

Title: Degravitation

Date: Sep 11, 2007 09:30 AM

URL: <http://pirsa.org/07090031>

Abstract:

No Signal
VGA-1

No Signal

VGA-1

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No Signal
VGA-1

Dynamische

CG-Problem

Degenerations

CG-Problem

$$\epsilon_{\text{dis}} \approx 10^{-12} \text{ eV}$$

Dezernat

CG-Problem

$$E_{\text{inf}}^{\text{dis}} \sim 10^{-17} \text{ eV}^4$$

$$E_{\text{inf}}^{\text{SM}} = G \overset{\text{UV-cut-off}}{\Lambda^4} + c_2 \Lambda^2 m^2 + c_4 m^4 \ln \frac{\Lambda}{m} + \dots$$

$$E_{\text{SM}}^{\text{SM}} = G \Lambda^4 + C_2 \Lambda^2 m^2 + C_4 m^4 \ln \frac{\Lambda}{m} + \dots$$

\swarrow UV-cut-off

Gesichert UV-completion?

EFT:

eV^4

$$\int_{\ln 7}^{e^{-}} \approx 10^{35} \int_{\ln 7}^{d_1}$$

$$E_{SM} = G \Lambda^4 + c_2 \Lambda^2 m^2 + \dots$$

\swarrow UV-cut-off

c_2 : Why is $E_{UV} \ll E_{IR}$ small?

$$F^{SM} = \dots$$

Q1: Why is E_{hs} small?

Q2: Why does E_{hs} generally scale?

Resonance

multi

Sol: $R \Rightarrow \frac{1}{L}$
Field eq
 $R \leq \frac{1}{L}$

Emulation

Flow-out

Degradation

$$E^{SM} = G A^4 + C$$

High-pow Rthn : $G \frac{A^4}{T_{mu}} = T_{mu}$

Differential Equations

$$E^{SM} = G \Lambda^4 + C$$

High-pen R.R. : $G_{\mu\nu}(\phi) G_{\mu\nu} = T_{\mu\nu}$

High-pure RLa : $G_N(C_{20}) (Eh)_{\mu} = T_{\mu}$

IR-behavior:

1 - m^2CB1

High speed RTR : $G_N(C_{20}) (Eh/m) = T_{\mu}$

TR-behavior:

$$1 - \frac{m^2 C_{20}}{D}$$

High-spin Rarita : $\nabla_{\lambda}(\xi^{\lambda})_{\mu\nu} = -T_{\mu\nu}$

IR-behavior : $\left\{1 - \frac{m^2 c^2}{D}\right\} (\tilde{h})_{\mu\nu} = -T_{\mu\nu}$

High spin RLA : $\square \partial_\mu \partial_\nu \tilde{h}^{\mu\nu} = -T_{\mu\nu}$

R-Limit : $\left\{ 1 - \frac{m^2 c^2}{\square} \right\} (\tilde{h})_{\mu\nu} = -T_{\mu\nu}$

$$(\tilde{h})_{\mu\nu} = \square \tilde{h}_{\mu\nu} - \eta_{\mu\nu} \square \tilde{h} - \partial^\alpha \partial_\mu \tilde{h}_{\nu\alpha} + \partial_\mu \partial^\alpha \tilde{h}_{\nu\alpha} + \partial_\mu \partial_\nu \tilde{h}$$

$$m^2(\text{D})^{\text{TR}} = \frac{1}{L^2} (\text{C}\Pi)^{\alpha}$$

High-pion R.R. : $\square \tilde{h}^{\mu\nu} (\tilde{E}h)_{\mu\nu} = -T_{\mu\nu}$

R. behavior: $\{ \square \tilde{h}^{\mu\nu} (\tilde{E}h)_{\mu\nu} = -T_{\mu\nu} \}$
 $\square \tilde{h}_{\mu\nu} - \tilde{h}_{\mu\alpha} \tilde{h}_{\nu\beta} \square \tilde{h}^{\alpha\beta}$

$$(\tilde{E}h)_{\mu\nu} = \square \tilde{h}_{\mu\nu} - \eta_{\mu\nu} \square \tilde{h} - \partial^\alpha \partial_\alpha \tilde{h}_{\mu\nu} + \partial_\mu \partial_\nu \tilde{h} + \partial_\mu \partial_\alpha \tilde{h}_{\nu\beta} + \partial_\nu \partial_\alpha \tilde{h}_{\mu\beta}$$

$$m^2(\mathbb{D}) \cong \frac{1}{L^2} (L^2 \mathbb{R})^\alpha \quad / \quad \alpha \leq 1$$

Q: lower bound? A: unitarity bound

$$m^2 \langle \phi | \phi \rangle \approx \frac{1}{L^2} (\langle \phi | \phi \rangle)^2 \quad / \quad \alpha \ll 1$$

Q: lower bound? A: unitarity bound

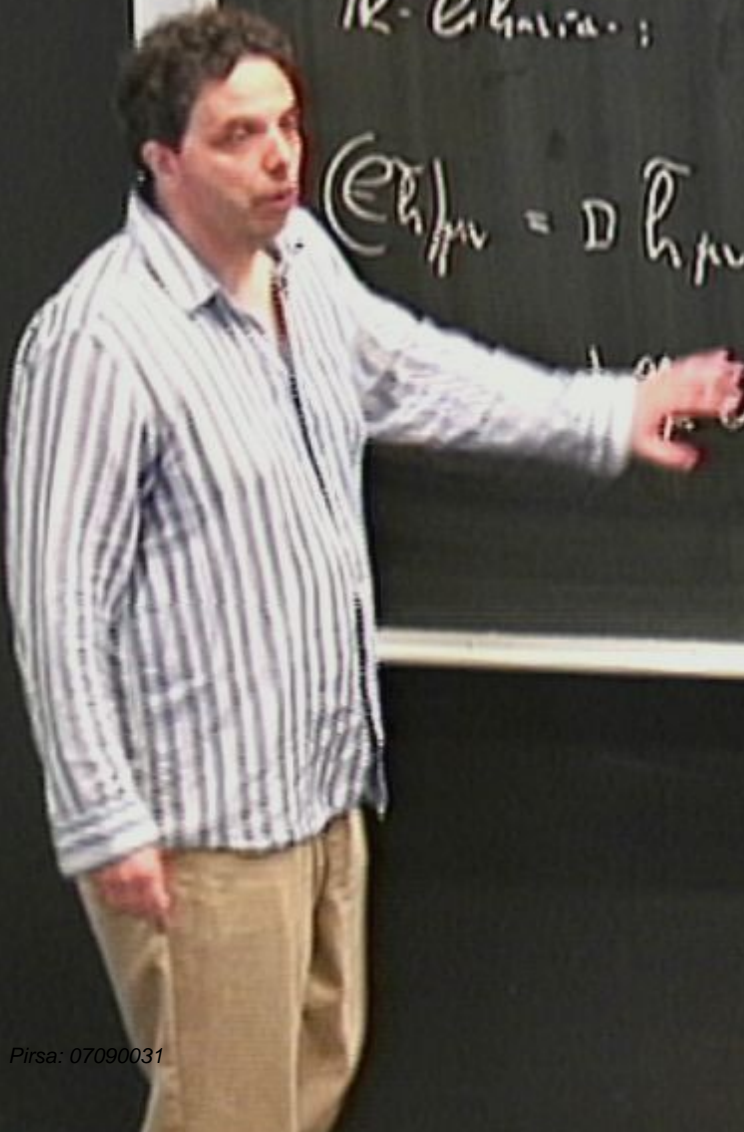
$$\Delta(\phi) = \frac{1}{L^2 + m^2(\phi)} = \int_0^{\infty} ds \frac{\rho(s)}{L^2 + s}$$

High-pure R-tensor : $\tilde{R}_{\mu\nu}(\tilde{h})_{\mu\nu} = -T_{\mu\nu}$

R-tensor :

$$\left(1 - \frac{m^2 \alpha^2}{\Lambda^2}\right) (\tilde{h})_{\mu\nu} = -T_{\mu\nu}$$

$$(\tilde{h})_{\mu\nu} = \square \tilde{h}_{\mu\nu} - \eta_{\mu\nu} \square \tilde{h} - \partial^\alpha \partial_\alpha \tilde{h}_{\mu\nu} + \partial_\mu \partial_\nu \tilde{h} + \partial_\mu \partial_\nu \tilde{h}$$



$$m^2 \langle D \rangle_{\mathbb{R}} = \frac{1}{L^2} (\langle \square \rangle)^{\alpha}$$

$$\alpha \leq 1$$

Q: lower bound? A: unitarity bound

$$\Delta(\mathcal{L}) = \frac{1}{k^2 + m^2(\mathcal{L})} \approx \int_0^{\infty} ds \frac{\Omega(s)^{\gamma-1}}{k^2 + s}$$

$\downarrow k^2 \rightarrow 0$
 $\frac{L^2}{(k^2 L^2)^{\alpha}}$

$$m^2(\Omega) \stackrel{\mathbb{R}}{=} \frac{1}{L^2} (\Omega \Omega)^{\alpha} \quad / \quad \alpha \leq 1$$

Q: lower bound? A: positivity bound

$$\Delta(k) = \frac{1}{k^2 + m^2(k)} = \int_0^{\infty} ds \frac{\Omega \cos(\sqrt{s})}{k^2 + s}$$

$\downarrow k \rightarrow 0$

$\alpha < 0$

$$\frac{L^2}{(k^2 L^2)^{\alpha}}$$

$$m^2(\mathbb{D}) \stackrel{\mathbb{R}}{=} \frac{1}{L^2} (L^2 \mathbb{D})^\alpha \quad / \quad \alpha \leq 1$$

Q: lower bound? A: unitarity bound

$$\Delta(k^2) = \frac{1}{k^2 + m^2(k)} = \int_0^\infty ds \frac{\Omega(s)^{-\alpha}}{k^2 + s}$$

$\downarrow k^2 \rightarrow 0$

$\alpha < 0$

$$\frac{L^2}{(k^2 L^2)^\alpha} \xrightarrow{\alpha < 0} L^2 (k^2 L^2)^{|\alpha|}$$

$$m^2 \langle O \rangle \stackrel{\mathbb{R}}{=} \frac{1}{L^2} \langle O \rangle^2 \quad / \quad \alpha \leq 1$$

α : lower bound? Δ : unitarity bound

$$\Delta(k^2) = \frac{1}{k^2 + m^2(k)} = \int_0^{\infty} ds \frac{\Omega(s)^{-1}}{k^2 + s}$$

$\downarrow k^2 \rightarrow 0$

$$\alpha < 0 \quad \frac{L^2}{(k^2 L^2)^\alpha} \xrightarrow{\alpha < 0} L^2 (k^2 L^2)^{|\alpha|} = 0$$

$$m^2(\Omega) \stackrel{\mathbb{R}}{=} \frac{1}{L^2} (\Omega \Omega)^{\alpha} \quad / \quad \alpha \leq 1$$

Q: lower bound? A: unitarity bound

$$\Delta(L) = \frac{1}{L^2 + m^2(L)} = \int_0^{\infty} ds \frac{\Omega(s)^{-1/2}}{L^2 + s}$$

\downarrow $L \rightarrow 0$

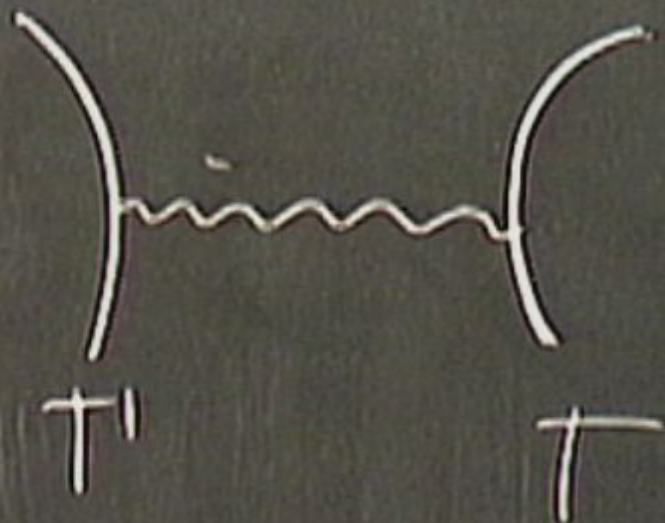
$\alpha < 0$

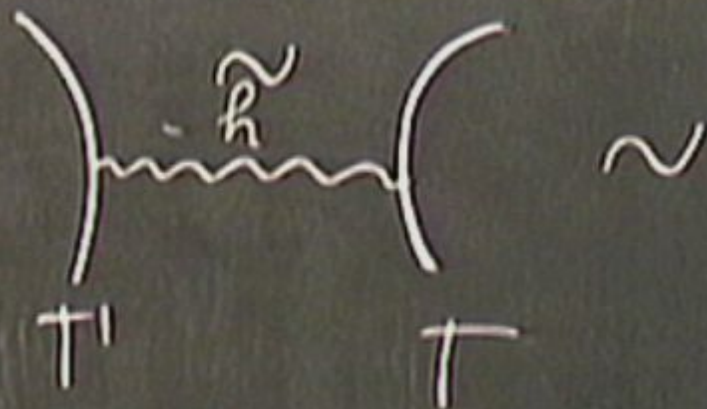
$$\frac{L^2}{(L^2 L)^{\alpha}} \xrightarrow{d \rightarrow 0} L^2 (L^2 L)^{\alpha} = 0$$

$$\begin{aligned} \Omega(s) &\geq 0 \\ \Omega(s) &\neq 0 \end{aligned}$$

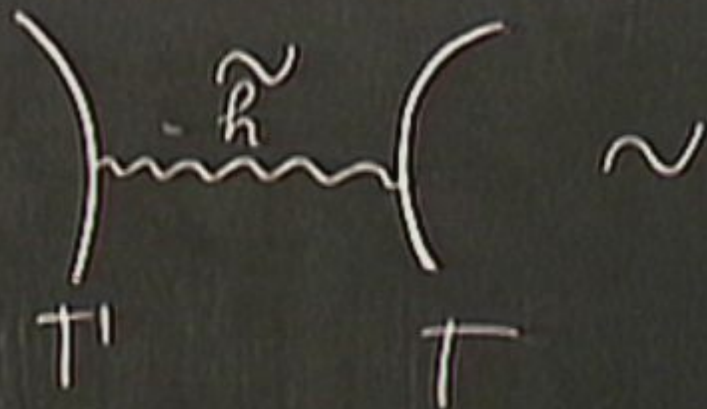
\rightsquigarrow

$$0 \leq \alpha \leq 1$$

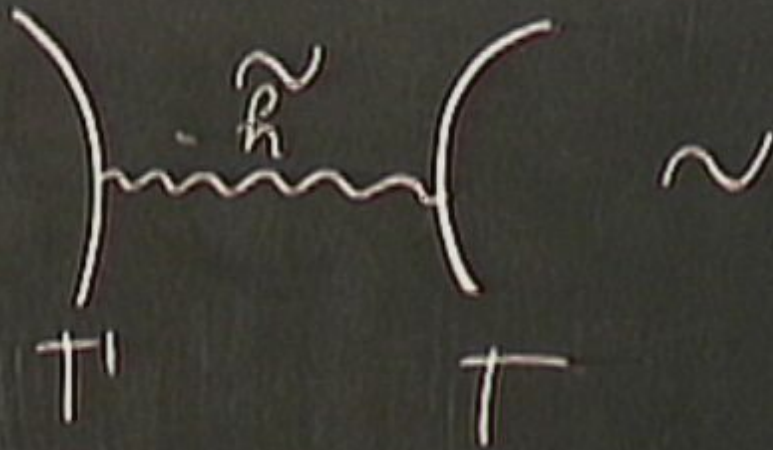




$$\sim T^{\alpha\beta} \frac{1}{2} \eta_{\alpha\mu} \eta_{\nu\beta} - T^{\mu\nu}$$



$$\sim T^{\alpha\beta} \frac{\frac{1}{2} \eta_{\alpha\mu} \eta_{\nu\beta} - \left(\frac{1}{2}\right) \eta_{\mu\nu} \eta_{\alpha\beta}}{\square - m^2(\square)} T^{\mu\nu}$$



$$\begin{array}{c}
 \sim T^{\alpha\beta} \quad \frac{1}{2} \eta_{\alpha\mu} \eta_{\nu\beta} - \left(\frac{1}{2} \eta_{\mu\nu} \eta_{\alpha\beta} \right) T^{\mu\nu} \\
 \xrightarrow{m \rightarrow 0} \text{Feynman} \quad \Delta - m^2(\square)
 \end{array}$$

naive gauge ghost-free quantized then mass gravity (incl. all polarizations)

range gauge front-free linearized thin mass gauge, (incl. all polarization)

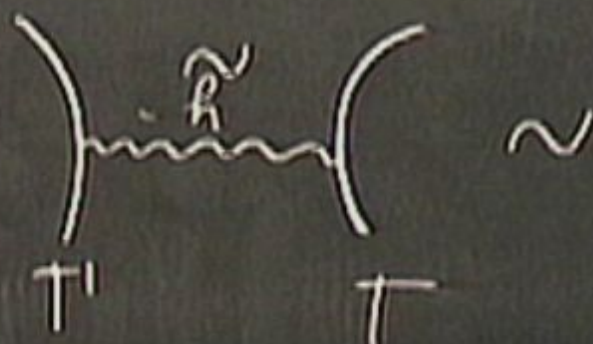
Trans-Part:

$$(Eh)_{\mu\nu} - m^2 (h_{\mu\nu} - \eta_{\mu\nu} h) = -T_{\mu\nu}$$

simple ground fault-free linearized two mass system (incl. all parameters)

Trans. P. 4.1:

$$(E_R)_{in} - m_{in}(\dot{h}_{in} - \eta_{in} \dot{h}_1) = -T_{in}$$

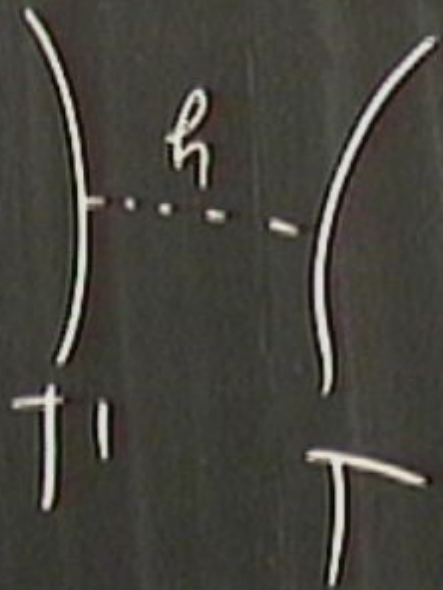


in general ghost-free linearized then mass gravity, (incl. all
 Feyn-Pauli; $(Eh)_{\mu\nu} - m^2 g_{\mu\nu} (h_{\mu\nu} - \eta_{\mu\nu} h) =$

raise general front-free linearized flow mass

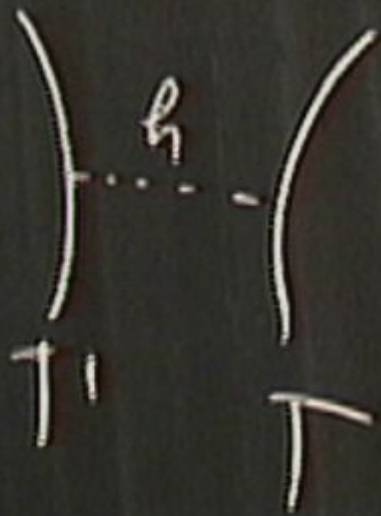
Front-Pack:

$(ER)_n - m^2 (h$



For Part 1:

$$(E_R)_{\text{in}} - m^2 c^2 (h_{\text{in}} - \eta_{\text{in}} h) =$$



$$\sim \frac{T_1 \alpha \rho \left(\frac{1}{2} \eta_{\text{in}} \eta_{\text{out}} - \left(\frac{1}{3} \right) \eta_{\text{in}} \eta_{\text{out}} \right)}{\rho - m^2 c^2} T_1$$

Trans. Pauli:

$$(E_R)_{\mu\nu} - m^2 c^4 (\delta_{\mu\nu} - \eta_{\mu\nu} h) = -T_{\mu\nu}$$

$$\left. \begin{array}{l} \dots h \\ T_{11} \end{array} \right\} \sim T_{11} p \quad \frac{1}{2} \eta_{\mu\nu} \eta_{\mu\nu} - \left(\frac{1}{3} \right) \eta_{\mu\nu} \eta_{\mu\nu} T_{\mu\nu}$$

\rightarrow Einst. \checkmark Dirac-disc.

$$d < 0$$

$$\frac{L^2}{(h^2 L^2)^2} \xrightarrow{d \rightarrow 0} L^2 (h^2 L^2)^{d/2} = 0$$

$$\begin{aligned} \psi(\infty) &= 0 \\ \psi'(\infty) &\neq 0 \end{aligned}$$

naive gauge fixed free quantized then mass gauge, (incl. all polarizations)

Trans. Pauli:

$$(Eh)_\mu - m^2 \omega_\mu (h_\mu - \eta_\mu h) = -T_\mu$$

$$\begin{pmatrix} \vdots \\ h \\ \vdots \end{pmatrix} \sim T^{\mu\nu} p_\nu \quad \frac{1}{2} \eta_{\mu\nu} p^\mu p^\nu - \left(\frac{1}{3}\right) p_\mu p^\mu h$$

$$p \sim m^2 \omega$$

\rightarrow ~~Grav~~ \rightarrow Graviton \checkmark D12 - disc.

more general ghost-free linearized than mass gravity (incl. all polarizations)

Temp. Pauli:

$$(Eh)_{\mu\nu} - m^2 \alpha_1 \left(h_{\mu\nu} - \eta_{\mu\nu} h \right) = -T_{\mu\nu}$$

$$\left. \begin{array}{l} \left. \begin{array}{l} \dots \\ \dots \\ \dots \end{array} \right\} h \\ \dots \\ \dots \\ \dots \end{array} \right\} T_{\mu\nu}$$

$$\sim T_{\mu\nu} \left[\frac{1}{2} \eta_{\mu\nu} \eta_{\alpha\beta} - \left(\frac{1}{3} \right) \eta_{\mu\alpha} \eta_{\nu\beta} \right] T^{\mu\nu}$$

$p \sim m^2 \alpha_1$

$\xrightarrow{h_{\mu\nu}} E_{\text{inst}} \quad \vee \text{D12} - \text{disc.}$

Stückelberg:

$$h_{\mu\nu} = \hat{h}_{\mu\nu}^{(0,1)} + \partial_{(\mu} A_{\nu)}^{(0,1)}$$

Stückelberg:

$$h_{\mu\nu} = \hat{h}_{\mu\nu}^{(0,1)} + \partial_\alpha A_\nu^{(0,1)}$$

gauge - theory

Stückelberg:

$$h_{\mu\nu} = \hat{h}_{\mu\nu}^{(0)} + \partial_{(\mu} A_{\nu)}$$

gauge - theory

$$(\mathcal{L})_{\mu} - m^2(\square) \left\{ \hat{h}_{\mu\nu} - \eta_{\mu\nu} \hat{h} + \partial_{(\mu} A_{\nu)} - \eta_{\mu\nu} \partial \cdot A \right\} = -T_{\mu}$$

$$\hat{h}_{\mu\nu} \rightarrow \hat{h}_{\mu\nu} + \partial_{(\mu} \xi_{\nu)}$$

Stückelberg:

$$h_{\mu\nu} = \hat{h}_{\mu\nu}^{(0)} + \partial_{(\mu} A_{\nu)}$$

gauge - stückelberg

$$(\mathcal{E}^{\hat{h}})_{\mu\nu} - m^2(\square) \left\{ \hat{h}_{\mu\nu} - \eta_{\mu\nu} \hat{h} + \partial_{(\mu} A_{\nu)} - \eta_{\mu\nu} 2 \partial \cdot A \right\} = -T_{\mu\nu}$$

$$\begin{aligned} \hat{h}_{\mu\nu} &\rightarrow \hat{h}_{\mu\nu} + \partial_{(\mu} \xi_{\nu)} \\ A_{\mu} &\rightarrow A_{\mu} - \xi_{\mu} \end{aligned}$$

High- $h_{\mu\nu}$ is gauge inv \Rightarrow $h_{\mu\nu}$ is an obs (on principle)

?R. $\Rightarrow h_{\mu\nu}$ must be the boundary of $h_{\mu\nu}$ change

~~$\mathcal{L}_{\mu\nu} = \int h_{\mu\nu} \dots$~~

High $h_{\mu\nu}$ is gauge inv \Rightarrow $h_{\mu\nu}$ is an obs (in principle)

? $h_{\mu\nu}$ must be the \mathbb{Z}_2 bundle of $h_{\mu\nu}$ change
 \Rightarrow \mathbb{Z}_2 work

$\mathbb{Z}_2 = \mathbb{Z}_2 \times \mathbb{Z}_2$
 $\mathbb{Z}_2 \times \mathbb{Z}_2 = \mathbb{Z}_2 \times \mathbb{Z}_2$
 $\mathbb{Z}_2 \times \mathbb{Z}_2 = \mathbb{Z}_2 \times \mathbb{Z}_2$
 $\mathbb{Z}_2 \times \mathbb{Z}_2 = \mathbb{Z}_2 \times \mathbb{Z}_2$

gauge - theory

$$h_{\mu\nu} = \hat{h}_{\mu\nu}^{(0)} + \partial_{(\mu} A_{\nu)}$$

$$(\mathcal{E}h)_{\mu\nu} - m^2 \eta_{\mu\nu} \left\{ \hat{h}_{\mu\nu} - \eta_{\mu\nu} \hat{h} + \partial_{(\mu} A_{\nu)} - \eta_{\mu\nu} \partial \cdot A \right\} = -T_{\mu\nu}$$

$$\hat{h}_{\mu\nu} \rightarrow \hat{h}_{\mu\nu} + \partial_{(\mu} \xi_{\nu)}$$

$$A_{\mu} \rightarrow A_{\mu} - \xi_{\mu}$$

$$\frac{\partial H}{\partial p_i} = -g_{ir}, \quad g_{ir} = \frac{\partial}{\partial p_i} (\hat{p}_{ir} - m_{ir} \hat{h}^r)$$

$$\frac{\partial H}{\partial t} F_{\mu\nu} = - \mathcal{L}_v, \quad \mathcal{L}_v = \frac{\partial}{\partial t} (\hat{h}_{\mu\nu} - \eta_{\mu\nu} \hat{h}) + \mathcal{L}_{\mu\nu}$$

$$A_{\mu} = \frac{\partial \mathcal{L}}{\partial \dot{\alpha}} \left\{ \hat{h}_{\nu\mu} - \eta_{\nu\mu} \hat{h} \right\}$$

Principles

$$h_{\mu\nu} = \hat{h}_{\mu\nu}^{(0)} + \partial_{\alpha} A_{\nu}^{(0)}$$

$\partial^{\alpha}\gamma^{\beta} - \text{slens}$

$$(\mathcal{L} \hat{h})_{\mu\nu} - m^2(\mathcal{D}) \left\{ \hat{h}_{\mu\nu} - \eta_{\mu\nu} \hat{h} + \partial_{\alpha} A_{\nu} - \eta_{\mu\nu} 2 \partial_{\alpha} A \right\} = -T_{\mu\nu}$$

$$\hat{h}_{\mu\nu} \rightarrow \hat{h}_{\mu\nu} + \partial_{\alpha} \xi_{\nu}$$

$$A_{\mu} \rightarrow A_{\mu} - \xi_{\mu}$$

$$\frac{\partial H}{\partial x^\mu} = -g_{\nu\mu}, \quad g_{\nu\mu} = \frac{\partial}{\partial x^\nu} (\hat{h}_{\mu\alpha} - \eta_{\mu\alpha} \hat{h}) \quad \text{e.g. } \hat{h}_{\mu\alpha}$$

$$A_\mu = -\frac{\partial \Theta}{\partial x^\mu} \left\{ \hat{h}_{\nu\mu} - \eta_{\nu\mu} \hat{h} \right\} + \frac{\partial \Theta}{\partial x^\mu} \hat{h}$$

P = m/c

$$\frac{\partial H}{\partial F_{\mu\nu}} = -g_{\mu\nu}$$

$$g_{\mu\nu} = \frac{\partial}{\partial \dot{z}^\mu} (h_{\mu\nu} - \eta_{\mu\nu} \dot{z}^\alpha \dot{z}^\beta)$$

$$g_{\mu\nu} = \frac{\partial}{\partial \dot{z}^\mu} (h_{\mu\nu} - \eta_{\mu\nu} \dot{z}^\alpha \dot{z}^\beta)$$

$$A_\mu = -\frac{\partial}{\partial \dot{z}^\mu} \left\{ h_{\nu\mu} - \eta_{\mu\nu} \dot{z}^\alpha \dot{z}^\beta \right\} + \frac{\partial}{\partial \dot{z}^\mu} \Theta$$

constraint eqn: $-\partial^\nu h_{\mu\nu} - \eta_{\mu\nu} \partial^\nu \dot{z}^\alpha \dot{z}^\beta = 0$

$$\frac{\partial H}{\partial F_{\mu\nu}} = -g_{\mu\nu}$$

$$g_{\mu\nu} = \frac{\partial H}{\partial h^{\mu\nu}}$$

$$g_{\mu\nu} = \frac{\partial H}{\partial h^{\mu\nu}} (h_{\mu\nu} - \eta_{\mu\nu} h) \quad (h = g_{\mu\nu} h^{\mu\nu})$$

$$A_{\mu} = \frac{\partial L}{\partial \dot{h}^{\mu\nu}} \left\{ h_{\nu\mu} - \eta_{\mu\nu} h \right\} + \frac{\partial L}{\partial h^{\mu\nu}} \Theta$$

constraint eqs: $-\partial^{\nu} \dot{h}_{\mu\nu} - \eta_{\mu\nu} \partial^{\nu} h = 0 \quad (\text{Poisson} = 0)$

$$\frac{\partial \mathcal{H}}{\partial F_{\mu\nu}} = -\mathcal{G}_{\mu\nu}, \quad \mathcal{G}_{\mu\nu} = \frac{1}{2} \partial_{[\mu} (\hat{h}_{\nu]} - \eta_{\nu]} \hat{h}^{\mu])} \quad (\text{Ricci} = 0)$$

$$A_{\mu} = -\frac{\partial \mathcal{L}}{\partial \hat{h}^{\mu\nu}} \left\{ \hat{h}_{\nu\mu} - \eta_{\mu\nu} \hat{h} \right\} + \partial_{\mu} \Theta$$

constraint eqs: $-\partial^{\nu} \hat{h}_{\mu\nu} - \eta_{\mu\nu} \partial^{\nu} \hat{h} = 0 \quad (\text{Ricci} = 0)$

$$\hat{h}_{\mu\nu} = \frac{\partial \mathcal{L}}{\partial \eta^{\mu\nu}} - \eta_{\mu\nu}$$

$$\frac{\partial \mathcal{L}}{\partial h_{\mu\nu}} = -g_{\mu\nu}, \quad g_{\mu\nu} = \partial_{\mu} (\hat{h}_{\mu\nu} - \eta_{\mu\nu} \hat{h})$$

$$A_{\mu} = -\frac{\partial \mathcal{L}}{\partial \hat{h}^{\mu\nu}} \{ \hat{h}_{\nu\mu} - \eta_{\mu\nu} \hat{h} \} + \partial_{\mu} \Theta$$

constraint eqn: $-\partial^{\mu} \partial^{\nu} \hat{h}_{\mu\nu} - \eta_{\mu\nu} \square \hat{h} = 0 \quad (\text{Ricci} = 0)$

$$\hat{h}_{\mu\nu} = \tilde{h}_{\mu\nu} - \eta_{\mu\nu} \frac{1}{3} \partial_{\alpha} \partial^{\alpha} \tilde{h}$$

$$h_{\mu\nu} = \hat{h}_{\mu\nu}^{(0)} + \partial_{\alpha} A_{\nu}^{(0)}$$

gauge - symmetry

$$(\mathbb{E} \hat{h})_{\mu\nu} - m^2(x) \left\{ \hat{h}_{\mu\nu} - \eta_{\mu\nu} \hat{h} + \partial_{\alpha} A_{\nu} - \eta_{\mu\nu} \partial_{\alpha} A \right\} = -T_{\mu\nu}$$

$$\hat{h}_{\mu\nu} \rightarrow \hat{h}_{\mu\nu} + \partial_{\alpha} \xi_{\nu}$$

$$A_{\mu} \rightarrow A_{\mu} - \xi_{\mu}$$

$$\left\{ 1 - \frac{m^2(x)}{\square} \right\} (\mathbb{E} \hat{h})$$

$\gamma^{\alpha\beta} - \text{slens}$

$$h_{\mu\nu} = \hat{h}_{\mu\nu}^{(0)} + \partial_{(\mu} A_{\nu)}$$

$$\partial_{\mu} \hat{h}^{\mu\nu} - m^2 \hat{h}^{\mu\nu} \left\{ \hat{h}_{\mu\nu} - \eta_{\mu\nu} \hat{h} + \partial_{(\mu} A_{\nu)} - \eta_{\mu\nu} \partial_{\alpha} A^{\alpha} \right\} = -T_{\mu\nu}$$

$$\hat{h}_{\mu\nu} \rightarrow \hat{h}_{\mu\nu} + \partial_{(\mu} \xi_{\nu)}$$

$$A_{\mu} \rightarrow A_{\mu} - \xi_{\mu}$$

$$\left\{ -\frac{m^2}{2} \right\} (\hat{h}^{\mu\nu})_{,\mu} + \mathcal{F}(\hat{h}^{\mu\nu}, \dots)$$

$$-m \vec{h} + \partial_\mu A_\nu - m^2 \partial_\mu A = -T_\mu$$

(M \sum_ν)

$$\left\{ -\frac{m^2 \square}{\square} \right\} (\mathbb{E} \tilde{h})_{\mu\nu} + \mathcal{F}(\tilde{h}, \alpha, \sigma) = -T_{\mu\nu}$$

$$-m \frac{h}{h} + (\partial_\mu A_\nu) - \frac{1}{\mu} \partial_\mu \partial_\nu A_\mu$$

(M \sum_v)

$$\left\{ -\frac{m^2 c^2}{\square} \right\} (E \tilde{h})_{\mu\nu} + \mathcal{F}(\tilde{h}, \alpha, \sigma)$$

$$= -T_{\mu\nu}, \quad \delta \mathcal{L}^* \mathcal{F}(\theta^*) = 0$$

↪

$$0 \leq \alpha \leq 1, \quad \alpha \leq \frac{1}{2}$$

$$\frac{\partial H}{\partial p_\mu} = -\dot{x}_\mu$$

$$G_\mu = \frac{\partial}{\partial x^\mu} (h_{\mu\nu} - \eta_{\mu\nu} h) \dot{x}^\nu$$

$$A_\mu = -\frac{\partial L}{\partial \dot{x}^\mu} \left\{ h_{\mu\nu} - \eta_{\mu\nu} h \right\} + \frac{\partial L}{\partial x^\mu} \Theta$$

constraint eq: $-\frac{\partial}{\partial x^\mu} h_{\mu\nu} - \eta_{\mu\nu} \frac{\partial}{\partial x^\mu} h = 0$ (Pirard=0)

$$\hat{h}_{\mu\nu} = \frac{\dot{x}^\mu \dot{x}^\nu}{\eta_{\mu\nu}} - \eta_{\mu\nu} \frac{1}{3} \left(\frac{\dot{x}^\alpha \dot{x}^\alpha}{\eta_{\alpha\beta}} \right) \eta^{\alpha\beta}$$

$$A_M = -\frac{\partial^\nu}{\square} \left\{ \vec{h}_{\nu\mu} - \eta_{\nu\mu} \vec{h} \right\} + \partial_\mu \Theta$$

constraint eqs: $-\partial^\mu \partial^\nu \vec{h}_{\mu\nu} - \eta_{\mu\nu} \square \vec{h} = 0$

$$\vec{h}_{\mu\nu} = \vec{h}_{\mu\nu}^{(0)} - \eta_{\mu\nu} \frac{1}{3} \left(\partial_\rho \partial^\rho \vec{h} \right) \chi^{\mu\nu}$$

$$g_{\mu\nu} = \eta_{\mu\nu} + \vec{h}_{\mu\nu} + \frac{1}{2} \eta_{\mu\nu} \chi^{\mu\nu} + \dots$$

$$\epsilon_{h/\mu\nu} = \Lambda \eta_{\mu\nu}$$

$$E h/\mu c = \Lambda \eta_{\mu\nu} \quad (\Lambda \neq 0)$$

$$E h/\mu c - m^2 c^2 \{ h_{\mu\nu} - \eta_{\mu\nu} h \} = \Lambda \eta_{\mu\nu}$$

$$\epsilon h_{\mu\nu} = \Lambda \eta_{\mu\nu} \quad (\Lambda \neq 0)$$

$$\epsilon (h_{\mu\nu} - m^2 c^2) \{ h_{\mu\nu} - \eta_{\mu\nu} h \} = \Lambda \eta_{\mu\nu}$$

$$g_{\mu\nu} = \left(1 + \frac{\Lambda}{3m^2} \right) \eta_{\mu\nu}$$