\underline{m}}} = \varepsilon_{KP} k_{\alpha\beta} g^{mn} (D_{\underline{k}} F^{\beta}_{\underline{kn}}) g^{kl} g^{\frac{1}{2}}$$

$$\frac{1}{g^{\frac{1}{2}}} \frac{\delta S_{ext}}{\delta D^{\alpha}_{\underline{m}}} = J^{\underline{m}}_{KP\alpha} \qquad g^{kl} (D_{\underline{k}} F^{\alpha}_{\underline{ml}}) = \frac{1}{\varepsilon_{SK}} J^{\alpha}_{\underline{m}}$$

$$D \wedge F = 0 \qquad D_{\underline{m}} J^{\underline{m}}_{\underline{\alpha}} = 0$$

$$T_{\underline{mn}} = \varepsilon_{KP} \left[F^{\kappa}_{\underline{mk}} F^{\nu}_{\underline{nl}} k_{\kappa\nu} g^{kl} - \frac{1}{4} g_{\underline{mn}} F^{\kappa}_{\underline{ab}} F^{\nu}_{\underline{cd}} k_{\kappa\nu} g^{ac} g^{bd} \right]$$

látkové pole

D na $gM \longrightarrow$ na AM

$$D_{\underline{m}} t_{\mu}{}^{\underline{A}}{}_{\underline{B}} = 0 \qquad D_{\underline{m}} H_{\underline{AB}} = 0$$

$$S_{YM}[\Phi, D, g] = -\frac{1}{2} \int \left(D_{\underline{m}} \Phi^{A} D_{\underline{n}} \Phi^{B} H_{\underline{AB}} g^{mn} + M^{2} \Phi^{A} \Phi^{B} H_{\underline{AB}} \right) g^{\frac{1}{2}}$$

$$\frac{\delta S_{YM}}{\delta \Phi^{A}} = -g^{\frac{1}{2}} \left(-g^{mn} D_{\underline{m}} D_{\underline{n}} \Phi^{B} + M^{2} \Phi^{B} \right) H_{\underline{BA}}$$

$$\frac{1}{g^{\frac{1}{2}}} \frac{\delta S_{ext}}{\delta \Phi^{A}} = J_{SP\underline{A}} \qquad \left[-g^{mn} D_{\underline{m}} D_{\underline{n}} + M^{2} \right] \Phi^{A} = J^{B}_{SP}$$

$$J_{KP}{}^{\underline{n}}{}_{\underline{\mu}} = -t_{\mu}{}^{M}{}_{\underline{K}} \Phi^{K} D_{\underline{n}} \Phi^{N} H_{\underline{MN}} g^{mn}$$

$$T_{\underline{mn}} = D_{\underline{m}} \Phi^{A} D_{\underline{n}} \Phi^{B} H_{\underline{AB}} - \frac{1}{2} g_{\underline{mn}} \left(D_{\underline{k}} \Phi^{A} D_{\underline{l}} \Phi^{B} H_{\underline{AB}} g^{kl} + M^{2} \Phi^{A} \Phi^{B} H_{\underline{AB}} \right)$$

kalibrační a látková pole

GM lokální kal. grupa

gM lokální kal. algebra

$c_{\mu\nu}{}^{\kappa} \qquad k_{\alpha\beta}$

D kalibrační pole

kov. der. na gM $\quad Dc = 0$

AM asoc. vekt. bundle

$T_{\underline{m}}{}^{\underline{A}}{}_{\underline{B}} \qquad t_{m}{}^{\underline{A}}{}_{\underline{B}} = m^{\alpha} t_{\alpha}{}^{\underline{A}}{}_{\underline{B}}$

$H_{\underline{AB}}$ metr. (sk. součin)

$t_{m}^{+} = -t_{m}$

Φ^{A} látkové pole $\in \mathrm{Sect}\, AM$

$$A_{\underline{m}}{}^{\underline{k}}{}_{\underline{L}} = A^{\kappa}_{\underline{m}} t_{\kappa}{}^{\underline{k}}{}_{\underline{L}}$$

kalibrační pole

trivializace E^M_A $\quad \partial$

$$D_{\underline{m}} m^\alpha = \partial_{\underline{m}} m^\alpha + [\mathcal{A}_{\underline{k}}, m]^\alpha$$

$$\mathcal{A}^\alpha_{\underline{m}} \qquad F^\alpha_{\underline{mn}} = \partial_{\underline{m}} \wedge \mathcal{A}^\alpha_{\underline{n}} + [\mathcal{A}_{\underline{m}}, \mathcal{A}_{\underline{n}}]^\alpha$$

$$D_{\underline{m}} \wedge D_{\underline{n}} m^\alpha = [F_{\underline{mn}}, m]^\alpha$$

$$S_{KP}[D, g] = -\frac{1}{4} \varepsilon_{KP} \int F^\alpha_{\underline{mn}} F^\beta_{\underline{kl}} k_{\alpha\beta} g^{mk} g^{nl} g^{\frac{1}{2}}$$

$$\delta S \qquad D \wedge \delta\mathcal{A} \quad F$$

$$\frac{\delta S_{KP}}{\delta D^\alpha_{\underline{m}}} = \varepsilon_{KP} k_{\alpha\beta} g^{mn} (D_{\underline{k}} F^\beta_{\underline{ln}}) g^{kl} g^{\frac{1}{2}}$$

$$\frac{1}{g^{\frac{1}{2}}} \frac{\delta S_{ext}}{\delta D^\alpha_{\underline{m}}} = J^m_{KP\underline{\alpha}} \qquad g^{kl} (D_{\underline{k}} F^\alpha_{\underline{ml}}) = \frac{1}{\varepsilon_{st}} J^\alpha_{\underline{m}}$$

$$D \wedge F = 0 \qquad D_{\underline{m}} J^m_{\underline{\alpha}} = 0$$

$$T_{\underline{mn}} = \varepsilon_{KP} \left[F^\mu_{\underline{mk}} F^\nu_{\underline{nl}} k_{\mu\nu} g^{kl} - \frac{1}{4} g_{\underline{mn}} F^\mu_{\underline{ab}} F^\nu_{\underline{cd}} k_{\mu\nu} g^{ac} g^{bd} \right]$$

látkové pole

D na $gM \longrightarrow$ na $A\Pi$

$$D_{\underline{m}} t_{K}{}^{A}{}_{\underline{B}} = 0 \qquad D_{\underline{m}} H_{\underline{AB}} = 0$$

$$S_{YM}[\Phi, D, g] = -\frac{1}{2}\int \left(D_{\underline{m}}\Phi^{A} D_{\underline{n}}\Phi^{B} H_{\underline{AB}} g^{mn} + M^2 \Phi^{A}\Phi^{B} H_{\underline{AB}} \right) g^{\frac{1}{2}}$$

$$\frac{\delta S_{YM}}{\delta \Phi^{A}} = -g^{\frac{1}{2}}\left(-g^{mn} D_{\underline{m}} D_{\underline{n}} \Phi^{B} + M^2 \Phi^{B} \right) H_{\underline{BA}}$$

$$\frac{1}{g^{\frac{1}{2}}}\frac{\delta S_{ost}}{\delta \Phi^{\underline{A}}} = J_{SP\,\underline{A}} \qquad \left[-g^{mn} D_{\underline{m}} D_{\underline{n}} + M^2 \right] \Phi^{A} = J_{SP}^{A}$$

$$\boxed{A_{\underline{m}}{}^{k}{}_{\underline{l}} = \mathcal{A}^{K}_{\underline{m}}\, t_{K}{}^{k}{}_{\underline{l}}}$$

$$J_{KP\,\underline{\mu}}{}^{\underline{n}} = -t_{\underline{\mu}}{}^{M}{}_{\underline{K}} \Phi^{K} D_{\underline{n}} \Phi^{N} H_{\underline{MN}} g^{mn}$$

$$T_{\underline{mn}} = D_{\underline{m}}\Phi^{A} D_{\underline{n}}\Phi^{B} H_{\underline{AB}} - \frac{1}{2} g_{\underline{mn}} \left(D_{\underline{k}}\Phi^{A} D_{\underline{l}}\Phi^{B} H_{\underline{AB}} g^{kl} + M^2 \Phi^{A}\Phi^{B} H_{\underline{AB}} \right)$$