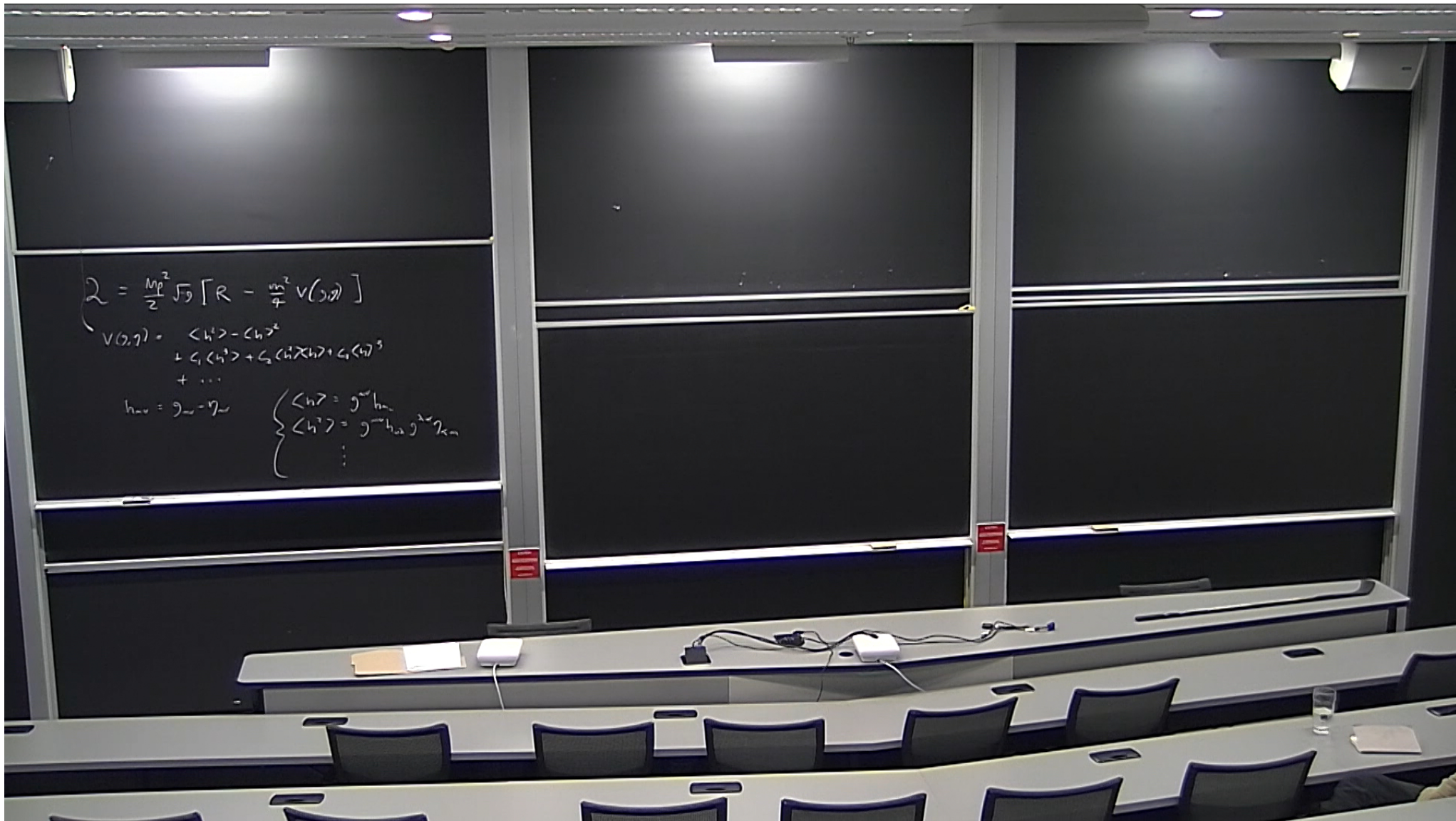


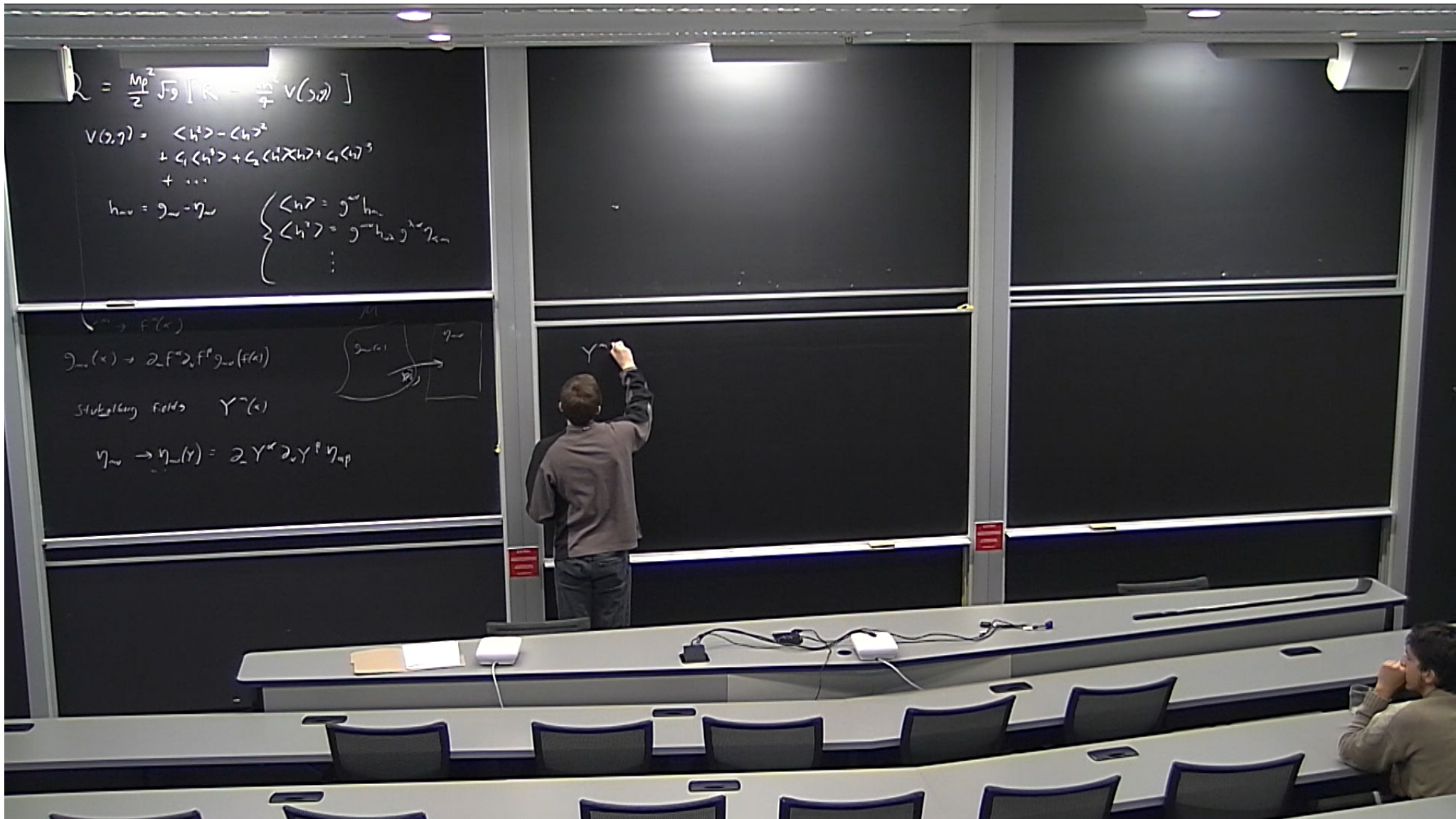
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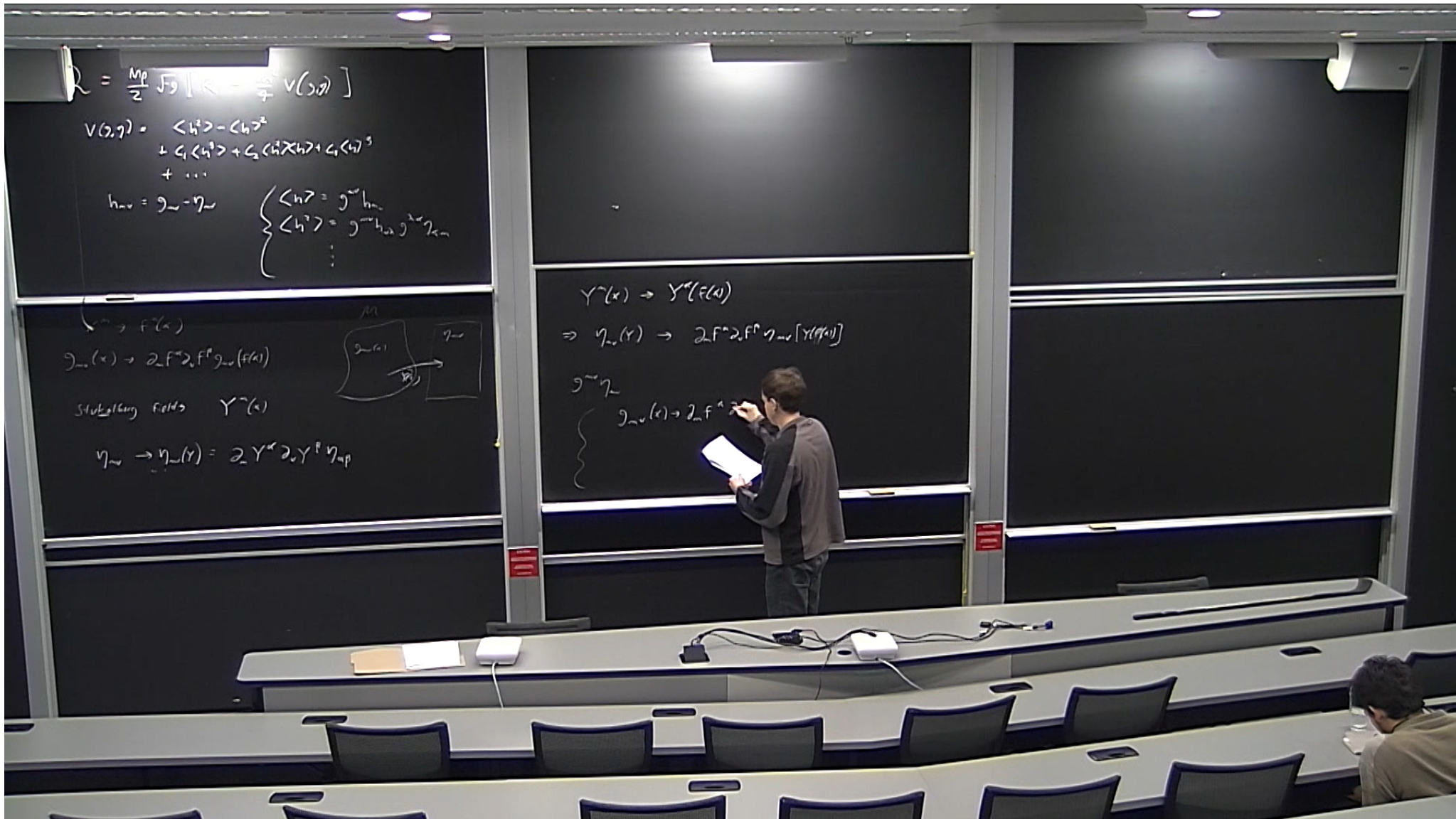
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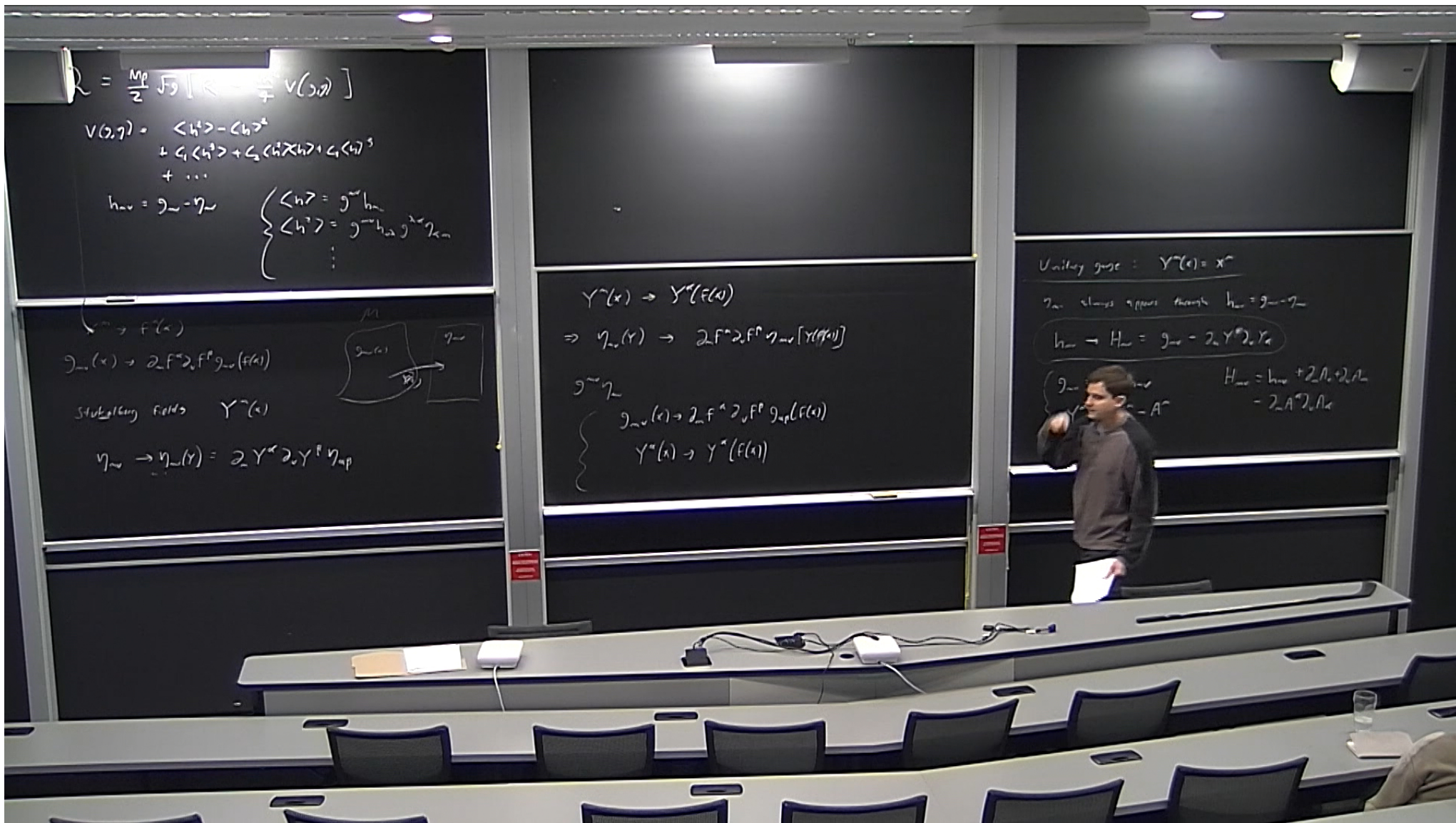
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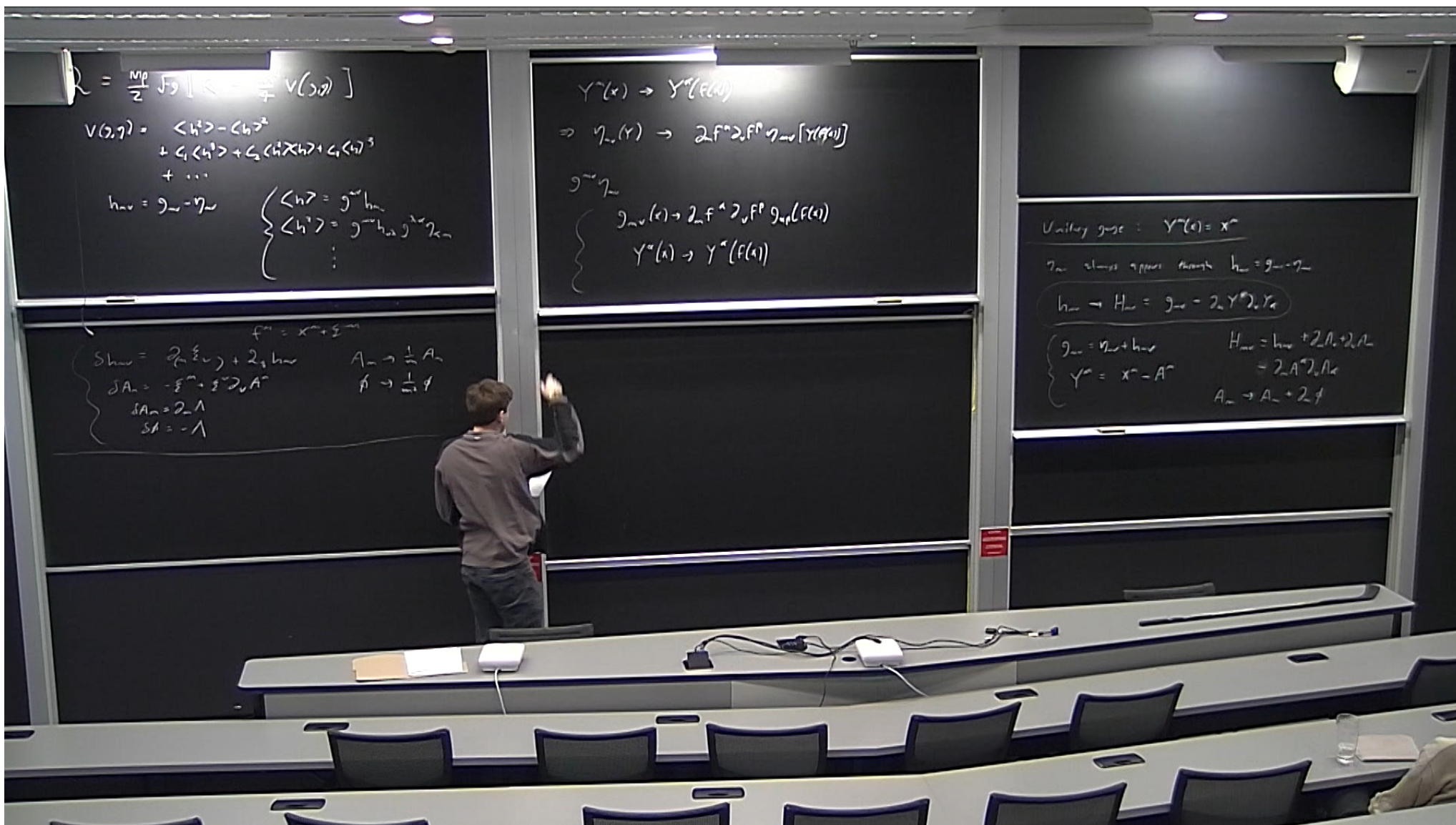
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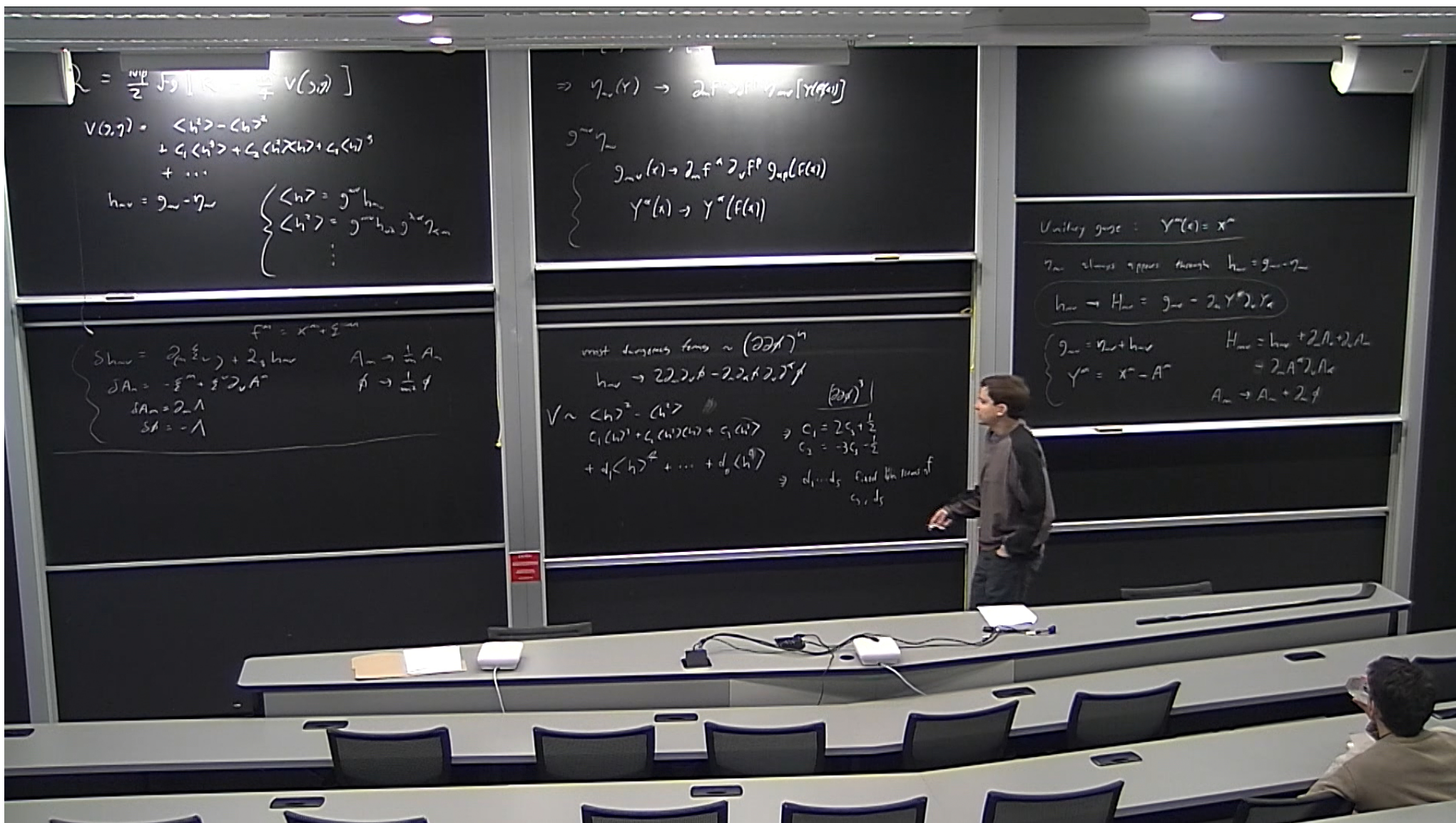


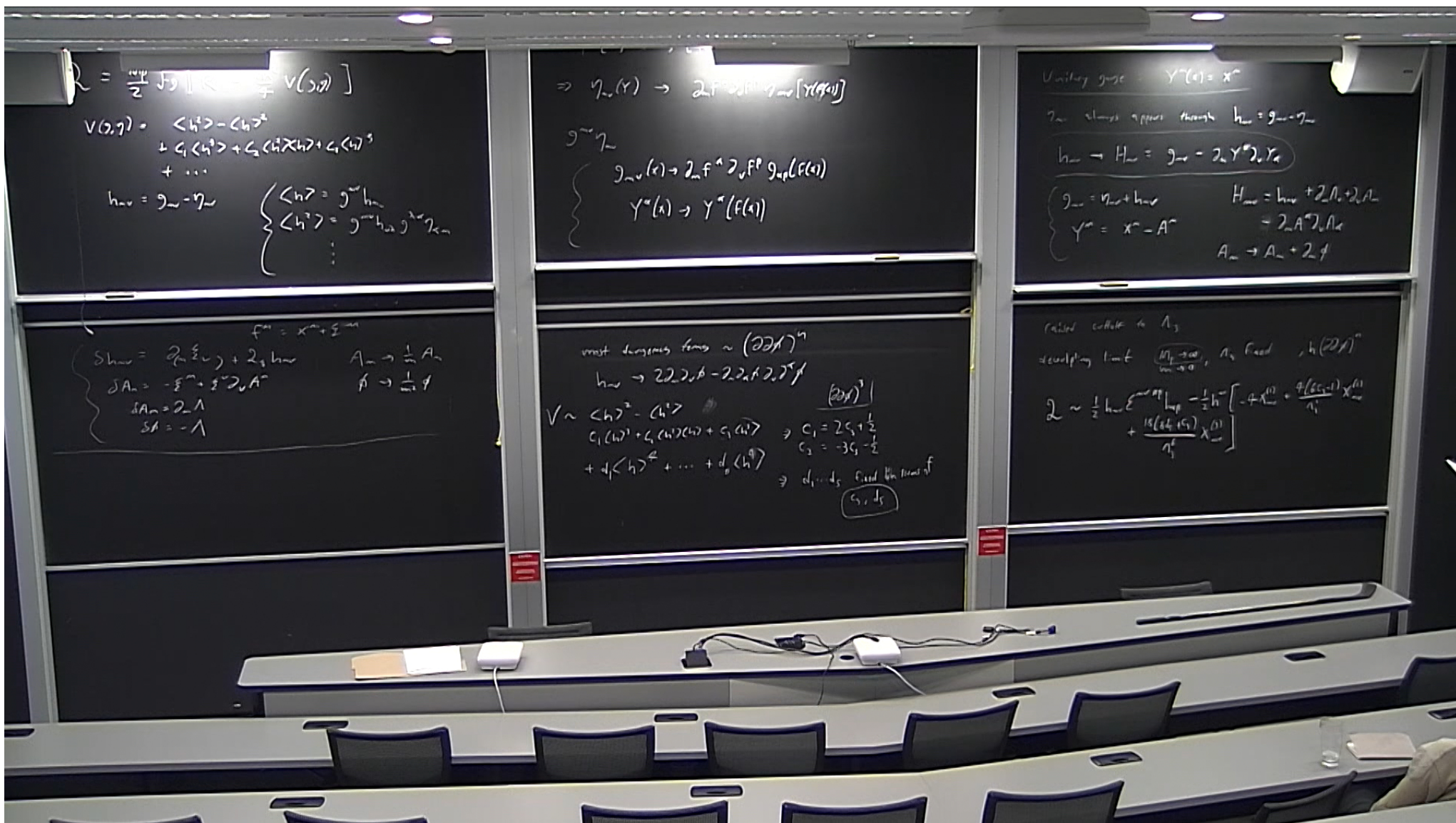


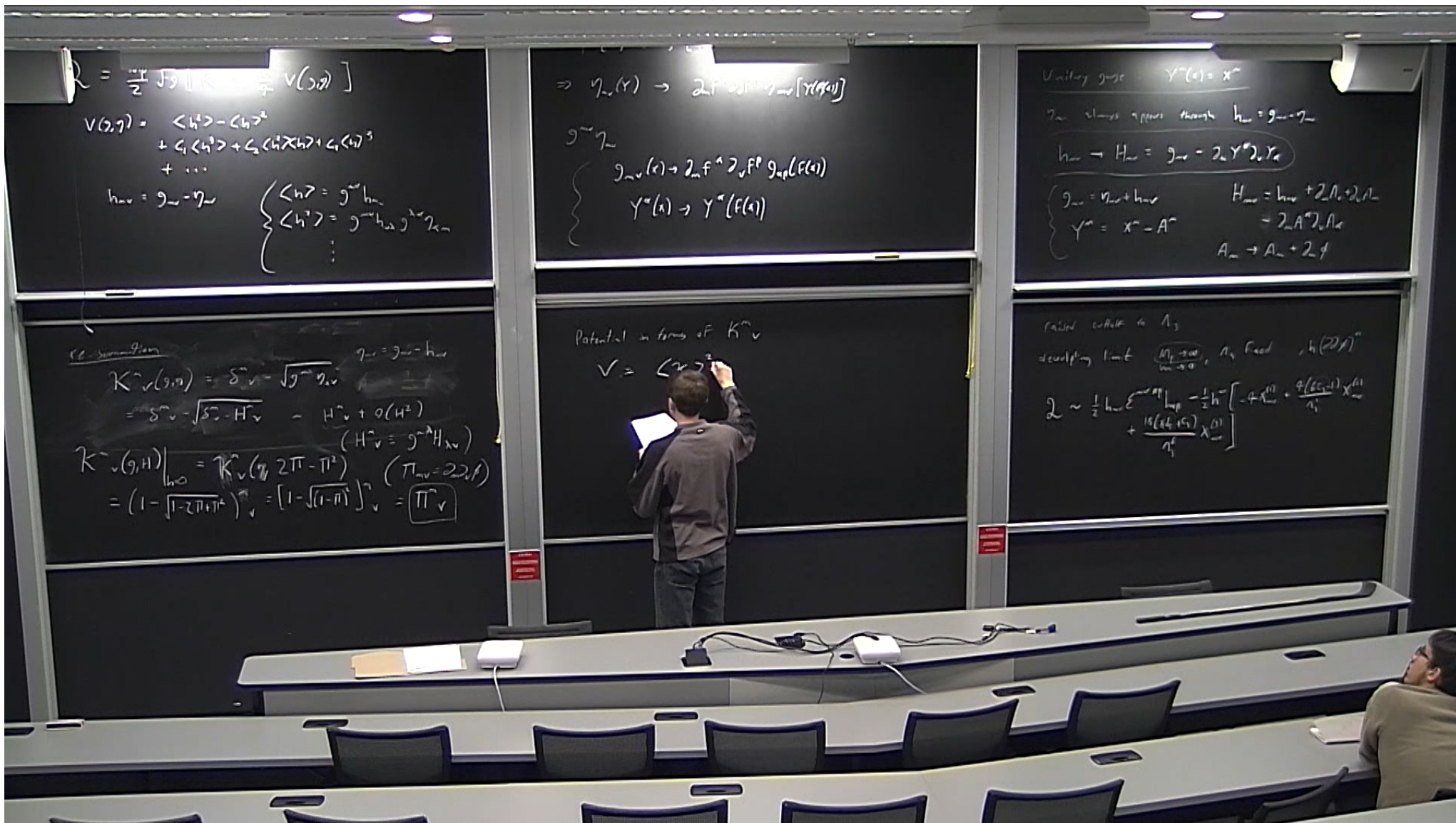


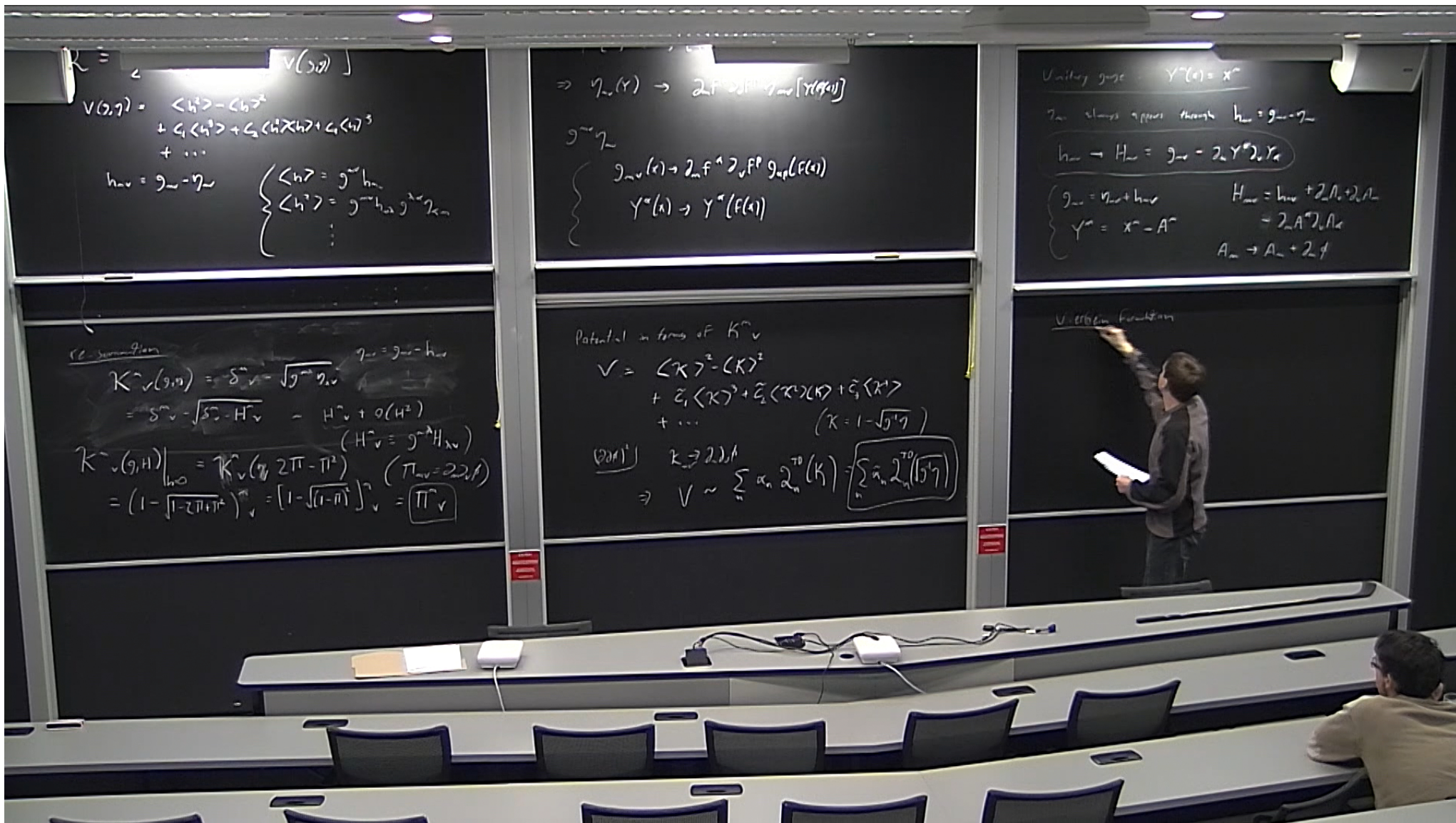


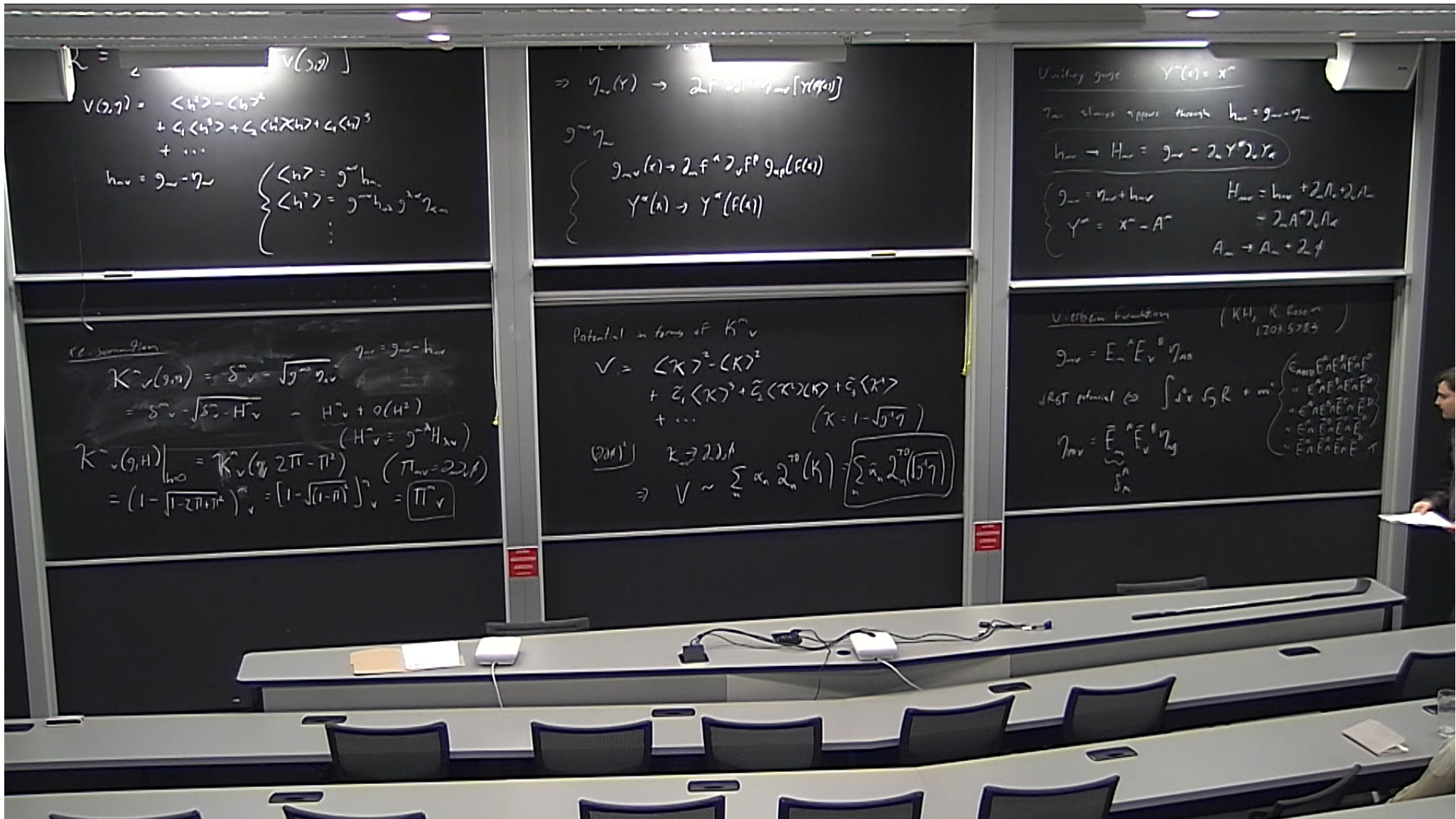












$$K = \begin{bmatrix} \dots & V(\phi) \end{bmatrix}$$

$$V(\phi) = \langle \phi^4 \rangle - \langle \phi^2 \rangle^2 + c_1 \langle \phi^4 \rangle + c_2 \langle \phi^2 \phi^2 \rangle + c_3 \langle \phi^4 \rangle^2 + \dots$$

$$h_{\mu\nu} = g_{\mu\nu} - \eta_{\mu\nu} \quad \begin{cases} \langle \phi^2 \rangle = g^{\mu\nu} h_{\mu\nu} \\ \langle \phi^4 \rangle = g^{\mu\nu} h_{\mu\nu} g^{\rho\sigma} h_{\rho\sigma} \\ \vdots \end{cases}$$

Effective action

$$K^{-1}_V(\phi, \phi) = -S''_V = \sqrt{g^{\mu\nu}} g_{\mu\nu}$$

$$= S''_V - \sqrt{S''_V - H''_V} = H''_V + O(H^2)$$

($H''_V = g^{\mu\nu} H_{\mu\nu}$)

$$K^{-1}_V(\phi, H) \Big|_{H=0} = K^{-1}_V(\phi, 2\pi - \pi^2) \quad (\pi_{\mu\nu} = 2g_{\mu\nu})$$

$$= (1 - \sqrt{1 - 2\pi/\pi^2})''_V = [1 - \sqrt{1 - \pi}]''_V = \boxed{\pi''_V}$$

$$\Rightarrow \eta_{\mu\nu}(\gamma) \rightarrow 2F^{\mu\alpha} \partial_\alpha F^{\nu\beta} g_{\mu\nu}(\gamma(q))$$

$$g^{\mu\nu} \eta_{\mu\nu}$$

$$\left\{ \begin{array}{l} g_{\mu\nu}(\gamma) \rightarrow 2F^{\mu\alpha} \partial_\alpha F^{\nu\beta} g_{\mu\nu}(\gamma(q)) \\ Y^\mu(\gamma) \rightarrow Y^\mu(\gamma(q)) \end{array} \right.$$

Potential in terms of $K^{\mu\nu}$

$$V = \langle K \rangle^2 - \langle K \rangle^2 + \tilde{c}_1 \langle K \rangle^3 + \tilde{c}_2 \langle K \rangle \langle K \rangle + \tilde{c}_3 \langle K \rangle^4 + \dots$$

($K = 1 - \sqrt{g^{\mu\nu}} g_{\mu\nu}$)

$$\boxed{(2\pi H)^4} \quad K \rightarrow 2\pi H^2$$

$$\Rightarrow V \sim \sum_n \alpha_n 2^n(K) = \boxed{\sum_n \tilde{\alpha}_n 2^n(1/\gamma)}$$

Unitary gauge: $Y^\mu(\gamma) = x^\mu$

$g_{\mu\nu}$ always appears through $h_{\mu\nu} = g_{\mu\nu} - \eta_{\mu\nu}$

$$h_{\mu\nu} \rightarrow H_{\mu\nu} = g_{\mu\nu} - 2Y^\mu \partial_\mu Y_\nu$$

$$\left\{ \begin{array}{l} g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu} \\ Y^\mu = x^\mu - A^\mu \end{array} \right. \quad \begin{array}{l} H_{\mu\nu} = h_{\mu\nu} + 2A_\mu \partial_\nu A_\nu \\ = 2A^\mu \partial_\mu A_\nu \\ A_\mu \rightarrow A_\mu + 2\partial_\mu \phi \end{array}$$

Verbeeten Formula (KH, R. Basse 1203.5783)

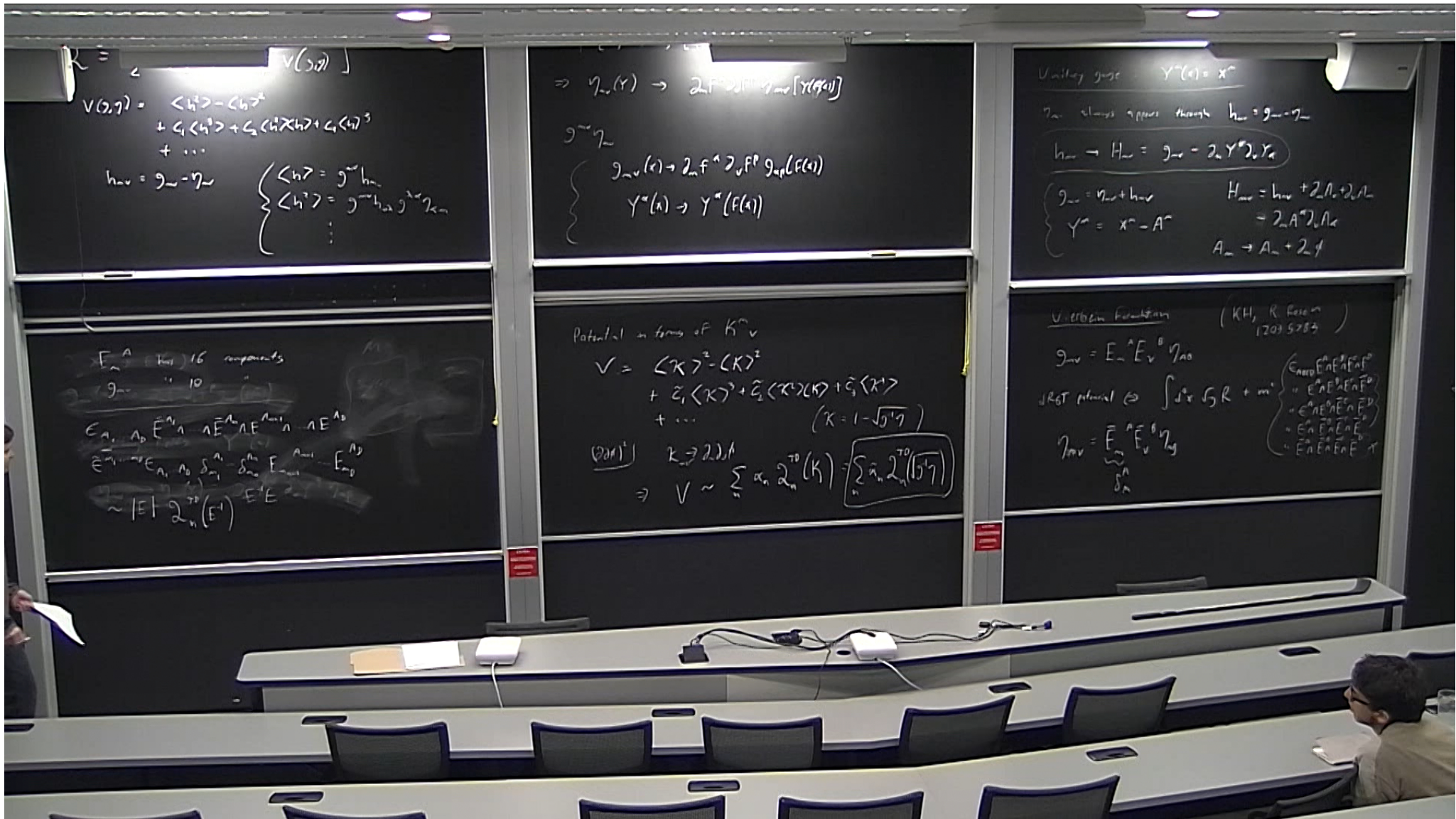
$$g_{\mu\nu} = E_\mu^A E_\nu^B \eta_{AB}$$

Left potential $\Leftrightarrow \int d^4x \sqrt{g} R + m^2$

$$\eta_{\mu\nu} = \tilde{E}_\mu^A \tilde{E}_\nu^B \eta_{AB}$$

\tilde{E}_μ^A

$$\left\{ \begin{array}{l} \text{Camp} E^A_\mu E^B_\nu E^C_\rho E^D_\sigma \\ E^A_\mu E^B_\nu E^C_\rho E^D_\sigma \\ E^A_\mu E^B_\nu E^C_\rho E^D_\sigma \\ E^A_\mu E^B_\nu E^C_\rho E^D_\sigma \\ E^A_\mu E^B_\nu E^C_\rho E^D_\sigma \end{array} \right.$$



$$K = \begin{bmatrix} V(\phi) \end{bmatrix}$$

$$V(\phi) = \langle h^2 \rangle - \langle h^2 \rangle^2 + c_1 \langle h^2 \rangle + c_2 \langle h^2 h^2 \rangle + c_3 \langle h^2 \rangle^3 + \dots$$

$$h_{\mu\nu} = g_{\mu\nu} - \eta_{\mu\nu} \quad \begin{cases} \langle h^2 \rangle = g^{\mu\nu} h_{\mu\nu} \\ \langle h^2 \rangle^2 = g^{\mu\nu} h_{\mu\nu} g^{\rho\sigma} h_{\rho\sigma} \\ \vdots \end{cases}$$

$$\Rightarrow \eta_{\mu\nu}(\gamma) \rightarrow 2F^{\mu\alpha} F^{\nu\beta} \eta_{\alpha\beta}[\gamma(q)]$$

$$g^{\mu\nu} \eta_{\mu\nu}$$

$$\left\{ \begin{array}{l} g_{\mu\nu}(\gamma) \rightarrow 2F^{\mu\alpha} F^{\nu\beta} g_{\alpha\beta}(\gamma(q)) \\ Y^\mu(\gamma) \rightarrow Y^\mu(\gamma(q)) \end{array} \right.$$

Unitary gauge: $Y^\mu(\gamma) = X^\mu$

$\eta_{\mu\nu}$ always appears through $h_{\mu\nu} = g_{\mu\nu} - \eta_{\mu\nu}$

$$h_{\mu\nu} \rightarrow H_{\mu\nu} = g_{\mu\nu} - 2_\mu Y^\alpha \partial_\nu Y_\alpha$$

$$\begin{cases} g_{\mu\nu} = \eta_{\mu\nu} + h_{\mu\nu} & H_{\mu\nu} = h_{\mu\nu} + 2_\mu A_\alpha \partial_\nu A_\alpha \\ Y^\mu = X^\mu - A^\mu & = 2_\mu A^\alpha \partial_\nu A_\alpha \\ A_\mu \rightarrow A_\mu + 2_\mu \phi \end{cases}$$

$E_{\mu\nu}^A$ has 16 components
 $g_{\mu\nu}$ " 10 "

$$E_{A_1 A_2} E_{A_3 A_4} E_{A_5 A_6} E_{A_7 A_8} E_{A_9 A_{10}} E_{A_{11} A_{12}} E_{A_{13} A_{14}} E_{A_{15} A_{16}}$$

$$\tilde{E}_{A_1 A_2} E_{A_3 A_4} \delta_{A_5 A_6} \delta_{A_7 A_8} E_{A_9 A_{10}} E_{A_{11} A_{12}} E_{A_{13} A_{14}} E_{A_{15} A_{16}}$$

$$\sim |E| 2_\mu^{\mu\nu} (E^1) E^1 E^2 \dots$$

Potential in terms of $K^{\mu\nu}$

$$V = \langle K \rangle^2 - \langle K \rangle^2 + c_1 \langle K \rangle^2 + c_2 \langle K \rangle^2 + c_3 \langle K \rangle^2 + \dots$$

($K = 1 - \sqrt{g} \eta$)

$$(2011) \quad K \rightarrow 2_\mu A^\mu$$

$$\Rightarrow V \sim \sum_n \alpha_n 2_\mu^{\mu\nu}(K) = \sum_n \tilde{\alpha}_n 2_\mu^{\mu\nu}(\sqrt{g} \eta)$$

Verbeke-Furman (KH, R. Rose 1203.5783)

$$g_{\mu\nu} = E_\mu^A E_\nu^B \eta_{AB}$$

4dGT potential $\Leftrightarrow \int d^4x \sqrt{g} R + m^2$

$$\eta_{\mu\nu} = \tilde{E}_\mu^A \tilde{E}_\nu^B \eta_{AB}$$

$$\delta_\mu^A$$

$\left\{ \begin{array}{l} \text{E}^{\mu\nu\rho\sigma} \text{E}^{\alpha\beta\gamma\delta} \text{E}^{\epsilon\zeta\eta\theta} \text{E}^{\iota\kappa\lambda\mu} \\ \text{E}^{\mu\nu\rho\sigma} \text{E}^{\alpha\beta\gamma\delta} \text{E}^{\epsilon\zeta\eta\theta} \text{E}^{\iota\kappa\lambda\mu} \\ \text{E}^{\mu\nu\rho\sigma} \text{E}^{\alpha\beta\gamma\delta} \text{E}^{\epsilon\zeta\eta\theta} \text{E}^{\iota\kappa\lambda\mu} \\ \text{E}^{\mu\nu\rho\sigma} \text{E}^{\alpha\beta\gamma\delta} \text{E}^{\epsilon\zeta\eta\theta} \text{E}^{\iota\kappa\lambda\mu} \end{array} \right.$

