

Title: Mini-Course on Mach's Principle - Lecture 9

Date: Apr 22, 2009 10:30 AM

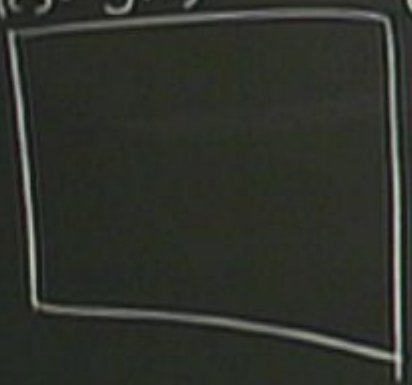
URL: <http://pirsa.org/09040030>

Abstract:

BR- Geometrodynamics
↓
(3+1) GR

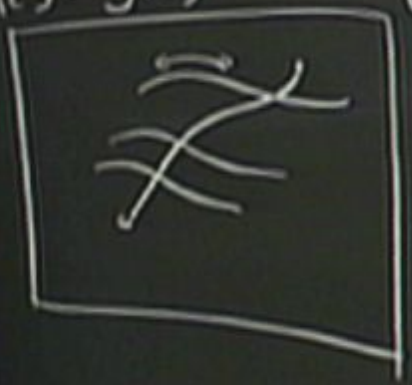
BB. Geometrodynamics

ACS - $g(\vec{r})$ (3+1) GR (Riem)



BB- Geometrodynamics

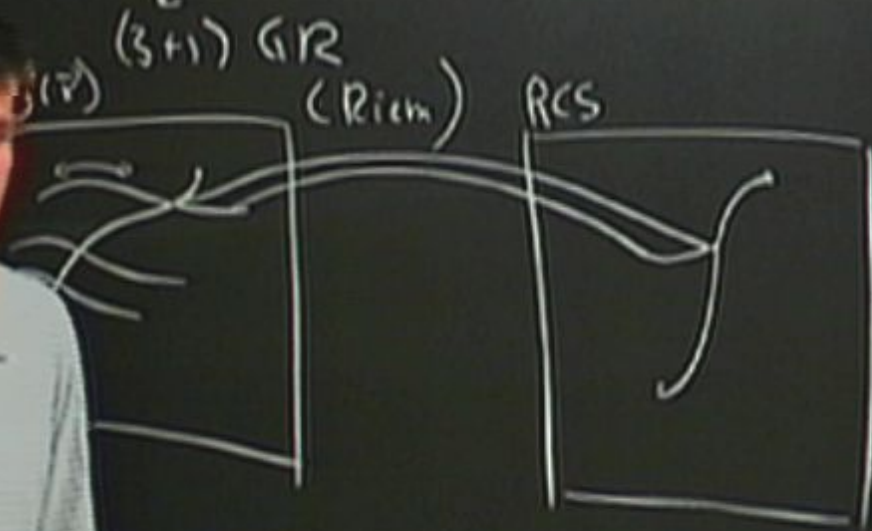
ACS- $g(\vec{t})$ (3+1) GR (Riem)



ACS



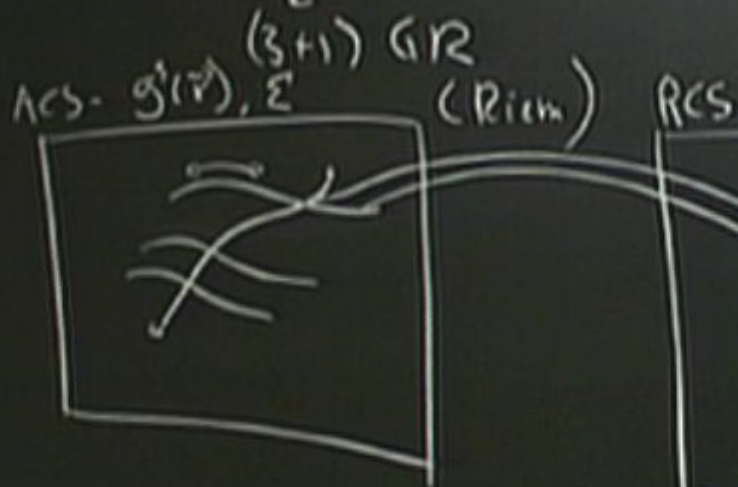
BB- Geometrodynamics



$$g_{ab} \rightarrow \exp\left\{ \int \xi \right\} g_{ab}$$

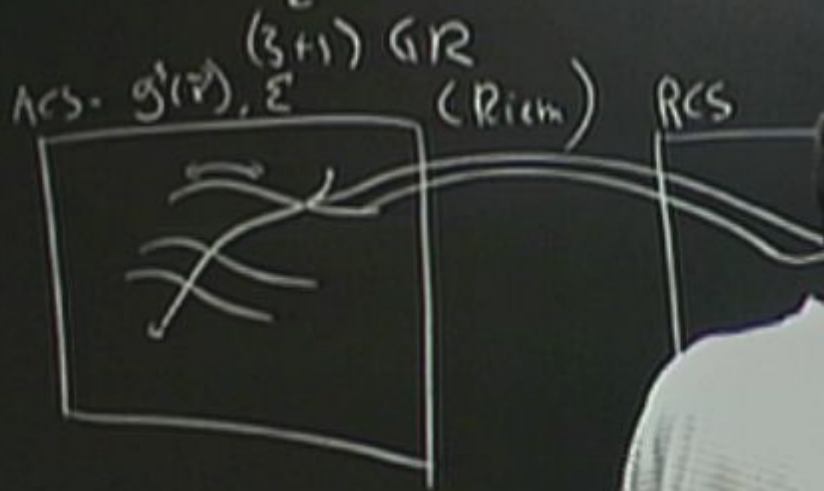
ξ^a - auxiliary

BB- Geometrodynamics



$g_{ab} \rightarrow \exp\left\{ \int \xi^a \right\} g_{ab}$
 ξ^a - auxiliary

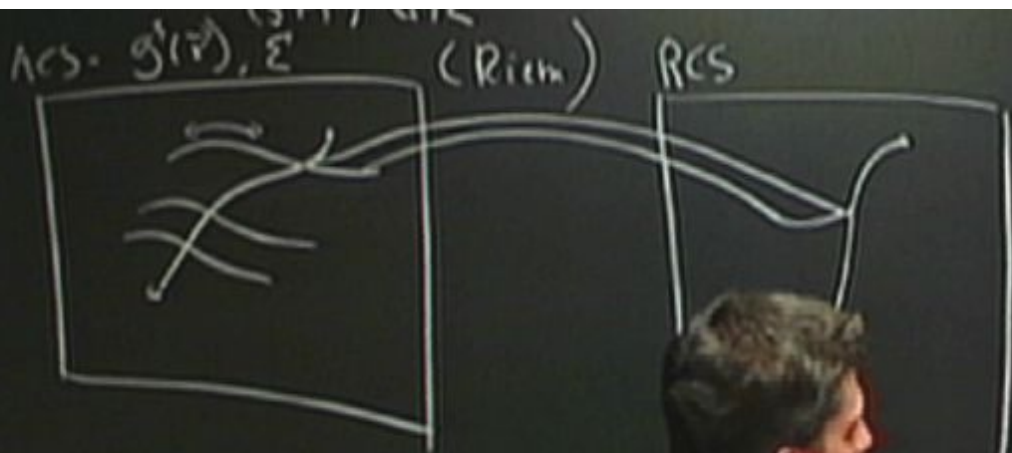
BB- Geometrodynamics



$$g_{ab} \rightarrow \exp\left\{ \int \xi^a \right\} g_{ab}$$

ξ^a - auxiliary

$$\frac{d}{dt} \rightarrow \frac{d}{dt} + \mathcal{L}_{\xi^a}$$

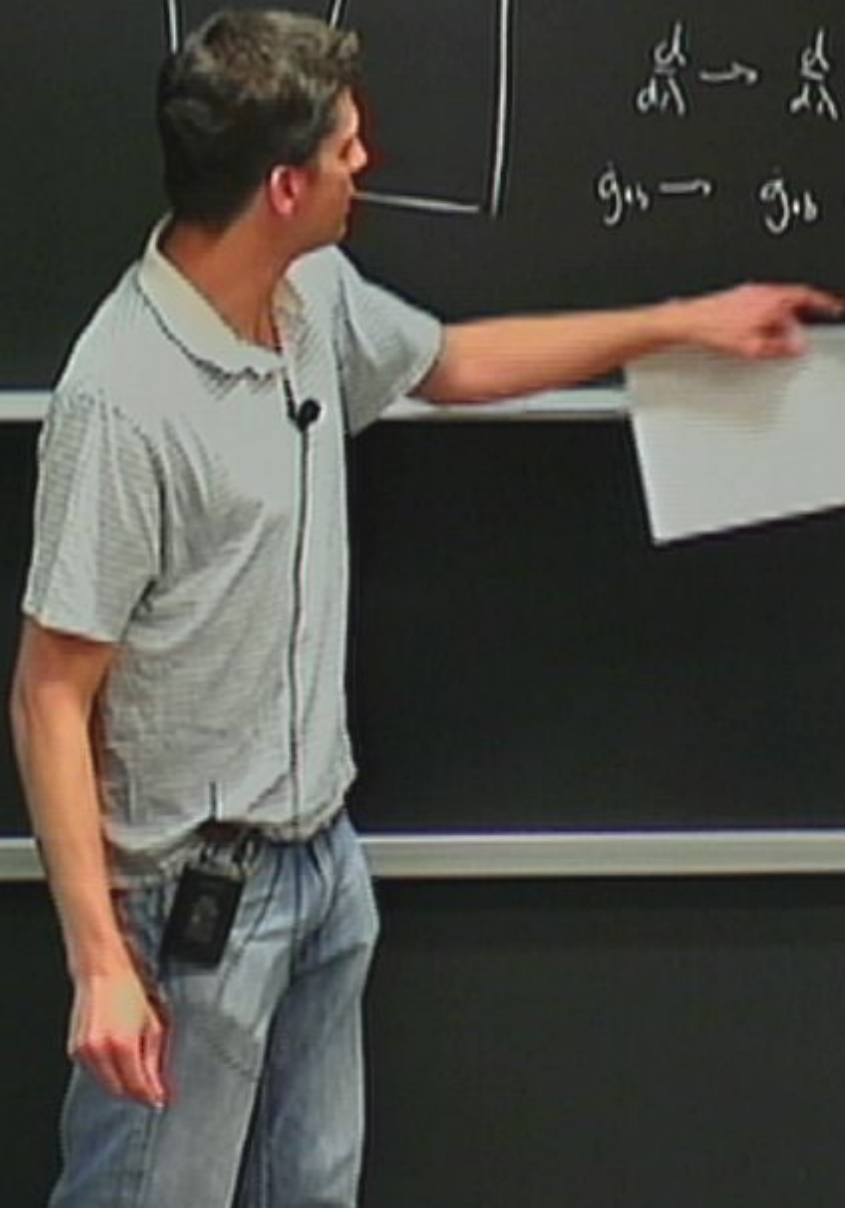


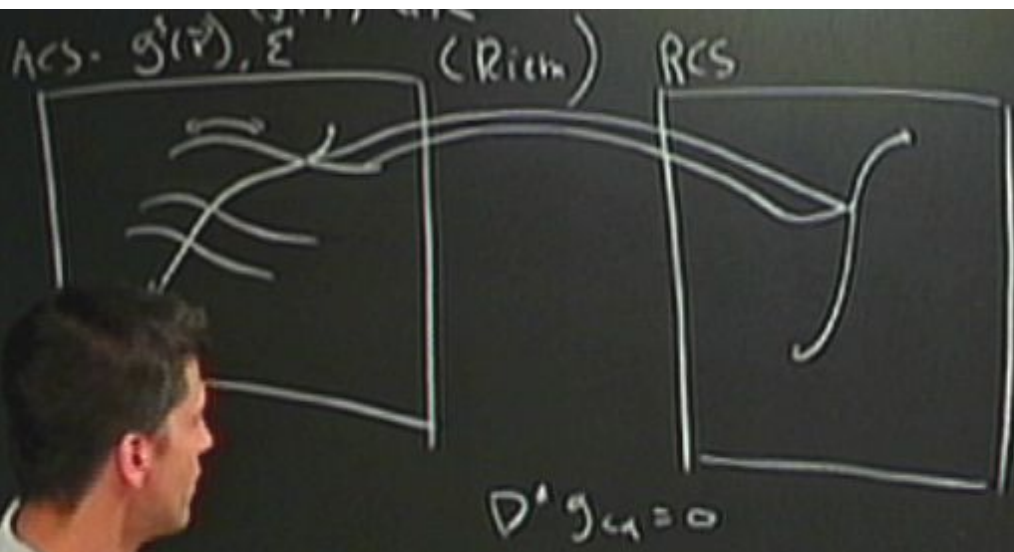
$$g_{0i} \rightarrow \exp\left\{ \int \xi \right\} g_{0i}$$

$\xi_{(i)}^a$ - auxiliary

$$\frac{d}{d\lambda} \rightarrow \frac{d}{d\lambda} + \int \xi^a$$

$$g_{0i} \rightarrow g_{0i} + \xi_{(i)0}$$





$g_{ab} \rightarrow \exp(\int \xi^a) g_{ab}$
 ξ^a - auxiliary

$\frac{d}{d\lambda} \rightarrow \frac{d}{d\lambda} + \int \xi^a$

$g_{ab} \rightarrow g_{ab} + \int \xi_{(a,b)}$

BB- Geometrodynamics

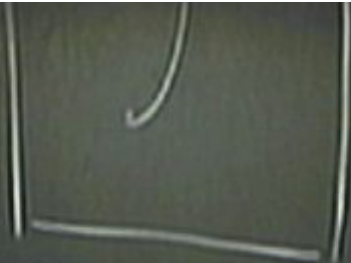
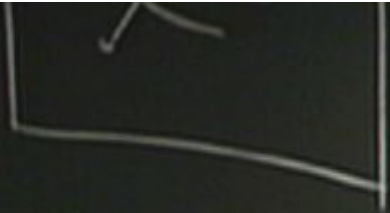


$\nabla^a g_{ab} = 0$

$g_{ab} \rightarrow \exp\left\{ \int \xi^a \right\} g_{ab}$
 ξ^a - auxiliary

$\frac{d}{dt} \rightarrow \frac{d}{dt} + \mathcal{L}_{\xi^a}$

$g_{ab} \rightarrow g_{ab} + \dot{\xi}_{(a,b)}$



$$\frac{d}{dt} \rightarrow \frac{d}{dt} + \sum \dot{\xi}_a$$
$$g_{ij} \rightarrow g_{ij} + \dot{\xi}_{(i,j)}$$

$$D^a g_{ca} = 0$$



$$S_{\text{RBG}} = \int d\lambda \int d^4x \sqrt{-g} \sqrt{-V} \sqrt{T} \quad G^{-1} \frac{d}{d\lambda} (G)$$

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$$V = R^2(g, \varphi) - 2\Lambda$$



$$\langle R_{BG} \rangle = \int d\lambda \int d^3x \sqrt{-g} \sqrt{-V} \sqrt{T} \quad G^{-1} \frac{d}{d\lambda} (G)$$

$$R'(g, \psi) = 2A$$

$$S_{\text{KBG}} = \int d\lambda \int d^3x \sqrt{-g} \sqrt{-V} \sqrt{T} \quad G^{-1} \frac{d}{d\lambda} (G)$$

$$V = R^2(g, \varphi) - 2\Lambda$$

$$S_{\text{RBG}} = \int d\lambda \int d^3x \sqrt{-g} \sqrt{-\det g_{\mu\nu}} \left(\frac{1}{2} R - \frac{1}{2} \frac{d\lambda}{d\tau} \left(\frac{d\lambda}{d\tau} \right) \right) \quad T = - \int d\lambda \sqrt{\frac{T}{F - V}}$$

$$V = R^2(g, \lambda) - 2$$



$$S_{KBG} = \sqrt{g} \sqrt{-v} \sqrt{T}$$

$$G^{-1} \frac{dG}{d\lambda}(G, \lambda)$$

$$T = - \int d\lambda \sqrt{\frac{T}{F-v}}$$

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$$S_{\text{KBG}} = \int d\lambda \int d^3x \sqrt{-g} \sqrt{-V} \sqrt{T}$$

$$G^{-1} \frac{d}{d\lambda} (G\lambda)$$

$$(T = -) \int d\lambda \sqrt{\frac{T}{F-V}}$$

$$V = R^2(g, \lambda) - 2\lambda$$

$$S_{\text{KBG}} = \int d\lambda \int d^3x \sqrt{-g} \sqrt{-V} \sqrt{T}$$

$$G^{-1} \frac{d}{d\lambda} (G\lambda)$$

$$T = \int d\lambda \sqrt{\frac{T}{F-V}}$$

$$V = R^2(g, \lambda) - 2\lambda$$

$$T = G^{\text{abru}} (g_{\text{us}}$$

$$S_{\text{reg}} = \int d\lambda \int d^3x \sqrt{-g} \sqrt{-V} \sqrt{T} \quad G^{-1} \frac{d}{d\lambda} (G\eta) \quad (T = -) \int d\lambda \sqrt{\frac{T}{F-V}}$$

$$V = R^2(g, \mathcal{D}) - 2\Lambda$$

$$T = G^{\text{ahed}} (g_{\text{ah}} + \dot{e}_{\text{ah}}) (g_{\text{ah}} + \dot{e}_{\text{ah}})$$

$$V = R'(g, \Omega)$$

$$T = G^{abcd}$$

$$= G^{abcd} (g_{ab} + \dot{\xi}_{(a,b)})$$

$$G^{abcd} = g^{ac} g^{bd}$$

$$\begin{aligned}
 R'(g, Dg) &= 2A \\
 &= G^{abcd} (g_{ab} + \xi_{ab})(g_{cd} + \xi_{cd}) \\
 &= G(D_s g, D_t g) \quad G^{abcd} = g^{ac} g^{bd}
 \end{aligned}$$

$$V = R^2(g, Dg) - 2A$$

$$T = G^{abcd} (g_{ab} + \dot{g}_{ab}) (g_{cd} + \dot{g}_{cd})$$

$$= G(D_s g, D_t g)$$

$$G^{abcd} = g^{ac} g^{bd} - g^{ab} g^{cd}$$

$$S_{\text{NG}} = \int d\tau \int d^3\vec{x} \sqrt{-g} \sqrt{G^{abcd} (\dot{g}_{ab} + \dot{\zeta}(a;b)) (\dot{g}_{cd} + \dot{\zeta}(c;d))}$$

$$S_{\text{NG}} = \int d\eta \int d^2x \sqrt{g} \sqrt{G^{abcd} (\dot{g}_{ab} + \dot{\xi}_{(a|b)}) (\dot{g}_{cd} + \dot{\xi}_{|c)d})} \sqrt{2A-R}$$

$$S_{NG} = \int d\eta \int d^3x \sqrt{-g} \sqrt{G^{abcd} (g_{ab} + \underbrace{\dot{\zeta}(a;b)}_{N_a}) (g_{cd} + \dot{\zeta}(c;d))} \sqrt{2A-R}$$

$$S_{\text{NG}} = \int d\eta \int d^3\vec{x} \sqrt{g} \sqrt{G^{abcd} (\dot{g}_{ab} + \dot{\xi}(a, b)) (\dot{g}_{cd} + \dot{\xi}(c, d))} \sqrt{2A-R}$$

N_a

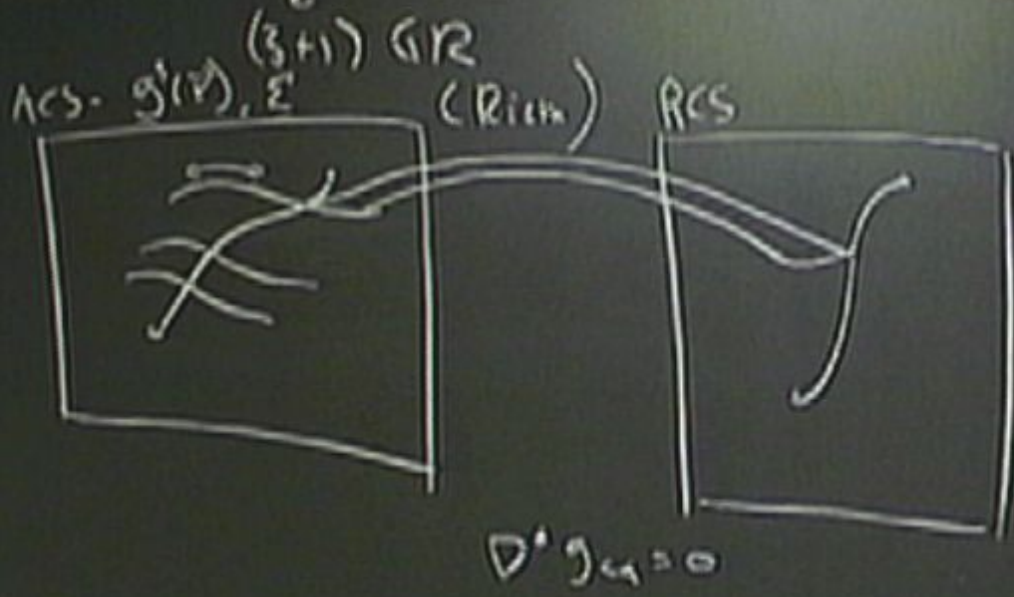
BR - $\dot{\xi}$ free spv

BSW - N_a fixed spv.

$$S_{\text{NG}} = \int d\eta \int d^3\vec{x} \sqrt{-g} \sqrt{G^{\text{abcd}} (\dot{g}_{ab} + \dot{\xi}^{\text{c}}(a, b)) (\dot{g}_{cd} + \dot{\xi}^{\text{e}}(c, d))} \sqrt{2A-R}$$

N_a $\left\{ \begin{array}{l} \text{BR} - \dot{\xi} \text{ free sp.} \\ \text{BSW} - N_a \text{ fixed sp.} \end{array} \right.$

12.5- Cosmology

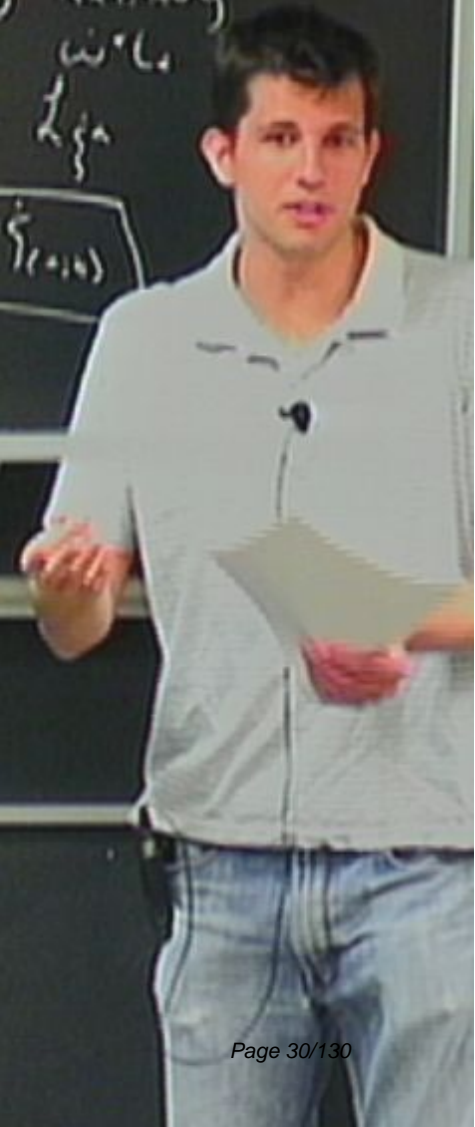


$g_{ab} \rightarrow \exp(\int \xi_a dx^a)$

ξ_a - auxiliary
vector

$\frac{d}{dt} \rightarrow \frac{d}{dt} + \xi_a \frac{\partial}{\partial x^a}$

$g_{ab} \rightarrow g_{ab} + \xi_{(a,b)}$

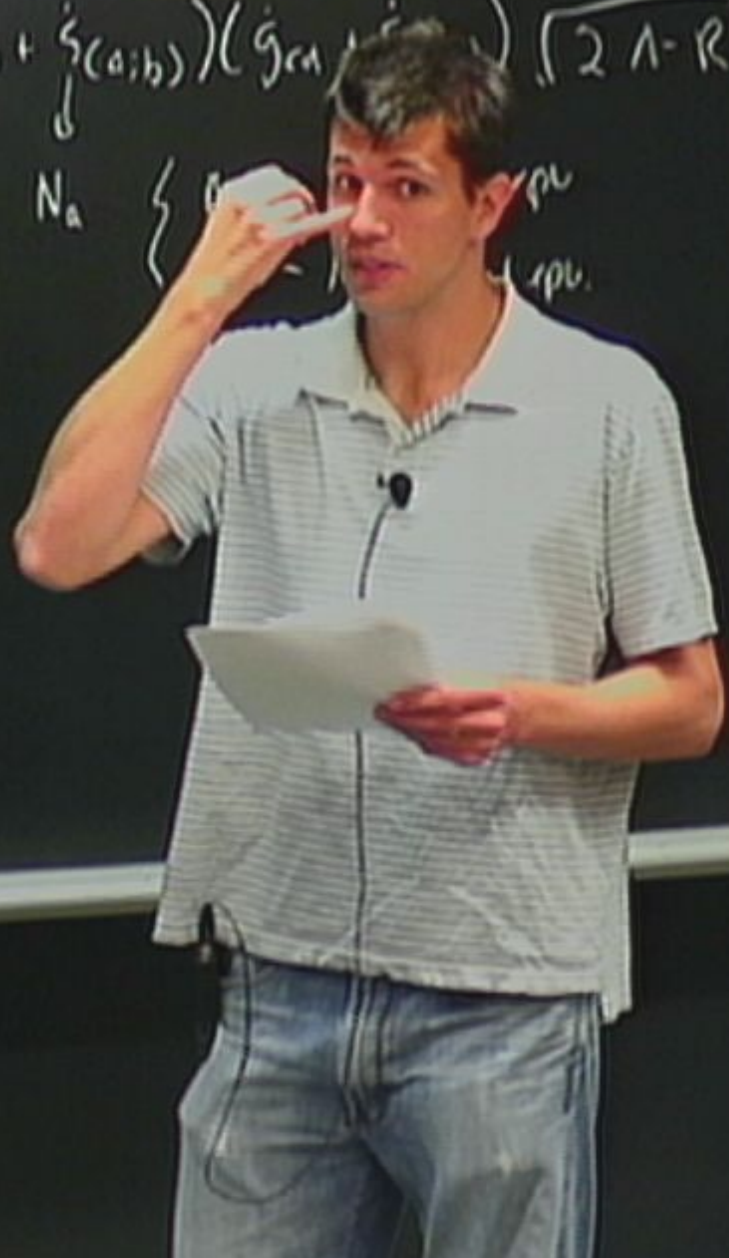


$$S_{\text{NG}} = \int d\tau \int d^3\vec{x} \sqrt{-g} \sqrt{G^{abcd} (g_{ab} + \zeta(a;b)) (g_{cd} + \zeta(c;d))} \sqrt{2A-R}$$

$N_a \left\{ \begin{array}{l} \dots \\ \dots \end{array} \right.$

Hamiltonian:

momenta: π^{ab}



$$S_{ABG} = \int d\lambda \int d^3x \sqrt{5} \sqrt{G^{abcd} (\dot{g}_{ab} + \dot{\xi}(a;b)) (\dot{g}_{cd} + \dot{\xi}(c;d))} \sqrt{2\lambda - R}$$

$N_a \begin{cases} \text{BR} - \dot{\xi} \text{ free spv} \\ \text{BSW} - N_a \text{ fixed spv.} \end{cases}$

Hamiltonian
momenta

$$\pi^{ab} = \frac{\partial \mathcal{L}}{\partial \dot{g}_{ab}} = \sqrt{\frac{2\lambda - R}{G(\lambda, g, \dot{g})}}$$

$$S_{\text{BGC}} = \int d\lambda \int d^3x \sqrt{-g} \sqrt{G^{abcd} (\dot{g}_{ab} + \zeta_{(a;b)}) (\dot{g}_{cd} + \zeta_{(c;d)})} \sqrt{2\Lambda - R}$$

$N_a \begin{cases} \text{BR} - \dot{\zeta} & \text{free spv} \\ \text{BSW} - N_a & \text{fixed spv.} \end{cases}$

Hamiltonian
momenta

$$\pi^{ab} = \frac{\partial \mathcal{L}}{\partial \dot{g}_{ab}} = \sqrt{\frac{2\Lambda - R}{G(\lambda, g, \dot{g})}} \sqrt{-g} G^{ab}(\lambda, g, \dot{g})$$

$$S_{\text{ADM}} = \int d^3x \sqrt{-g} \sqrt{G^{abcd} (\dot{g}_{ab} + \dot{\xi}(a;b)) (\dot{g}_{cd} + \dot{\xi}(c;d))} \sqrt{2\Lambda - R}$$

N_a $\begin{cases} \text{BR} - \dot{\xi} \text{ free exp.} \\ \text{BSW} - N_a \text{ fixed exp.} \end{cases}$

Hamiltonian:
momenta:

$$\pi^{ab} = \frac{\partial \mathcal{L}}{\partial \dot{g}_{ab}} = \sqrt{\frac{2\Lambda - R}{G(\pi, g)}} \sqrt{-g} G^{ab}(\pi, g, -)$$

$$P^a = \frac{\partial \mathcal{L}}{\partial \dot{\xi}_a} =$$

$$S_{ABG} = \int d\tau \int d^3x \sqrt{-g} \sqrt{G^{abcd} (\dot{g}_{ab} + \dot{\xi}(a;b)) (\dot{g}_{cd} + \dot{\xi}(c;d))} \sqrt{2\Lambda - R}$$

$N_a \begin{cases} BR - \dot{\xi} & \text{free spv.} \\ BSW - N_a & \text{fixed spv.} \end{cases}$

Hamiltonian
momenta

$$\pi^{ab} = \frac{\partial \mathcal{L}}{\partial \dot{g}_{ab}} = \sqrt{\frac{2\Lambda - R}{G(\eta_\gamma, \eta_\gamma)}} \sqrt{-g} G^{ab}(\eta_\gamma, -)$$

$$p^a = \frac{\partial \mathcal{L}}{\partial \dot{\xi}_a} = \sqrt{\frac{2\Lambda - R}{G(\eta_\gamma, \eta_\gamma)}} \sqrt{-g}$$

$$S_{ABG} = \int d\tau \int d^3x \sqrt{-g} \sqrt{G^{abcd} (\dot{g}_{ab} + \dot{\xi}(a; b)) (\dot{g}_{cd} + \dot{\xi}(c; d))} \sqrt{2\Lambda - R}$$

N_a $\begin{cases} BR - \dot{\xi} & \text{free spin} \\ BSW - N_a & \text{fixed spin} \end{cases}$

Hamiltonian
momenta

$$\pi^{ab} = \frac{\partial L}{\partial \dot{g}_{ab}} = \sqrt{\frac{2\Lambda - R}{G(\pi, g, \dot{\xi})}} \sqrt{-g} G^{ab}(\pi, g, -)$$

$$p^a = \frac{\partial L}{\partial \dot{\xi}_a} = \sqrt{\frac{2\Lambda - R}{G(\pi, g, \dot{\xi})}} \sqrt{-g} G^{ab}(\pi, g, -)$$

$$S_{ABC} = \int d\tau \int d^3x \sqrt{-g} \sqrt{G^{abcd} (\dot{g}_{ab} + \dot{\xi}(a;b)) (\dot{g}_{cd} + \dot{\xi}(c;d))} \sqrt{2\Lambda - R}$$

N_a $\begin{cases} BR - \dot{\xi} & \text{free spin} \\ BSW - N_a & \text{fixed spin} \end{cases}$

Hamiltonian
momenta

$$\pi^{ab} = \frac{\partial L}{\partial \dot{g}_{ab}} = \sqrt{\frac{2\Lambda - R}{G(\pi, g, -)}} \sqrt{-g} G^{ab}(\pi, g, -)$$

$$p^a = \frac{\partial L}{\partial \dot{\xi}_a} = \sqrt{\frac{2\Lambda - R}{G(\pi, g, -)}} \sqrt{-g} G^{ab}(\pi, g, -)$$

$$L^a = \rho^a + 2 \nabla_b \pi^{ab}$$



$$L^a = p^a + 2 \nabla_b \pi^{ab}$$

$$\nabla_b \pi^{ab} + \nabla_b \pi^{ba}$$

$$L^a = p^a + 2 \nabla_b \pi^{ab} = 0$$

$$\boxed{p^a = 0} \Rightarrow \boxed{\nabla_b \pi^{ab} = 0} \text{ Diff. GR}$$

$$L^a = p^a + 2 \nabla_b \pi^{ab} = 0$$

$$\boxed{p^a = 0} \Rightarrow \boxed{\nabla_b \pi^{ab} = 0} \text{ Diffes. GR}$$

Helmholtz:

$$L^a = p^a + 2 \nabla_b \pi^{ab} = 0$$

$$\boxed{p^a = 0} \Rightarrow \boxed{\nabla_b \pi^{ab} = 0} \text{ Diff. GR}$$

Ham Const: G_{ab}

$$L^a = p^a + 2 \nabla_b \pi^{ab} = 0$$

$$\boxed{p^a = 0} \Rightarrow \boxed{\nabla_b \pi^{ab} = 0} \text{ Diff. GR}$$

$$\text{Helmholtz: } G_{abcd} \pi^{ab} \pi^{cd} - (2\Lambda - R) = 0 \quad \left(\sum_i \frac{p_i^2}{2m_i} + V = 0 \right)$$

$$L^a = p^a + 2 \nabla_b \pi^{ab} = 0$$

$$\boxed{p^a = 0} \Rightarrow \boxed{\nabla_b \pi^{ab} = 0} \text{ Diff. GR}$$

Ham Const: $\frac{G_{abcd} \pi^{ab} \pi^{cd}}{\sqrt{-g}} (2\Lambda - R) = 0 \left(\sum_i \frac{p_i^2}{2m_i} + V = 0 \right)$

check:



$$L'' = p'' + 2 \nabla_b \pi^{ab} = 0$$

$$\boxed{p'' = 0} \Rightarrow \boxed{\nabla_b \pi^{ab} = 0} \text{ Diff. GR}$$

Ham (un) \Rightarrow $\pi^{ab} \pi^{cd} - (2\Lambda - R) = 0 \left(\sum_i \frac{p_i^2}{2m} + V = 0 \right)$

check

$$L'' = p^a + 2 \nabla_b \pi^{ab} = 0$$

$$\boxed{p^a = 0} \Rightarrow \boxed{\nabla_b \pi^{ab} = 0} \text{ Diff. GR}$$

Ham Const: $\frac{G_{abcd} \pi^{ab} \pi^{cd}}{-g} - (2\Lambda - R) = 0 \quad \left(\sum \frac{p_i^2}{2m} + V = 0 \right)$

elect: $\frac{1}{-g} \left[G_{abcd} \frac{(2\Lambda - R)}{G(a, b, c, d)} \cdot G^{abnm} (g_{nm} + \dot{g}_{nm}) \right] / G^{cdop} (g_{op} + \dot{g}_{op})$

$$L^a = p^a + 2 \nabla_b \pi^{ab} = 0$$

$$\boxed{p^a = 0} \Rightarrow \boxed{\nabla_b \pi^{ab} = 0} \text{ Diff. GR}$$

Ham Const: $\frac{G_{ab} \pi^{ab} \pi^{cd} - (2\Lambda - R)}{-g} = 0 \quad \left(\sum \frac{p_i^2}{2m_i}, v=0 \right)$

check: $\frac{1}{-g} \left[\text{check } \frac{(2\Lambda - R)}{G(\mathcal{D}_g, \mathcal{D}_g)} \cdot G^{ab} \text{tr}(g_{mn} \dot{g}_{mn}) \right] / G(\mathcal{D}_g, \mathcal{D}_g)$

$$L^a = p^a + 2 \nabla_b \pi^{ab} = 0$$

$$\boxed{p^a = 0} \Rightarrow \boxed{\nabla_b \pi^{ab} = 0} \text{ Diff. GR}$$

Ham Const: $\frac{G_{abcd} \pi^{ab} \pi^{cd}}{-g} - (2\Lambda - R) = 0 \quad \left(\sum_i \frac{p_i^2}{2m_i} + V = 0 \right)$

elect.: $\frac{1}{-g} \left[G_{abcd} \frac{(2\Lambda - R)}{G(\rho, \eta, \eta)} \cdot G^{abnm} (g_{mn} + \dot{g}_{mn}) \right] \left[G^{cdop} (g_{op} + \dot{g}_{op}) \right]$

$$L^a = p^a + 2 \nabla_b \pi^{ab} = 0$$

$$\boxed{p^a = 0} \Rightarrow \boxed{\nabla_b \pi^{ab} = 0} \text{ Diffus. GR}$$

Flux (ant): $\boxed{\frac{G_{abcd} \pi^{ab} \pi^{cd} - (2\Lambda - R)}{-g} = 0} \left(\sum \frac{p_i^2}{2m_i} + V = 0 \right)$

check: $\frac{1}{-g} \left[\frac{G_{abcd} (-g \frac{(2\Lambda - R)}{g(\rho, \gamma, \eta, \eta)})}{g(\rho, \gamma, \eta, \eta)} \right] \left[g^{abcd} (g_{op} + \gamma(\rho, \rho)) \right] = 0 \checkmark$

Hand Const:

$$\frac{G_{abid} \pi^{ab} \pi^{cd}}{1-g} - \left(\dots \right)$$

elect:

$$\frac{1}{-g} \left[G_{abid} \frac{-g(2\Lambda - R)}{G(0, g, \Lambda g)} \cdot G^{abnm} (g_{nm} + g_{(in)}) \left(G^{cdop} (g_{op} + g_{(o,m)}) \right) \right] - (2\Lambda - R) = 0 \checkmark$$



$(0, 5, 2, 9)$

$-(2 \wedge - 12)$
 $= 0 \checkmark$

$$H_c = \Gamma_i^{nl} \dot{g}_{uh} + \rho^a \dot{g}_a - L(\pi, p, g, \dot{g})$$

$$G(a, g, b, g)$$

$$-(2A - R) \\ = 0 \checkmark$$

$$H_c = T_i^{ab} g_{ab} + P^a \dot{q}_a - L(\pi, P, g, \dot{g})$$

$$= \sqrt{-g} \left(\sqrt{\frac{2A \cdot R}{G(a, g, b, g)}} G(a, g, \dot{g}_a) \right)$$

$$G(\rho, \gamma, h, \gamma)$$

$$-(2A - R) = 0 \checkmark$$

$$H_c = \pi^{ab} \dot{g}_{ab} + p^a \dot{g}_a - L(\pi, p, g, \gamma)$$

$$= \sqrt{-g} \left(\sqrt{\frac{2A - R}{G(\rho, \gamma, h, \gamma)}} G(\rho, \gamma, \dot{g}_a) + \right)$$

$$G(\rho, \gamma, \lambda, \eta)$$

$$-(2\lambda - R) = 0 \checkmark$$

$$H_c = \pi^{ab} g_{ab} + p^a \dot{q}_a - L(\pi, p, g, \dot{g})$$

$$= \sqrt{-g} \left(\sqrt{\frac{2\lambda \cdot R}{G(\rho, \gamma, \lambda, \eta)}} G(\rho, \gamma, \dot{g}_a) + \sqrt{\frac{2\lambda \cdot R}{G(\rho, \gamma, \lambda, \eta)}} G(\rho, \gamma) \dot{g} \right)$$

$$G(a, b, c)$$

$$-(2\lambda - R) = 0 \checkmark$$

$$H_c = \pi^{ab} g_{ab} + p^a \dot{q}_a - L(\pi, p, q, \dot{q})$$

$$= \sqrt{-g} \left(\sqrt{\frac{2\lambda \cdot R}{G(a, b, c)}} G(a, b, c) + \sqrt{\frac{2\lambda \cdot R}{G(a, b, c)}} G(a, b, c) \right)$$

$G(r, \dot{r}, \dot{\theta})$

$-(2\Lambda - R)$
 $= 0 \checkmark$

$$H_c = T_{\text{rel}} + P^a \dot{q}_a - L(\pi, P, q, \dot{q})$$

$$= \sqrt{-g} \left(\sqrt{\frac{2\Lambda - R}{G(r, \dot{r}, \dot{\theta})}} G(r, \dot{r}, \dot{\theta}) + \sqrt{\frac{2\Lambda - R}{G(r, \dot{r}, \dot{\theta})}} \dot{q}_a \right) - L$$

$$= \sqrt{-g} \sqrt{\frac{2\Lambda - R}{G(r, \dot{r}, \dot{\theta})}} \cdot G(r, \dot{r}, \dot{\theta})$$

$$-(2\Lambda - R) = 0 \checkmark$$

$$H_c = \Gamma_i^{ab} \dot{g}_{ab} + p^a \dot{q}_a - L(\pi, p, g, \dot{g})$$

$$= \sqrt{-g} \left(\sqrt{\frac{2\Lambda - R}{G_1(\rho, \gamma, \lambda, \gamma)}} G_1(\rho, \gamma, \dot{g}_a) + \sqrt{\frac{2\Lambda - R}{G_1(\rho, \gamma, \lambda, \gamma)}} G_1(\rho, \gamma, \dot{q}_a) \right)$$

$$= \underbrace{\sqrt{-g} \sqrt{\frac{2\Lambda - R}{G_1(\rho, \gamma, \lambda, \gamma)}}}_{= L} \cdot G_1(\rho, \gamma, \lambda, \gamma) - L = 0 \checkmark$$

$$G(a, y, R, g)$$

$$-(2\Lambda - R) \\ = 0 \checkmark$$

$$H_c = \Gamma_i^{ab} \dot{g}_{ab} + P^a \dot{q}_a - L(\pi, P, g, \dot{g})$$

$$= \sqrt{-g} \left(\sqrt{\frac{2\Lambda - R}{G(a, y, R, g)}} G(a, y, \dot{g}_a) + \sqrt{\frac{2\Lambda - R}{G(a, y, R, g)}} G(a, y, \dot{q}(a, y)) \right) - L$$

$$= \underbrace{\sqrt{-g} \sqrt{\frac{2\Lambda - R}{G(a, y, R, g)}}}_{-L} \cdot G(a, y, R, g) - L = 0 \checkmark$$

$H(x) = N_0 \cdot \frac{1}{x}$ ADM - 1. line.

$$H_T = N_H + N_{\text{sl}} \left(\frac{H}{L} \right)$$

\downarrow \downarrow
type sl. fl

ADM - 1. line.

$$H_T = N_H + N_a \left(\frac{H}{H_0} \right)^n$$

\downarrow \downarrow
 slope slope

ADM - flow.

$$\xi^a = \{ \xi^a, H_T \} =$$

$$H_T = N_H + N_a \cdot \frac{1}{N} \quad \text{ADM. Klem.}$$

\downarrow \downarrow
 type St. F1

$$\boxed{S^a = \{ \xi^a, H_T \} = N^a}$$

$$H = N H + N_a \mathcal{L}''$$

\downarrow \downarrow
 lapse v.f.f

ADM - 1.6m.

$$[S^a = \{ \dots \} N^a]$$

$$\int_{\Sigma_t} S^a \rightarrow (3,1)EE \quad N = g_{uv}$$

$$H_T = N \cdot K + N_a \cdot \frac{1}{2} \dot{\phi}^2$$

\downarrow \downarrow
 lapse st. ft

ADM - time.

$$\boxed{S^a = \{ \xi^a, H_T \}} = N$$

$$\int_{\Sigma_t} S^a \rightarrow (3,1) EE.$$

$$N = g_{00}''$$

$$\xi_i = N_i = g_{0i}''$$

$$H_{\text{ir}} = N H + N_a \frac{1}{2} \dot{\phi}^2$$

\downarrow \downarrow
 lapse v.l.f.t

ADM - time.

$$\boxed{S^a = \{ \xi^a, H_{\text{ir}} \} = N^a}$$

$$\delta g_{\mu\nu} S^{\mu\nu} \rightarrow (3,1,1) \text{EE} \quad \begin{cases} N = g_{00}^{\text{tr}} \\ \dot{\xi}_i = N_{,i} = g_{0i}^{\text{tr}} \end{cases}$$

$$\int g_n S = \omega \rightarrow (311)EE \quad \begin{cases} N = g'_{uu} \\ \dot{\xi}_k = N_n = g''_{ou} \end{cases}$$

Observablen:

$$\delta g_n S = 0 \rightarrow (3.11) EE \quad \begin{cases} N = g''_{00} \\ \dot{\xi} = N_n = g''_{0n} \end{cases}$$

Observabili:

$$g_{ab} = \text{tr} P \{ L_i \} g_{ab}$$

$$\int_{g_n} S = \int (311) E E \quad \left\{ \begin{array}{l} N = g''_{00} \\ \dot{\xi} = N_n = g''_{00} \end{array} \right.$$

$N(x)$

Observation: $g_{ab} = \exp\{L_i\} g_{ab} \Rightarrow$

$$\int_{g_m} S = 0 \rightarrow (3.11) E E \quad \begin{cases} N = g''_{00} \\ \dot{g}_b = N_b = g''_{00} \end{cases}$$

$N(x)$

Observation: $g_{ab} = \exp\{L_i\} g_{ab} \Rightarrow D_b(N G^{ab}(D_i g)) = 0$

$$\int_{g_m} S = \omega \rightarrow (3,1,1) E E \quad \begin{cases} N = g_{00}'' \\ \dot{t}_c = N_n = g_{00}'' \end{cases}$$

$N(x)$

Observables:

$$g_{ab} = \exp\{L_i\} g_{ab} \Rightarrow D_0(N G^{ab}(D_i g)_{-}) =$$

$$\int_{g_n} S = 0 \rightarrow (3.11) EE \quad \begin{cases} N = g''_{00} \\ \dot{g}_i = N_i = g''_{0i} \end{cases}$$

$N(x)$

Observation: $g_{ab} = \exp\{L_i\} g_{ab} \Rightarrow D_b(N G^{ab}(D_i g)) = 0$

$$\int_{g_m} S = \int \rightarrow (3,1,1) E E$$

$N(\vec{r})$

$$\begin{cases} N = g_{00}'' \\ \dot{t} = N_n = g_{00}'' \end{cases}$$

reGlktion inv.
 \Rightarrow

Observation: $g_{ab} = \exp\{L_i\} g_{ab} \Rightarrow D_b(N G^{ab}(D_i g)) = 0$

$$\int_{\mathcal{M}} S = 0 \rightarrow (3.11) EE$$

$N(\vec{r})$

$$\begin{cases} N = g^{00} \\ \dot{\gamma}_b = N_n = g^{0n} \end{cases}$$

reGktion inv.
 \Rightarrow

Observation:

$$g_{ab} = \text{exp} \left\{ \int L_{\vec{r}} \right\} g_{ab}$$

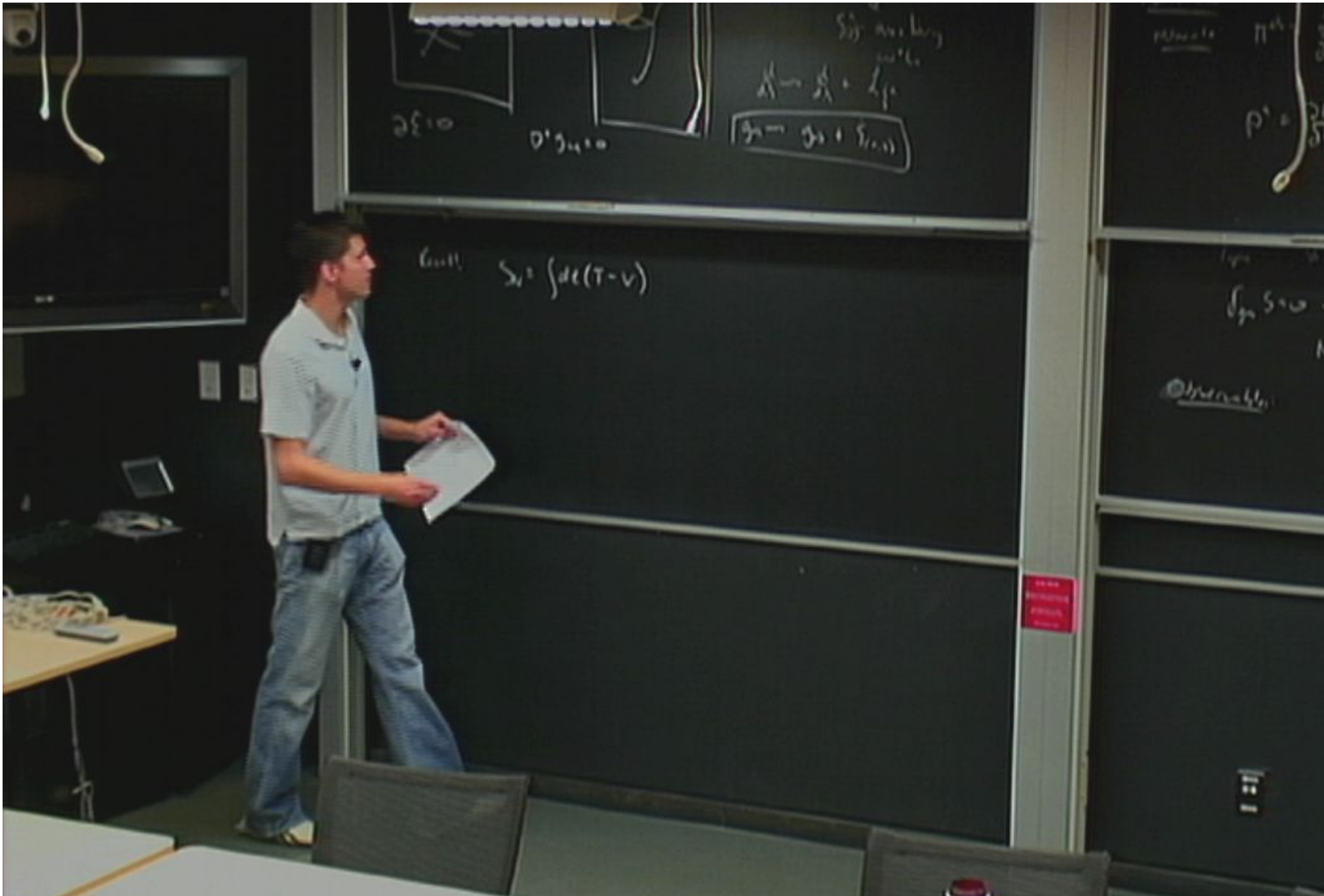
$$\Rightarrow D_b (N G^{ab} (D_c g)) = 0$$

type 5b.7.1

$$\int_{g_n} S = \int (3.11) EE \quad \left\{ \begin{array}{l} N = g^{00} \\ \dot{g}_i = N_n = g^{0i} \end{array} \right.$$

reduction inv.
 \Rightarrow

Observables: $g_{ab} = \exp\{L_i\} g_{ab} \Rightarrow D_0(N G^{ab}(D_i g)_{ab}) = 0$



Recall,

$$S_u = \int dt \rightarrow$$

$$\sum v = \int dt (T - v) \rightarrow \sum_{\text{ring}} = \int d\lambda \left(\frac{T}{c} - \dot{x} v \right)$$

Recall,

$$S_U = \int dt (T - v) \longrightarrow S_{\text{ren}} = \int dt \left(\frac{I}{t} - tv \right)$$

↓
free epv.

Recall $S_U = \int dt (T - v) \rightarrow S_{\text{ren}} = \int d\tau \left(\frac{T}{t} - t v \right)$

$t \rightarrow t + a$

\downarrow
free ev.

$$(g, Dg) - 2A$$

$$\hookrightarrow \text{abcd} (g_{ab} + \xi_{ab}) (g_{cd} + \xi_{cd})$$

$$(D_a g, D_b g)$$

$$\Gamma_{abcd} = g^{ac} g^{bd} - g^{ab} g^{cd}$$

Recall,

$$S_U = \int (1 - v) \rightarrow S_{\text{prop}} = \int dt \left(\frac{1}{t} - t v \right)$$

$$t \rightarrow t + a$$

free spv.

$$S_{\text{string}} =$$

$$S_V = \int dt (T - V) \longrightarrow S_{\text{path}} = \int dt \left(\frac{1}{2} \dot{x}^2 - V \right)$$

$$S_{\text{string}} = \int dt \int d\sigma \sqrt{-g} \left(\underline{G_1(B_1, B_2)} \right)$$

$t \rightarrow t + a$

free eqn.

$$R'(g, Dg) = 2A$$

$$= G^{abcd} (g_{ab} + \delta_{ab}) (g_{cd} + \delta_{cd})$$

$$= G(Dg, Dg)$$

$$G^{abcd} = g^{ac}g^{bd} - g^{ab}g^{cd}$$

$$S_{\text{string}} = \int d\lambda \int d^2\vec{x} \sqrt{-g} \left[\frac{G_1(\lambda, \vec{x}, R_1)}{g_2(\lambda, \vec{x})} - g_2'(\lambda, \vec{x})(2\lambda - R) \right]$$

$t \rightarrow t + a$ free end.

Recall $\int_{\gamma} (T-v) \rightarrow S_{\text{ren}} = \int d\lambda \left(\frac{T}{t} - t v \right)$

$t \rightarrow t + R$

free $g_{\mu\nu}$

$S_{\text{ren}} = \int d^d x \sqrt{-g} \left[\frac{G_1(R, g, R_1)}{g_1(\lambda, x)} - g_1'(\lambda, x) (2\lambda - R) \right]$

$$V = (\quad) - 2A$$

$$T = (g_{ab} + \xi_{(a,b)}) (g_{cd} + \xi_{(c,d)})$$

$$g_{ab} = g_{(a,b)}$$

$$g_{abcd} = g^{ac} g^{bd} - g^{ab} g^{cd}$$

$$(\quad) \partial \lambda \sqrt{\frac{L}{F-v}}$$

Recall: $S_V = \int dt (T - v) \rightarrow S_M = \int d\tau \left(\frac{T}{t} - t v \right)$

String: $S_{\text{string}} = \int d\tau \int d^2 \sigma \sqrt{-g} \left[\frac{1}{2} \dot{X}^2 - \frac{1}{2} X'^2 - \mathcal{R} \right]$

free eqv.

Recall. $S_U = \int dt (T - v) \rightarrow S_{\text{mem}} = \int d\lambda \left(\frac{T}{t} - t v \right)$

$S_{\text{string}} = \int d\lambda \int d^2 \vec{x} \sqrt{-g} \left[\frac{G(\lambda, \vec{x}, R)}{g(\lambda, \vec{x})} - \dot{q}(\lambda, \vec{x}) (-2\lambda + R) \right]$

$t \rightarrow t + R$

$\frac{T}{t}$ free env.

Recall.

$$S_U = \int dt (T - v) \longrightarrow S_{\text{mem}} = \int d\lambda \left(\underbrace{\frac{T}{t}}_{\text{free spv.}} - t v \right)$$

$$S_{\text{string}} = \int d\lambda \left(\int d^2 \vec{x} \sqrt{-g} \right) \left[\frac{G_1(\lambda, \vec{x}, R_1)}{g_2(\lambda, \vec{x})} - \dot{q}(\lambda, \vec{x}) (-2\lambda + R) \right]$$

$t \rightarrow t + R$

free spv.

$\lambda \rightarrow \rho$

Recall, $S_N = \int dt (T - v) \rightarrow S_{\text{mem}} = \int d\lambda \left(\frac{T}{t} - t v \right)$

$S_{\text{string}} = \int d\lambda \left(d^2 \vec{x} \sqrt{-g} \right) \left[\frac{G_1(\lambda, \vec{x}, R_1)}{g_1(\lambda, \vec{x})} - \dot{q}(\lambda, \vec{x}) (-2\lambda + R) \right]$

$t \rightarrow t + R$

$\frac{T}{t}$ free grav.

$N \rightarrow g_1$

Recall. $S_N = \int dt (T - v) \rightarrow S_{\text{mem}} = \int d\lambda \left(\frac{T}{t} - t v \right)$

$S_{\text{string}} = \int d\lambda \int d^2 \vec{x} \sqrt{-g} \left[\frac{G_1(\lambda, \vec{x}, R_1)}{g_2(\lambda, \vec{x})} - g_2'(\lambda, \vec{x}) (-2\lambda + R) \right]$

$t \rightarrow t + a$

$\frac{T}{t} \text{ free env.}$

$N \rightarrow g_2$

Recall,

$$S_U = \int dt (T - v) \rightarrow S_{\text{ren}} = \int d\lambda \left(\frac{T}{t} - t v \right)$$

$$S_{\text{ren}} = \int d\lambda \int d^2 \vec{x} \sqrt{-g} \left[\frac{G_1(\lambda, \vec{x}, R)}{g_1(\lambda, \vec{x})} - g_1(\lambda, \vec{x}) (-2\lambda + R) \right]$$

$t \rightarrow t + R$ free env.

$N \rightarrow g_1$

Recall.

$$S_U = \int dt (T - V) \longrightarrow S_{\text{min}} = \int d\lambda \left(\frac{T}{t} - tV \right)$$

$$S_{\text{min}} = \int d\lambda \int d^3 \vec{x} \sqrt{-g} \left[\frac{G(\lambda, \vec{x}, \dot{\lambda}, \dot{\vec{x}})}{q(\lambda, \vec{x})} - q'(\lambda, \vec{x}) (-2\lambda + R) \right]$$

$t \rightarrow t + a$ $\frac{1}{t}$
free ev.

$N \rightarrow g$

Recall. $S_U = \int dt (T - v) \rightarrow S_{\text{mem}} = \int d\lambda \left(\frac{T}{t} - t v \right)$

$S_{\text{string}} = \int d\lambda \int d^2 \vec{x} \sqrt{-g} \left[\frac{G_1(\lambda, \vec{x}, R_1)}{g_1(\lambda, \vec{x})} - g_1'(\lambda, \vec{x}) (-2\lambda + R) \right]$

$N \rightarrow g_1$ G_1 fixed up to g_1

Recall. $S_U = \int dt (T - v) \rightarrow S_{\text{mem}} = \int d\lambda \left(\frac{T}{t} - t v \right)$

$S_{\text{string}} = \int d\lambda \int d^2 \vec{x} \sqrt{-g} \left[\frac{G_1(\lambda, \vec{x}, R_1)}{g_1(\lambda, \vec{x})} - g_1'(\lambda, \vec{x}) (-2\lambda + R) \right]$
 $t \rightarrow t + R$ free grav.
 $M \rightarrow g_0$ G_1 and g_1

01a (10/10/11)

$$\frac{\partial \mathcal{L}}{\partial x} - \frac{d}{dt} \left(\frac{\partial \mathcal{L}}{\partial \dot{x}} \right) = 0$$

01a (10/10/11)

$$\frac{\partial L}{\partial x} - \frac{d}{dt} \left(\frac{\partial L}{\partial \dot{x}} \right) = 0$$

$$\frac{\partial L}{\partial x} = 0$$

cycle

$$\frac{\partial \mathcal{L}}{\partial x} - \frac{d}{dt} \left(\frac{\partial \mathcal{L}}{\partial \dot{x}} \right) = 0$$

$$\lambda = 1 \quad \left(\frac{\partial \mathcal{L}}{\partial x} = 0 \right)$$

cycle

$$\frac{\partial \mathcal{L}}{\partial \dot{x}} = \text{const.}$$

$$\frac{\partial \mathcal{L}}{\partial x} - \frac{d}{dt} \left(\frac{\partial \mathcal{L}}{\partial \dot{x}} \right) = 0$$

$$\lambda = 1 \quad \left(\frac{\partial \mathcal{L}}{\partial x} = 0 \right)$$

cycle

$$\frac{\partial \mathcal{L}}{\partial \dot{x}} = \text{const.} > 0 \rightarrow (p_1, p_2)$$

01a (10/10/11)

Topic

St. 11

$$\delta g_n S = 0 \rightarrow (3.11) EE. \quad \begin{cases} N = g^{00} \\ \dot{L}_i = N_{,i} = g^{00}_{,i} \end{cases}$$

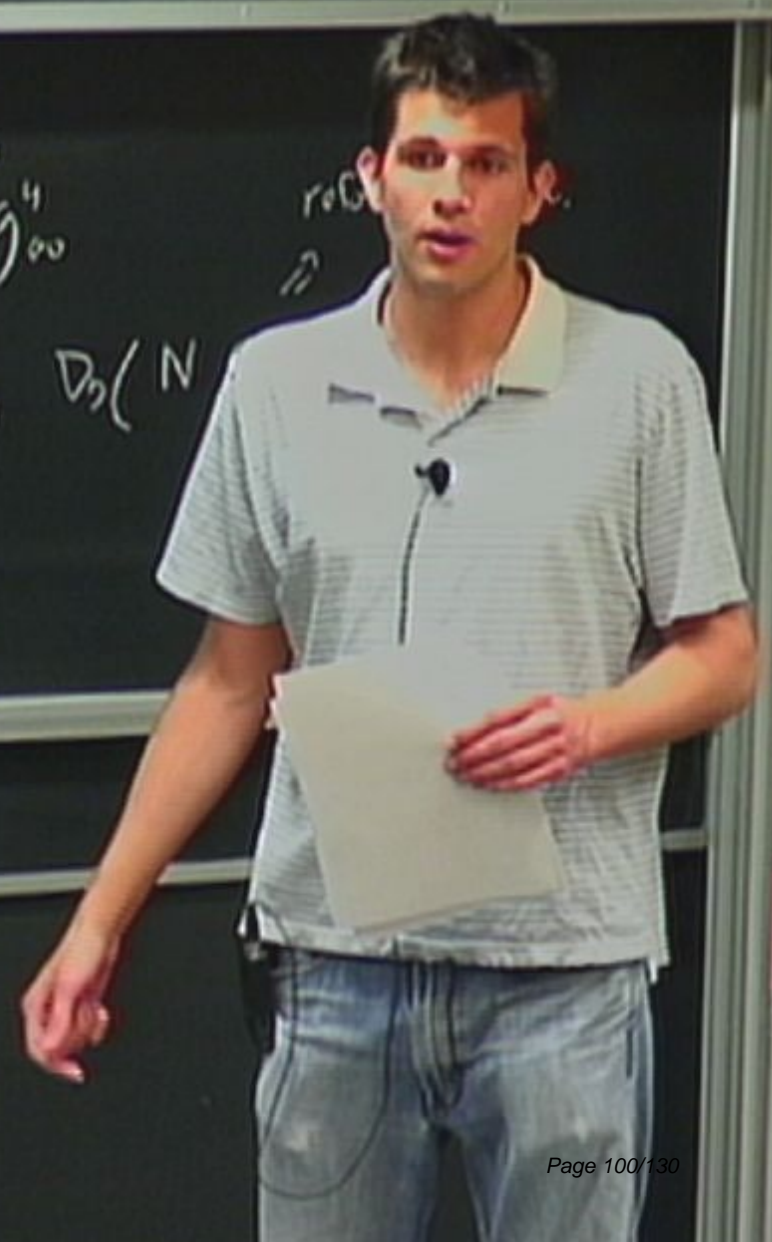
$N(\vec{x})$

reg
 \Rightarrow

Observables:

$$g_{ab} = \exp\{L_i\} g_{ab}$$

$\Rightarrow D_0(N)$



Topre

Sk. 11

$$\delta g_n S = 0 \rightarrow (3.11) EE. \quad \begin{cases} N = g^{00} \\ \dot{z} = N_n = g^{0n} \end{cases}$$

$N(\vec{x})$

reGlktion inv.
↗

Observables:

$$g_{ab} = \exp\{L_i\} g_{ab}$$

$$\Rightarrow D_n(N G^{ab}(h_i, g)) = 0$$

Plan: Max. out

momenta

$$\pi^{ab} = \frac{\partial L}{\partial g_{ab}} = \sqrt{\frac{2\Lambda - R}{G(\rho, \eta, \gamma)}} \sqrt{-g} G^{ab} (\rho, \eta, -)$$

$$p^a = \frac{\partial L}{\partial \dot{\xi}_a} = \sqrt{\frac{2\Lambda - R}{G(\rho, \eta, \gamma)}} \sqrt{-g} G^{ab} (\rho, \eta, -)$$

$$\delta g_{ab} S = 0 \rightarrow (3.11) EE. \quad N(\tilde{r})$$

$$\begin{cases} N = g_{ab} \\ \xi_c = N_{ab} \end{cases}$$

reflection inv.

$$\Rightarrow \left(G^{ab} (\rho, \eta, -) \right) = 0$$

Observables:

$$g_{ab} = \exp \left\{ \int L_{\tilde{r}} \right\} g_{ab} \Rightarrow$$

Momenta

Momenta

$$\pi^{ab} = \frac{\partial \mathcal{L}}{\partial g_{ab}} = \sqrt{\frac{2\Lambda - R}{G(\lambda_1, \lambda_2)}} \sqrt{-g} G^{ab} (\lambda_1, \lambda_2, -)$$

$$p^a = \frac{\partial \mathcal{L}}{\partial \dot{\lambda}_a} = \frac{1}{g} \sqrt{\frac{2\Lambda - R}{G(\lambda_1, \lambda_2)}} \sqrt{-g} G^{ab} (\lambda_1, \lambda_2, -)$$

1.1.1

$$\delta g_{ab} S = 0 \rightarrow (3.11) EE. \quad \begin{cases} N = g''_{00} \\ \dot{\lambda}_a = N_a = g''_{0a} \end{cases} \text{ inv.}$$

Observables:

$$g_{ab} = \tau_{IP} \{ \mathcal{L}_i \} g_{ab} \Rightarrow D_0(N)$$

21-

Momenti

$$\pi^{ab} = \frac{\partial L}{\partial g_{ab}}$$



$\frac{1}{g}$

Momenta:

$$\pi^{ab} = \frac{\partial L}{\partial g_{ab}} = \sqrt{-g} \frac{1}{g^0} G^{ab}(R, g, \dots)$$

$$p^a = \frac{\partial L}{\partial \dot{x}^a} =$$

$\frac{1}{g}$

Momenta:

$$\pi^{ab} = \frac{\partial L}{\partial g_{ab}} = \sqrt{-g} \frac{1}{g^0} G^{ab} (m, g, -)$$

$$p^a = \frac{\partial L}{\partial \dot{x}^a} = -2 \nabla_b \left(\frac{G^{ab} (m, g, -)}{g^0} \right)$$



$\frac{1}{g}$

Momenta

$$\pi^{ab} = \frac{\partial L}{\partial g_{ab}} = \sqrt{-g} \frac{1}{g^0} G^{ab}(m, g, \dots)$$

$$p^a = \frac{\partial L}{\partial \dot{x}^a} = -2 \nabla_b \left(\frac{G^{ab}(m, g, \dots) \sqrt{-g}}{g^0} \right) \Rightarrow \boxed{L^a = p^a - \nabla_b \pi^{ab} = 0}$$

$$\frac{1}{g}$$

Momenta:

$$\pi^{ab} = \frac{\partial L}{\partial g_{ab}} = \sqrt{-g} \frac{1}{g^0} G^{ab}(m, g, \dots)$$

$$p^a = \frac{\partial L}{\partial \dot{x}^a} = -2 \nabla_b \left(\frac{G^{ab}(m, g, \dots) \sqrt{-g}}{g^0} \right) \Rightarrow \boxed{L^a = p^a - \nabla_b \pi^{ab} = 0}$$

$$p^0 = \frac{\partial L}{\partial \dot{x}^0} =$$

$\frac{1}{g}$

Momenta:

$$\pi^{ab} = \frac{\partial L}{\partial g_{ab}} = \sqrt{-g} \frac{1}{g^0} G^{ab} (m, g, -)$$

$$p^a = \frac{\partial L}{\partial \dot{x}^a} = -2 \nabla_b \left(\frac{G^{ab} (m, g, -) \sqrt{-g}}{g^0} \right) \Rightarrow \boxed{L^a = p^a - \nabla_b \pi^{ab} = 0}$$

$$p^0 = \frac{\partial L}{\partial \dot{q}^i} = -\sqrt{-g} \left(\frac{G_{ij} (m, g, g)}{g^{0i}} + (R - 2\Lambda) \right)$$

$\frac{1}{g}$

Momenta:

$$\pi^{ab} = \frac{\partial L}{\partial g_{ab}} = \sqrt{-g} \frac{1}{g^0} G^{ab} (m, g, \dots)$$

$$p^a = \frac{\partial L}{\partial \dot{x}^a} = -2 \nabla_b \left(\frac{G^{ab} (m, g, \dots) \sqrt{-g}}{g^0} \right) \Rightarrow \boxed{L^a = p^a - \nabla_b \pi^{ab} = 0}$$

$$p^0 = \frac{\partial L}{\partial \dot{t}} = -\sqrt{-g} \left(\frac{G_{(R, \dots, R, \dots)}(m, g, \dots)}{g^{00}} + (R - 2\Lambda) \right)$$

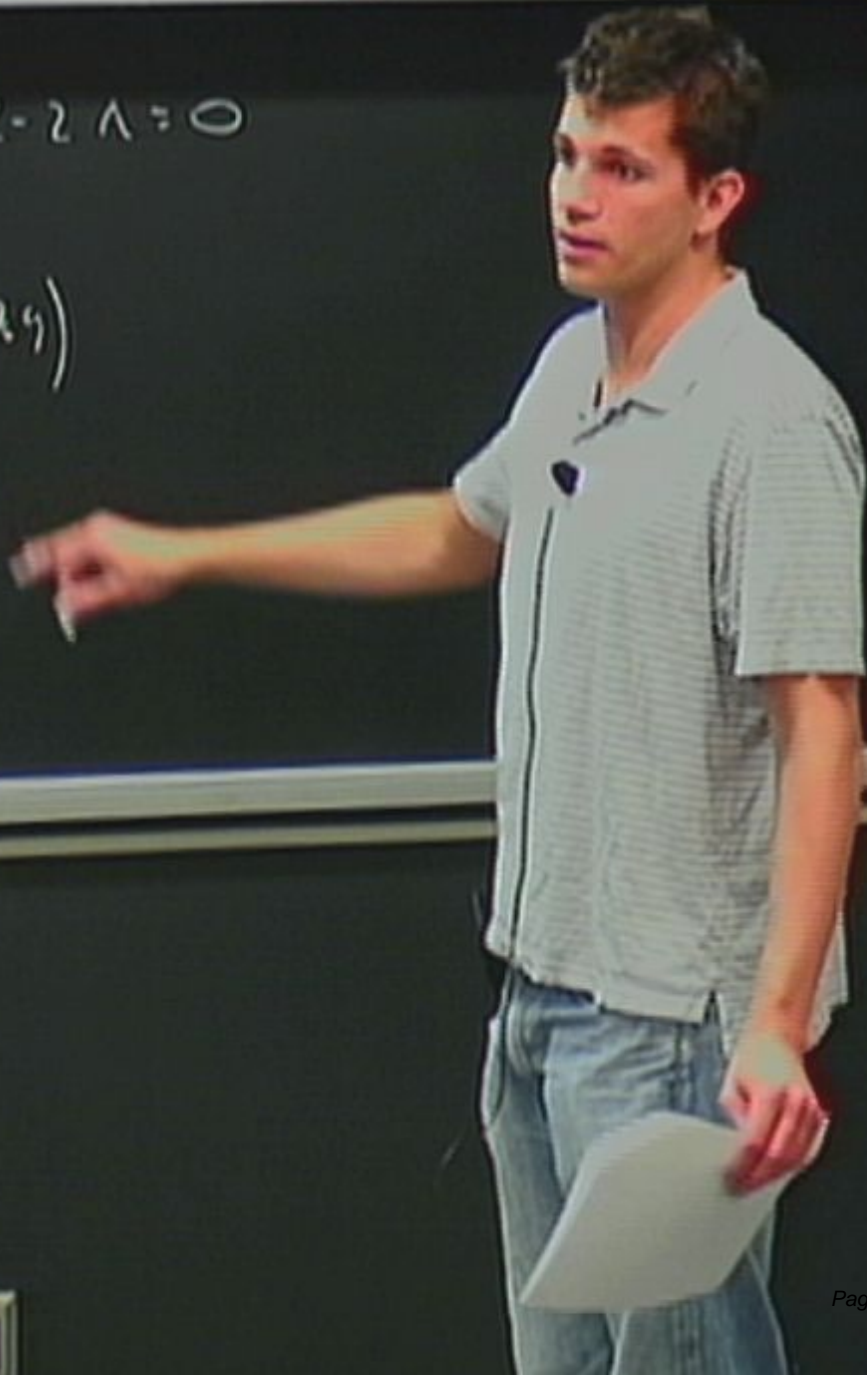
$$C_{x_1, b, c, d} \pi^{ab} \pi^{cd}$$

$$\frac{\text{Cov}_{ab} \pi^{ab} \pi^{cd}}{-g} + \frac{P^{\nu}}{\sqrt{-g}} + R - 2\Lambda = 0$$

Check $\frac{\text{Cov}_{ab} (-g)}{-g} \frac{1}{g_{\mu\nu}}$

$$\frac{G_{ab} \pi^{ab} \pi^{cd} + \frac{R}{\sqrt{-g}} + R - 2\Lambda = 0}{-g}$$

Check: ~~$\frac{1}{\sqrt{-g}}$~~ $(-)$ $\frac{1}{g_{\mu\nu}}$ $G(\mu, \nu)$



$$\frac{G_{ab} \pi^{ab} \pi^{cd} + \frac{P^0}{\sqrt{-g}} + R - 2\Lambda = 0}{-g}$$

Check $\frac{1}{\sqrt{-g}} (-2) \frac{1}{g_{00}} G(h_{ij}, R_{ij})$

$$\frac{G_{abcd} \pi^{ab} \pi^{cd}}{-g} + \frac{p^0}{\sqrt{-g}} + R - 2\Lambda = 0$$

Check: ~~$\frac{G_{abcd} \pi^{ab} \pi^{cd}}{-g}$~~ $\left(-\frac{1}{g_{00}} G(h_{ij}, k_{ij}) \right) + \frac{p^0}{\sqrt{-g}} + R - 2\Lambda = 0$

$$\frac{G_{abcd} \pi^{ab} \pi^{cd}}{-g} + \frac{\rho^{\nu}}{\sqrt{-g}} + R - 2\Lambda = 0 \quad \sum_i \frac{p_i^2}{2m_i} + p_0 + V = 0$$

Check ~~term~~ $\left(-\frac{1}{g_{\mu\nu}} \right) G(\eta, \eta) + \frac{\rho^{\nu}}{-g} + R - 2\Lambda = 0 \checkmark$

$$\frac{G_{ab} \pi^{ab} \pi^{cd}}{-g} + \frac{p^{\nu(1,1)}}{\sqrt{-g}} + R - 2\Lambda = 0$$

$$\sum_i \frac{\hat{p}_i^2}{2m_i} + \hat{p}_0 + V = 0$$

Check: ~~$\frac{1}{\gamma}$~~ $(-\gamma) \frac{1}{g_{\mu\nu}} G(\eta_{ij}, R_{ij}) + \frac{p^\nu}{-\gamma} + R - 2\Lambda = 0 \checkmark$ $\hat{p}_0 = -\frac{\partial}{\partial t}$

$$\left[\frac{C_{\text{kin}}}{-g} + \pi^{\text{cd}} + \frac{p^{\text{cd}}(t, \vec{r})}{\sqrt{-g}} + R - 2\Lambda = 0 \right]$$

$$\sum_i \frac{\hat{p}_i^2}{2m_i} + \hat{p}_0 + V = 0$$

Check

$$G(\mu, \nu, \alpha, \gamma) + \frac{p_\nu}{\gamma} + R - 2\Lambda = 0 \quad \checkmark \quad \hat{p}_0 = -\frac{\partial}{\partial t}$$

H

(Check) $\frac{d}{dt} \left(-\frac{1}{g} \frac{d}{dt} G(m_1, m_2) + \frac{p}{g} \right) = 0 \checkmark$

$\hat{p} = -\frac{\partial}{\partial t}$

$H_c = 0 \quad H_1 = NX + N_2 L^2 \quad L =$

$= L$

Check: $\frac{d}{dt} \left(-\frac{1}{g_{\mu\nu}} G(\mu, \nu) \right) + \frac{p^\nu}{-g} + R \cdot 2\Lambda = 0 \checkmark$ $\hat{p}_\alpha = -\frac{\partial}{\partial t}$

$H_c = 0$ $H_h = N_X + N_L L^X$ $L = \pi^{\mu\nu} \dot{g}_{\mu\nu} + P_0 L^0 + P^i \dot{g}^i - W_T$

$= L$

(Check: $\frac{d}{dt} \left(-\frac{1}{g^{02}} G(m, g, R, y) \right) + \frac{p^0}{-g} + R \cdot 2\lambda = 0 \checkmark$ $\hat{p}_0 = -\frac{2}{g} t$

$H_c = 0$ $H_1 = N_X + N_L L^X$ $L = \pi^{ab} \dot{g}_{ab} + p_0 L^0 + p^i \dot{q}^i - H_T$
 $+ \underline{\underline{q^i \nabla_i p_0}}$

$= L$

$$\frac{G_{ab,cd} \pi^{ab} \pi^{cd} + \frac{p^0(1,7)}{\sqrt{-g}} + R - 2\Lambda = 0$$

$$\xi^i \dots + v = 0$$

Check: $\frac{1}{\sqrt{-g}} (-\gamma) \frac{1}{g_{\mu\nu}} G(\eta_{ij}, R_{ij}) + \frac{p^0}{\sqrt{-g}} + R - 2\Lambda$

$H_c = 0$ $H_i = N\dot{X} + N_i L^a$ $L = \pi^{ab} \dot{g}_{ab} + P_i L^i + \dots$

Check: $\frac{d}{dt} \left(-\frac{1}{q^u} G(h, q, a, \eta) \right) + \frac{p^u}{-q} + R \cdot \lambda = 0 \checkmark$ $\hat{p}_0 = -\frac{\partial}{\partial t}$

$H_c = 0$ $H_1 = NX + N_2 L^a$ $L = \pi^{ab} \dot{q}_{ab} + p_1 L^1 + p_2 \dot{q}^2 - W_T$
 $+ \underline{q^i \nabla_i p_0}$

$= L$



$$\text{Check } \frac{\partial}{\partial t} \left(-\frac{1}{q^0} G(m, g, n, q) + \frac{p^0}{q^0} + \pi \cdot L \right) + \hat{p}_0 = -\frac{\partial}{\partial t}$$

$$H_0 = 0 \quad H_1 = NX + N_2 L^2 \quad L = \pi^{ab} \dot{q}_{ab} + p_1 L^1 + p_2 \dot{q}^2 - W_T$$

$$\boxed{+ \dot{q}^i \nabla_i p_0}$$

Field eq q^0

$$\underbrace{\hspace{15em}}_{=L}$$

$$\left[\frac{G_{ab} \pi^{ab} \pi^{cd} + \frac{p^0(1,2)}{\sqrt{-g}} + R - 2\Lambda = 0 \right]$$

$$\sum_i \dots + V = 0$$

Check: $\frac{(-3) \frac{1}{g_{00}}}{\cdot 3} (2g) + \frac{p}{-3}$

$H_c = 0 \quad H_1 = NX + N_2 L^2 \quad L = \pi^{ab} \dot{g}_{ab} + P_1 L^1$

Field eq q^0

$$p^0 = 0$$

$$\frac{G_{ab,cd} \pi^{ab} \pi^{cd}}{-g} + \frac{p^0(\lambda, \eta)}{\sqrt{-g}} + R - 2\Lambda = 0$$

$$\sum_i \frac{\hat{p}_i^2}{2m_i} + \hat{p}_0 + \dots$$

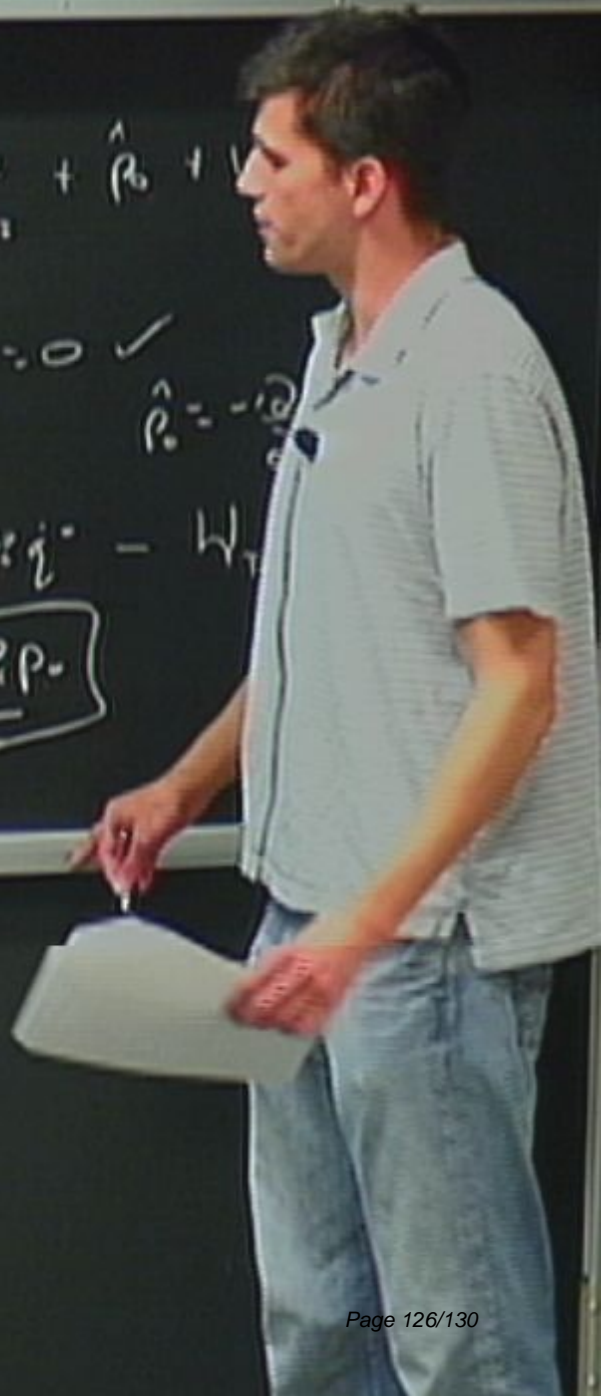
Check: $\frac{1}{\gamma} (-\gamma) \frac{1}{q^{0i}} G(\lambda, \eta, \lambda, \eta) + \frac{p^0}{-g} + R - 2\Lambda = 0 \checkmark$

$$H_0 = 0 \quad H_1 = N\dot{X} + N_i \dot{L}^i$$

$$L = \pi^{ab} \dot{q}_{ab} + p_i \dot{L}^i + p^0 \dot{q}^0 - H_T$$

$$+ \underline{q^i \nabla_i p_0}$$

Find q^0



$$H_c = 0 \quad H_1 = NX + N_2 L^2 \quad L = \pi^{ab} \dot{q}_{1a} + P_1 L^1 + P_2 \dot{q}^2 - W_T$$

q^0

$F. \text{ of } q^0(\lambda_1) : \dot{q}^2(\lambda_2)$

$+ \dot{q}^i \nabla_i P_0$

$$= \sqrt{-g} \int \frac{L(\lambda_1, \lambda_2)}{(A, \dot{q}_1, \dot{q}_2)} - L = 0$$

$-L$

$$\left(\frac{G_{abcd} \pi^{ab} \pi^{cd}}{-g} + \frac{p^0(\lambda, \dot{\lambda})}{\sqrt{-g}} + R - 2\Lambda = 0 \right)$$

$$\sum_i \frac{\hat{p}_i^2}{2m_i} + \hat{p}_0 + V = 0$$

Check: $\frac{d}{dt} \left(-\dot{\lambda} \frac{1}{g_{00}} G(\lambda, \dot{\lambda}, \lambda, \dot{\lambda}) + \frac{p^0}{-g} + R - 2\Lambda = 0 \right) \checkmark$

$H_c = 0$ $H_t = N\dot{X} + N_i L^i$

$L = \pi^{ab} \dot{g}_{ab} + p_i L^i + p^0 \dot{\lambda} - H$

$$+ \underline{\underline{q^i \nabla_i p_0}}$$

Field eq $q^0(\lambda_1) ; \dot{q}^0(\lambda_2)$



$$\left(\frac{G_{ab} \pi^a \pi^b}{-g} + \frac{p^u(\lambda, \dot{\lambda})}{\sqrt{-g}} + R - 2\Lambda = 0 \right)$$

$$\sum_i \frac{\hat{p}_i^2}{2m_i} + \hat{p}_0 + V = 0$$

Check: $\frac{d}{dt} \left(-\dot{\lambda} \frac{1}{g_{uu}} G(\lambda, \dot{\lambda}, \lambda, \dot{\lambda}) + \frac{p^u}{\sqrt{-g}} + R - 2\Lambda = 0 \right) \checkmark$ $\hat{p}_0 = -\frac{\partial}{\partial t}$

$H_c = 0$ $H_1 = N_X + N_L L^A$ $L = \pi^{ab} \dot{g}_{ab} + p_i L^i + p^i \dot{q}^i - H_T$

Field eq $q^a(\lambda_1), \dot{q}^a(\lambda_2)$

$$\boxed{+ q^i \nabla_i p_i}$$

H_{tot} const: $\frac{G_{abcd} \pi^{ab} \pi^{cd}}{-g} - \left(G^{abnm} (g_{nm} + \dot{g}_{nm}) \right) \left(\dot{g}^{cdop} (g_{op} + \dot{g}_{op}) \right)$
 check: $-\frac{1}{g} \left[\frac{-g(2\Lambda - R)}{G(\dot{a}, \dot{b}, \dot{c}, \dot{d})} \cdot G^{abnm} (g_{nm} + \dot{g}_{nm}) \right] \left(\dot{g}^{cdop} (g_{op} + \dot{g}_{op}) \right)$
 $-(2\Lambda - R)$
 $= 0 \checkmark$

$$\frac{G_{abcd} \pi^{ab} \pi^{cd}}{-g} + \frac{p^0(\dot{x})}{\sqrt{-g}} + R - 2\Lambda = 0 \quad \sum_i \frac{\hat{p}_i^2}{2m_i} + \hat{p}_0 + V = 0$$

check: $\frac{1}{g} \left(-\dot{x} \frac{1}{q^{0i}} G(\dot{a}, \dot{b}, \dot{c}, \dot{d}) \right) + \frac{p^0}{-g} + R - 2\Lambda = 0 \checkmark$
 $\hat{p}_0 = -\frac{\partial}{\partial t}$

$H_c = 0 \quad H_1 = N\dot{X} + N_i L^i \quad L = \pi^{ab} \dot{g}_{ab} + p_i L^i + p_0 \dot{x} - H_T$

Field eq $q^a(\lambda_1), \dot{q}^a(\lambda_2)$

$$+ \underline{q^i \nabla_i p_0}$$