Title: Lecture - Canonical b

Speakers:

Collection: Celestial Holography Summer School 2024

Date: July 23, 2024 - 10:00 AM

URL: https://pirsa.org/24070008

Covariant Phase Space

1. $\mathbb{F}$
2. $\delta L = E\,\delta\phi + d\Theta$
3. $\widetilde{H} = \int_\Sigma \Theta$
4. $\Omega = \dfrac{\tilde{\Omega}}{\ker \hat{\Omega}}$

① $\mathbb{F}$

$$ds^2 = -e^{2\beta} U\, du^2 - 2e^{2\beta} du\, dr + g_{AB}(dx^A - U^A du)(dx^B - U^B du)$$

$$\partial_r \det\left(\frac{g_{AB}}{r^2}\right) = 0$$

$$U = O(1) \qquad \beta = O\left(\frac{1}{r^2}\right)$$

$$U^A = O\left(\frac{1}{r^2}\right) \qquad g_{AB} = r^2 q_{AB}(x) + O(r)$$

$$^{B}-U^{B}du\,)$$

$$_{AB}(x)+O(r)$$

$$② \quad L = \frac{1}{16\pi G}\,\epsilon R$$

$$\delta L = \frac{1}{16\pi G}\,\epsilon\, G_{\mu\nu}\,\delta g^{\mu\nu} + d\Theta$$

$$(*\Theta)^{\mu} = \underbrace{\frac{1}{16\pi G}\left(g^{\mu\nu}\,\delta\Gamma^{\rho}_{\mu\rho} - g^{\nu\rho}\,\delta\Gamma^{\mu}_{\nu\rho}\right)}_{\Theta_{\text{canonical}}} + (*dY)^{\mu}$$

$$(*dY)^\mu$$

$$(\hat{M})$$

$$U = \frac{\bar{R}}{2} + \frac{1}{r}\left(-2\boxed{M} + \frac{1}{8}\partial_u (C^2)\right)$$

$$M(u_0)$$

$$\beta = \frac{1}{r^2}\left(-\frac{1}{32}C^2\right) \qquad P^A(u_0)$$

$$U^A = \frac{1}{r^2}\left(-\frac{1}{2}D^B C_B^A\right) + \frac{1}{r^3}\left(-\frac{2}{3}\boxed{P^A} + \dots\right)$$

$$g_{AB} = r^2 \boxed{q_{AB}(x)} + r\boxed{C_{AB}(u,x)} + \dots$$

Covariant Phase Space

$\cancel{1}$ $\mathbb{F}$

$\cancel{2}$ $\delta L = E\,\delta\phi + d\theta$

3 $\tilde{H} = \int_\Sigma \theta$

4 $\Omega = \dfrac{\tilde{\Omega}}{\ker \tilde{\Omega}}$

$$\tilde{\Theta} = \int_{\Sigma} \Theta$$

$$= \int_{g^+} \sqrt{-g}\,(\times\Theta_{can})^r$$

$$+ \int^r dr \sqrt{-g}\,(*\Theta_{can})^{u\cdot}$$

$$+ \int_{g^+_-} \sqrt{-g}\,(*Y)^{ur}$$

② $L = \ldots$

$\delta L = \frac{1}{16\pi G} \ldots$

$(\times\Theta)^{\mu} = \frac{1}{16\pi \ldots}$

$\mathcal{I}^+$

$\mathcal{I}^+_-$

$$\tilde{\Theta} = \frac{1}{32\pi G}\int_{\mathcal{I}^+}\left[N^A_B\, \delta C^B_A + \frac{1}{2}\left(D^2 C_{AB} - \frac{R}{2} C_{AB}\right)\delta q^{AB}\right]$$

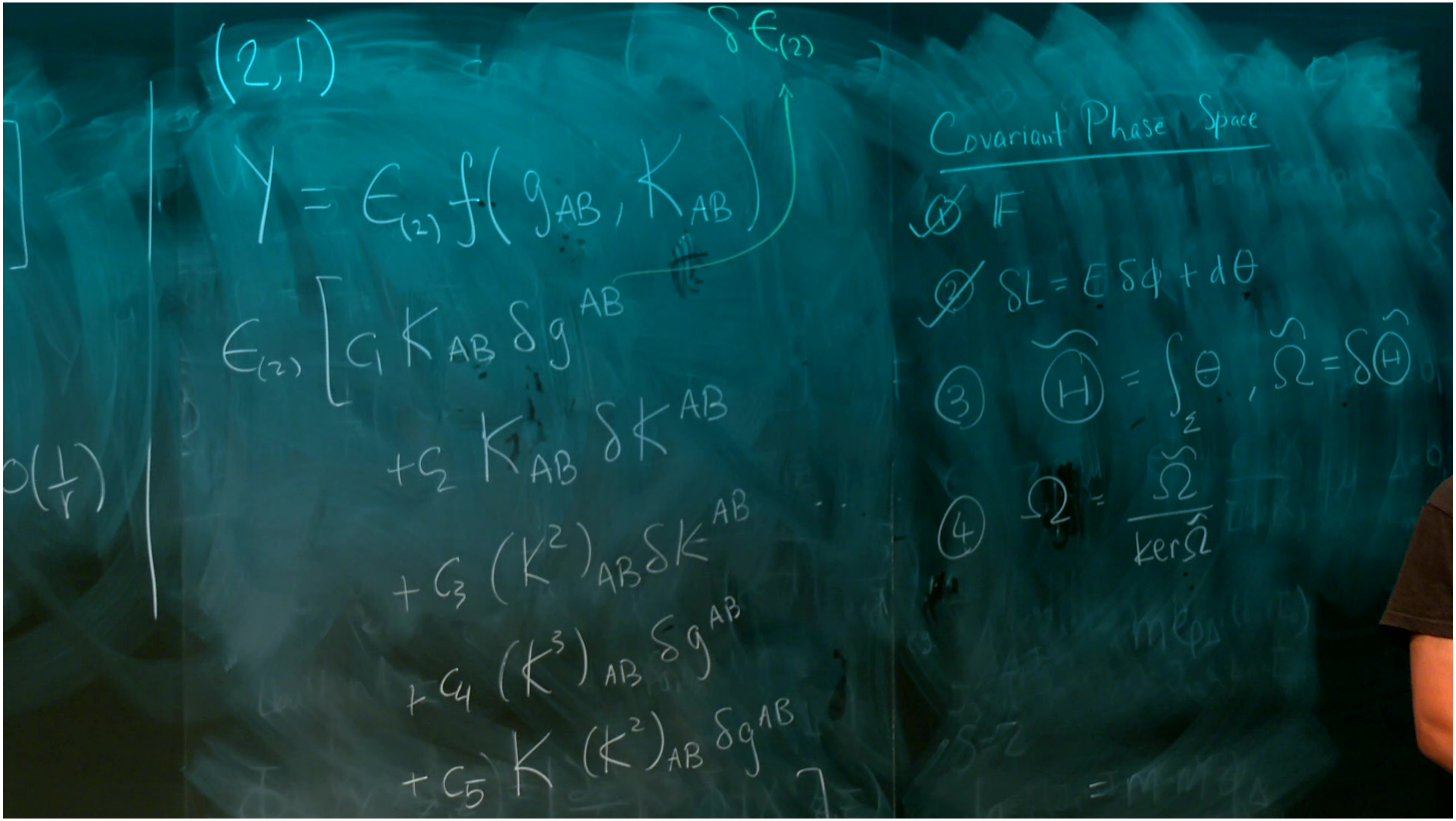
$$+ \int_{\mathcal{I}^+} \delta\sqrt{q}\, (\qquad)$$

$$+ \int_{\mathcal{I}^+_-}\left(-r^2 (\star Y)^{ur} + \frac{r}{2} C_{AB}\,\delta q^{AB}\right) + O\left(\frac{1}{r}\right)$$

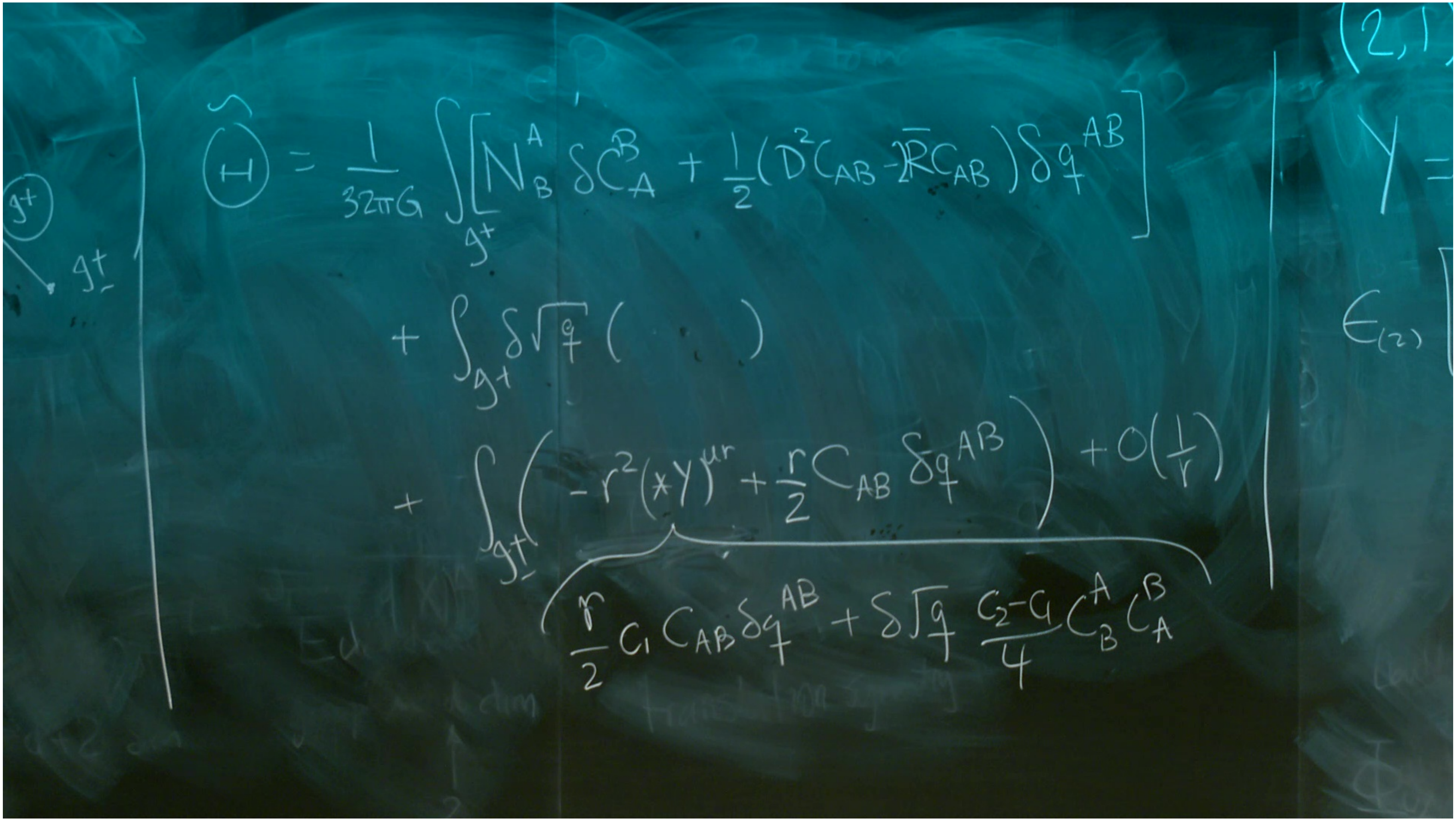
$$= \frac{1}{32\pi G}\int_{\mathcal{I}^+}\left[N^A_B\,\delta C^B_A + \frac{1}{2}\left(D^2 C_{AB} - \bar{R}C_{AB}\right)\delta q^{AB}\right]$$

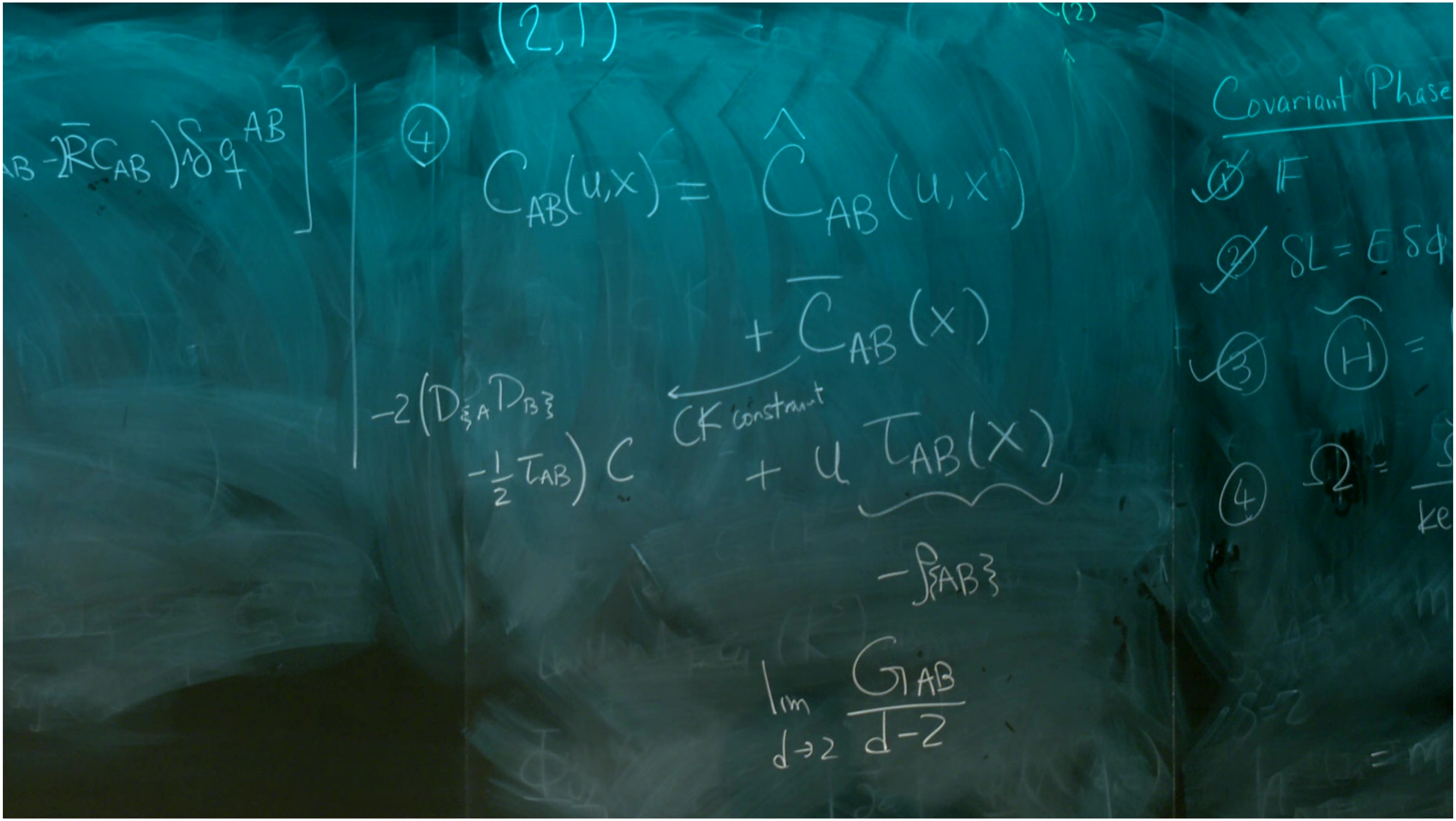
$$+ \int_{\mathcal{I}^+}\delta\sqrt{q}\,\left(\quad\right)$$

$$+ \int_{\mathcal{I}^+}\left(-r^2 (*Y)^{ur} + \frac{r}{2}C_{AB}\,\delta q^{AB}\right) + O\left(\frac{1}{r}\right)$$



$(2,1)$
$\delta \epsilon_{(2)}$
$Y = \epsilon_{(2)} f(g_{AB}, K_{AB})$
$\epsilon_{(2)} \Big[c_1 K_{AB} \delta g^{AB}$
$+ c_2 K_{AB} \delta K^{AB}$
$+ c_3 (K^2)_{AB} \delta K^{AB}$
$+ c_4 (K^3)_{AB} \delta g^{AB}$
$+ c_5 K (K^2)_{AB} \delta g^{AB} \Big]$
$O(\frac{1}{r})$
Covariant Phase Space
① $\mathbb{F}$
② $\delta L = E \delta\phi + d\Theta$
③ $\widetilde{\Theta} = \int_\Sigma \Theta$, $\hat{\Omega} = \delta \widetilde{\Theta}$
④ $\Omega = \frac{\tilde{\Omega}}{\ker \hat{\Omega}}$


$\mathscr{I}^+$
$\mathscr{I}^+_-$
$\hat{\Theta} = \frac{1}{32\pi G}\int_{\mathscr{I}^+}\left[N^A_B\,\delta C^B_A + \frac{1}{2}\left(D^2 C_{AB} - \bar{R}\,C_{AB}\right)\delta q^{AB}\right]$
$+ \int_{\mathscr{I}^+}\delta\sqrt{q}\,(\quad)$
$+ \int_{\mathscr{I}^+_-}\Big(\underbrace{-r^2(\star Y)^{ur} + \frac{r}{2}C_{AB}\,\delta q^{AB}}_{\frac{r}{2}c_1 C_{AB}\delta q^{AB} + \delta\sqrt{q}\,\frac{c_2-c_1}{4}C^A_B C^B_A}\Big) + O\left(\frac{1}{r}\right)$
$(2,1)$
$Y =$
$\epsilon_{(2)}$



(2,1)
$AB - \bar{R} C_{AB}) \delta q^{AB}]$
④
$C_{AB}(u,x) = \hat{C}_{AB}(u,x)$
$+ \bar{C}_{AB}(x)$
CK constraint
$-2(D_{\xi A} D_{B\xi}$
$-\frac{1}{2}\tau_{AB}) C$
$+ u \, \underbrace{\tau_{AB}(x)}$
$-\rho_{\{AB\}}$
$\lim_{d\to 2} \frac{G_{AB}}{d-2}$
Covariant Phase
① IF
② $\delta L = E \delta \phi$
③ $\widetilde{H} =$
④ $\Omega =$
ke

$\mathcal{I}^+$

$\mathcal{I}^+_-$

$$\tilde{\Omega} = \frac{1}{32\pi G}\int_{\mathcal{I}^+}\left[\delta N_B^{\ A}\wedge\delta C_A^{\ B} + \frac{\delta}{2}\left(D^2 C_{AB} - \bar{R} C_{AB}\right)\wedge\delta q^{AB}\right]$$

$$\delta x^a \partial_{x^a} x^A$$

$$= \int_{\mathcal{I}^+}\delta\sqrt{q}\wedge\delta(\qquad)$$

$$\hat{\Theta} = \frac{1}{32\pi G}\int_{\mathcal{I}^+}\hat{N}_B^{\ A}\,\delta\hat{C}_A^{\ B} + \frac{1}{8\pi G}\int_{\mathcal{I}^+_-}\left(2M\delta C + \delta\tilde{\chi}^A N_A\right)$$

$$-2\left(D_{\xi_A} D_B \xi - \frac{1}{2}\tau_{AB}\right)$$

$$+\frac{1}{16\pi G}\int_{\mathcal{I}^+_-}\delta\sqrt{q}\,F(\chi,\Phi)$$

4

$q_{AB}(x$

$C_{AB}(u,$

$$\tilde{\Omega} = \frac{1}{32\pi G}\int_{\mathcal{I}^+}\left[N_B{}^A \wedge \delta C_A{}^B + \frac{\delta}{2}\left(D^2 C_{AB} - \bar{R} C_{AB}\right) \wedge \delta q^{AB}\right]$$

$$= \int_{\mathcal{I}^+} \delta\sqrt{q} \wedge \delta(\qquad)$$

$$\delta \chi^a \partial_{\chi^a} x^A$$

$$\tilde{\Theta} = \frac{1}{32\pi G}\int_{\mathcal{I}^+} \hat{N}_B{}^A \delta \hat{C}_A{}^B + \frac{1}{8\pi G}\int_{\mathcal{I}^+_-}\left(2M\delta C + \delta\tilde{\chi}^A N_A\right)$$

$$+ \frac{1}{16\pi G}\int_{\mathcal{I}^+_-} \delta\sqrt{q}\, F(\chi, \Phi)$$

$$q_{AB}(x) = e^{\ldots}$$

(4) $C_{AB}(u,x) =$

$$-2\left(D_{\xi_A} D_{B\xi} - \frac{1}{2}\tau_{AB}\right) C$$

$\leftarrow$ CK

$$q_{AB}(x) = e$$

$$\tilde{\Omega} = \frac{1}{32\pi G}\int_{\mathcal{I}^+}\left[N^A_B \wedge \delta C^B_A + \frac{\delta}{2}\left(D^2 C_{AB} - \bar{R} C_{AB}\right)\wedge\delta q^{AB}\right]$$

$$\delta x^a \partial_{x^a} x^A$$

$$= \int_{\mathcal{I}^+} \delta\sqrt{q}\wedge\delta(\qquad)$$

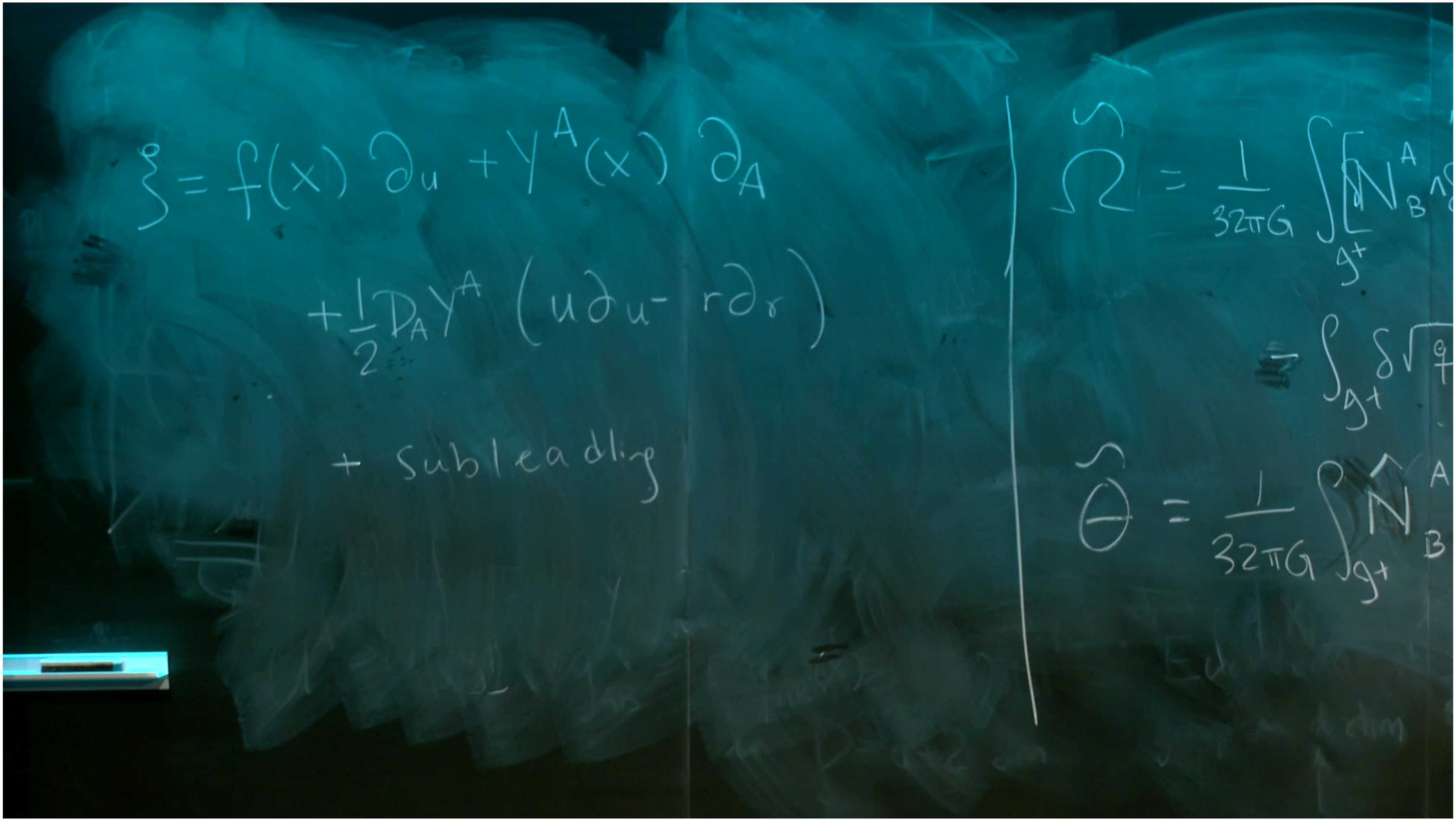
(4) $C_{AB}(u,x) =$

$$\hat{\Theta} = \frac{1}{32\pi G}\int_{\mathcal{I}^+}\hat{N}^A_B\,\delta\hat{C}^B_A + \frac{1}{8\pi G}\int_{\mathcal{I}^+_-}\left(2M\delta C + \delta\tilde{X}^A N_A\right)$$

$$-2\left(D_{\xi A}D_{B\xi} - \frac{1}{2}\tau_{AB}\right)C$$

$\leftarrow$ CK

$$+\frac{1}{16\pi G}\int_{\mathcal{I}^+_-}\delta\sqrt{q}\left(-2uM + \cdots\right)$$


$\xi = f(x)\,\partial_u + Y^A(x)\,\partial_A$
$+\frac{1}{2} D_A Y^A (u\partial_u - r\partial_r)$
+ subleading
$\hat{\Omega} = \frac{1}{32\pi G}\int_{\mathscr{I}^+} [N^A{}_B \wedge$
$= \int_{\mathscr{I}^+} \delta\sqrt{q}$
$\hat{\Theta} = \frac{1}{32\pi G}\int_{\mathscr{I}^+} \hat{N}^A{}_B$

$$\frac{\delta}{2}\left(D^2 C_{AB} - \bar{R}\, C_{AB}\right)\delta g^{AB}\Big]$$

$$\delta x^a \partial_{x^a} x^A$$

$$)$$

$$+\frac{1}{8\pi G}\int_{\mathcal{I}^+_-}\left(2M\delta C + \widetilde{\delta X}^A N_A\right)$$

$$\delta H_\xi = \Omega(\delta, \mathcal{L}_\xi)$$

$$= \frac{1}{4\pi G}\int_{\mathcal{I}^+_-}\left(f\delta M - \frac{1}{2}\delta X^A L_A\right)$$

$$+ \frac{1}{8\pi G}\int_{\mathcal{I}^+_-}\left(Y^A \delta N_A - \frac{u}{2}\delta X^A L_A\right)$$

$N_A = P_A + ($

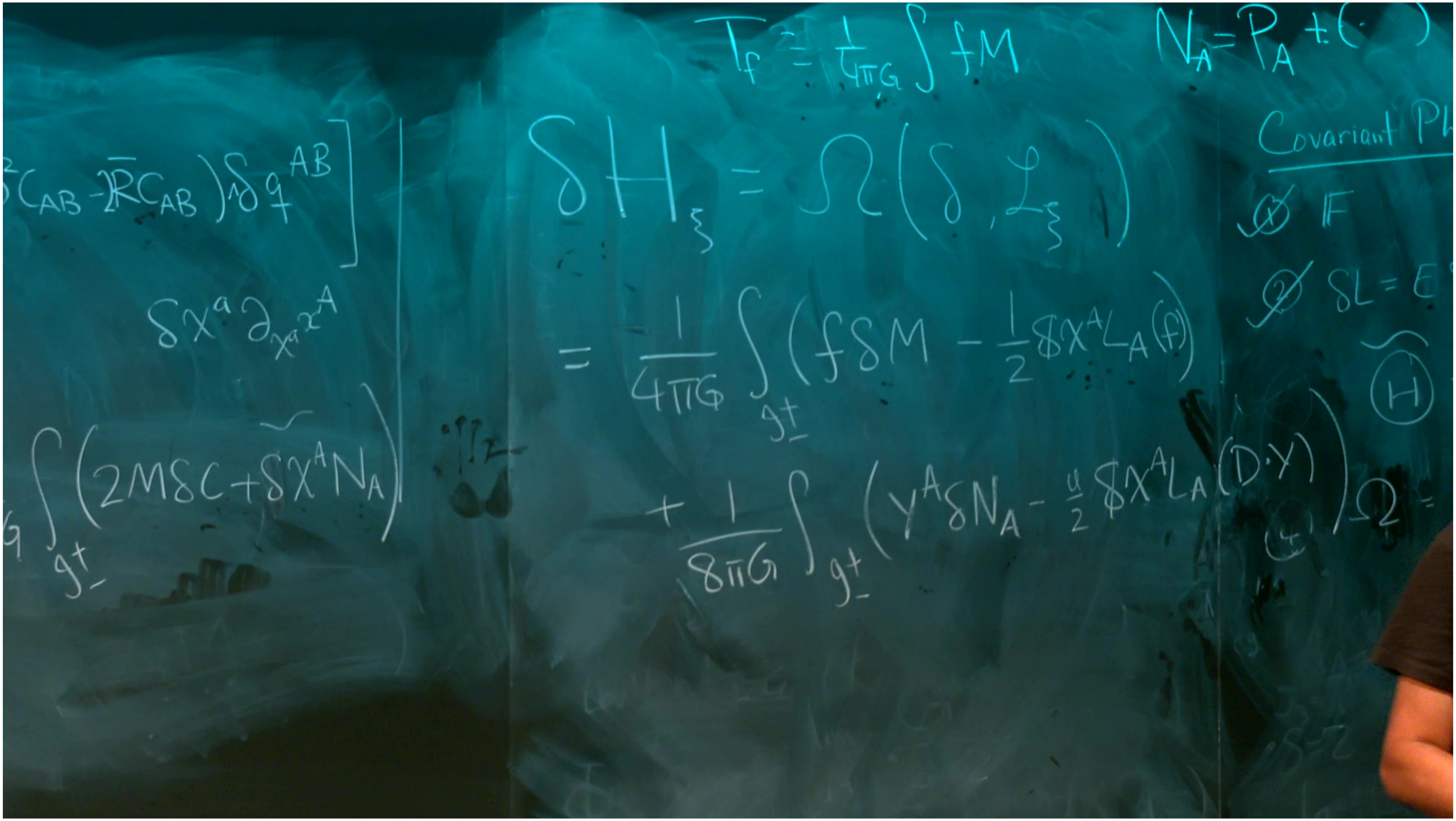
Covari

① IF

② δL

③

④


$T_f \stackrel{?}{=} \frac{1}{4\pi G}\int fM$
$N_A = P_A + (\cdot\ \ )$
Covariant Ph
$\delta H_\xi = \Omega(\delta, \mathcal{L}_\xi)$
$= \frac{1}{4\pi G}\int_{\mathscr{I}^+_-}\left(f\delta M - \frac{1}{2}\delta\chi^A L_A(f)\right)$
$+ \frac{1}{8\pi G}\int_{\mathscr{I}^+_-}\left(Y^A\delta N_A - \frac{u}{2}\delta\chi^A L_A(D\cdot Y)\right)$
$\delta\chi^a\partial_{\chi^a}x^A$
$\int_{\mathscr{I}^+_-}\left(2M\delta C + \delta\chi^A N_A\right)$