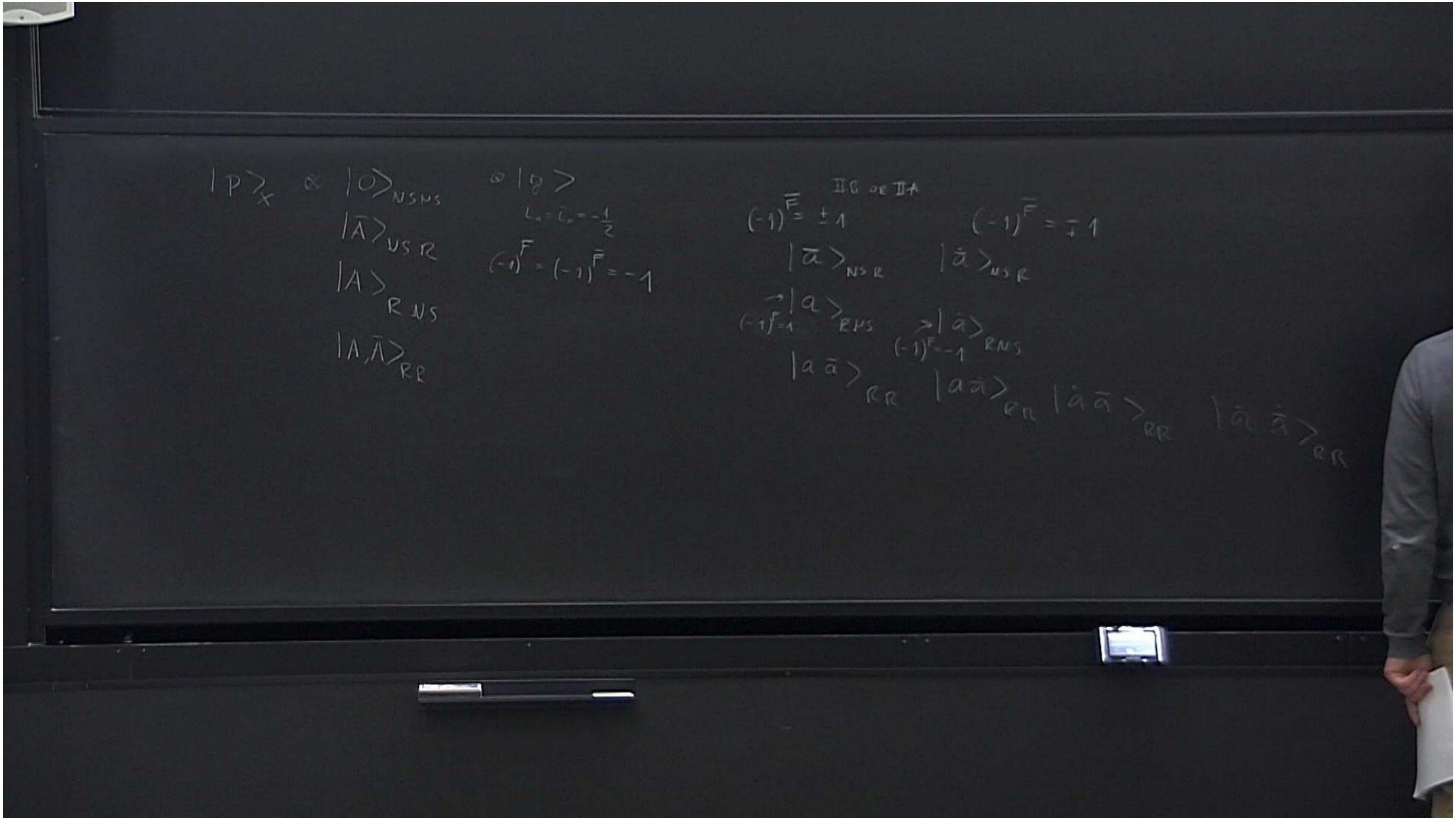
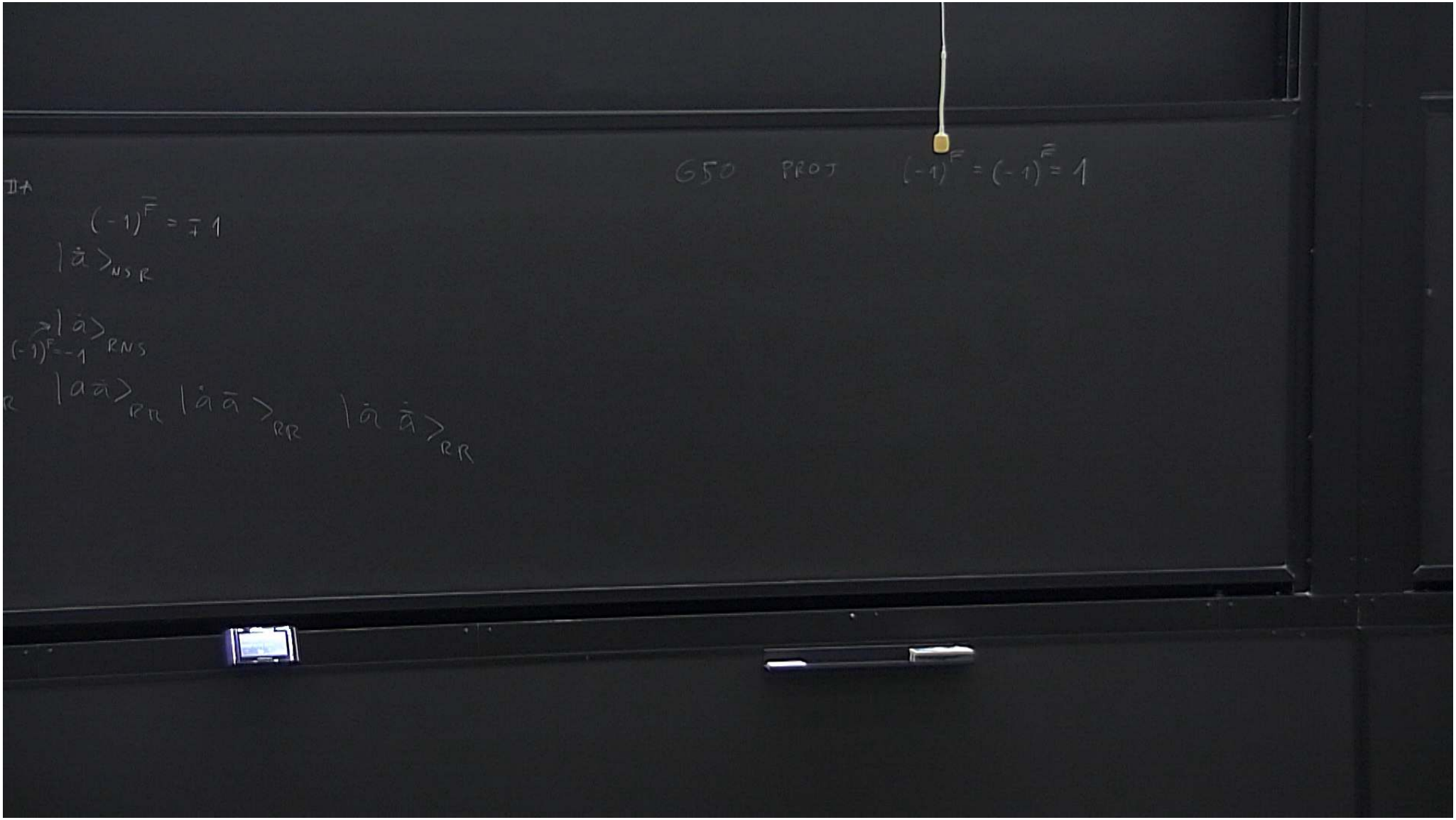
Title: PSI 2016/2017 String Theory (Review) - Lecture 13

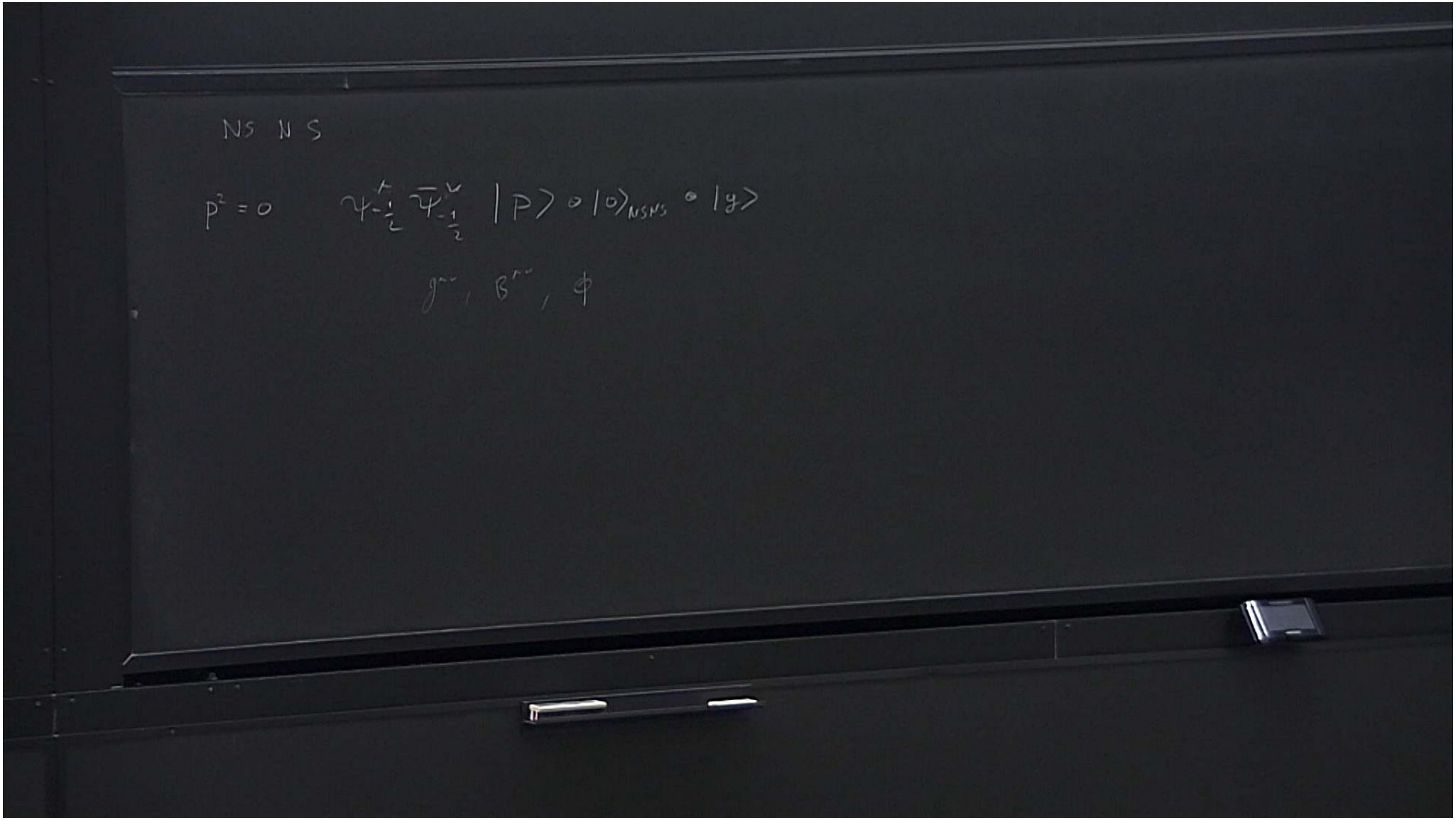
Date: Mar 10, 2017 10:00 AM

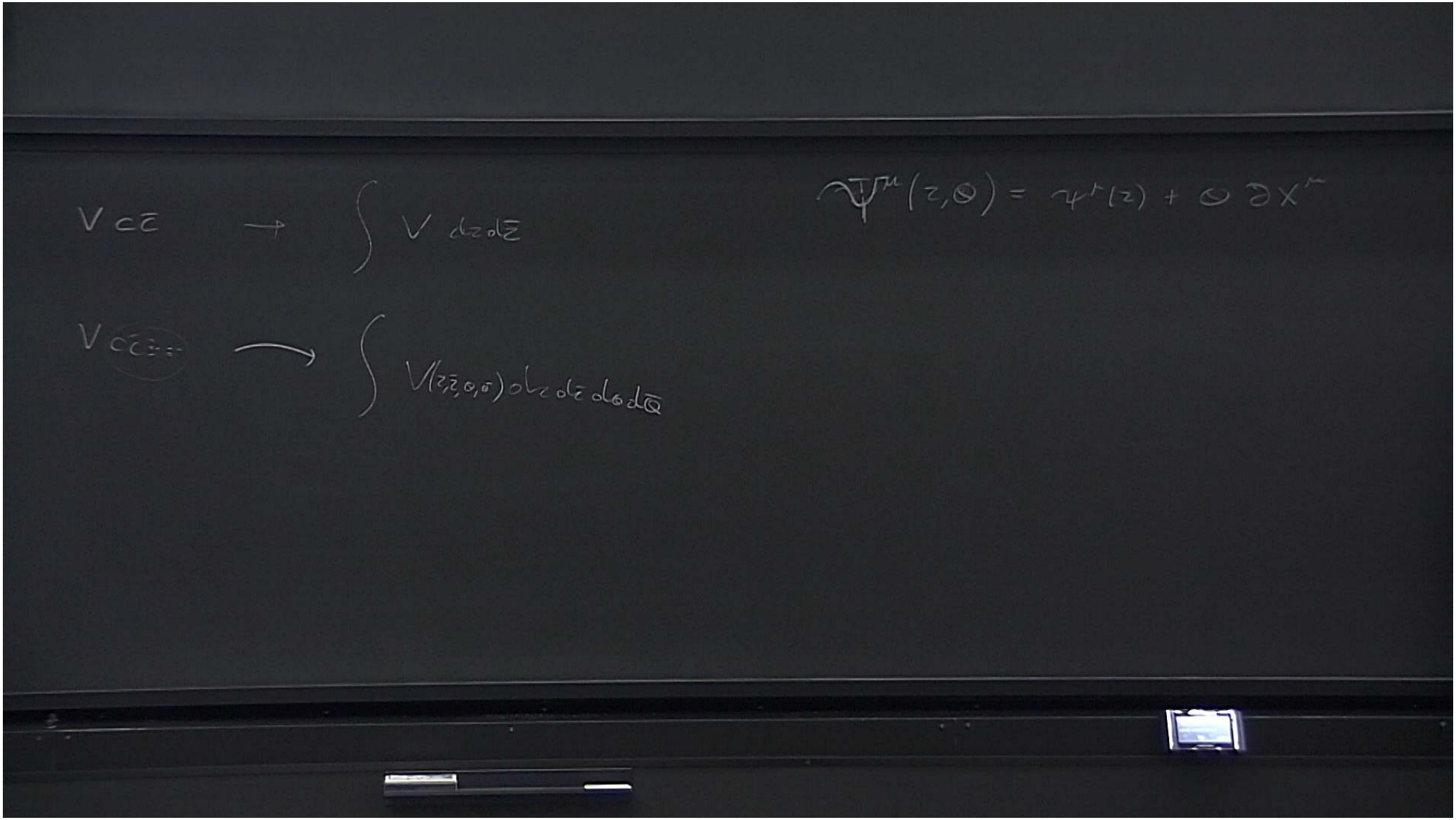
URL: http://pirsa.org/17030029

Abstract:


$|P\rangle_x \propto |0\rangle_{NSNS} \oplus |g\rangle$
$L_0 = \bar{L}_0 = -\frac{1}{2}$
$|\bar{A}\rangle_{NSR}$
$(-1)^F = (-1)^{\bar{F}} = -1$
$|A\rangle_{RNS}$
$|A, \bar{A}\rangle_{RR}$
IIB or IIA
$(-1)^{\bar{F}} = \pm 1$
$(-1)^F = \mp 1$
$|\bar{a}\rangle_{NSR}$
$|\dot{a}\rangle_{NSR}$
$\rightarrow |a\rangle_{RNS}$
$(-1)^F = 1$
$\rightarrow |\dot{a}\rangle_{RNS}$
$(-1)^F = -1$
$|a\bar{a}\rangle_{RR}$
$|a\bar{a}\rangle_{RR}$
$|\dot{a}\bar{a}\rangle_{RR}$
$|\dot{a}\dot{\bar{a}}\rangle_{RR}$


GSO PROJ $(-1)^F = (-1)^{\bar{F}} = 1$
IIA
$(-1)^{\bar{F}} = \mp 1$
$|\dot{a}\rangle_{NSR}$
$(-1)^F = -1$
$|\dot{a}\rangle_{RNS}$
$|a\dot{a}\rangle_{RR}$ $|\dot{a}\bar{a}\rangle_{RR}$ $|\dot{a}\dot{\bar{a}}\rangle_{RR}$

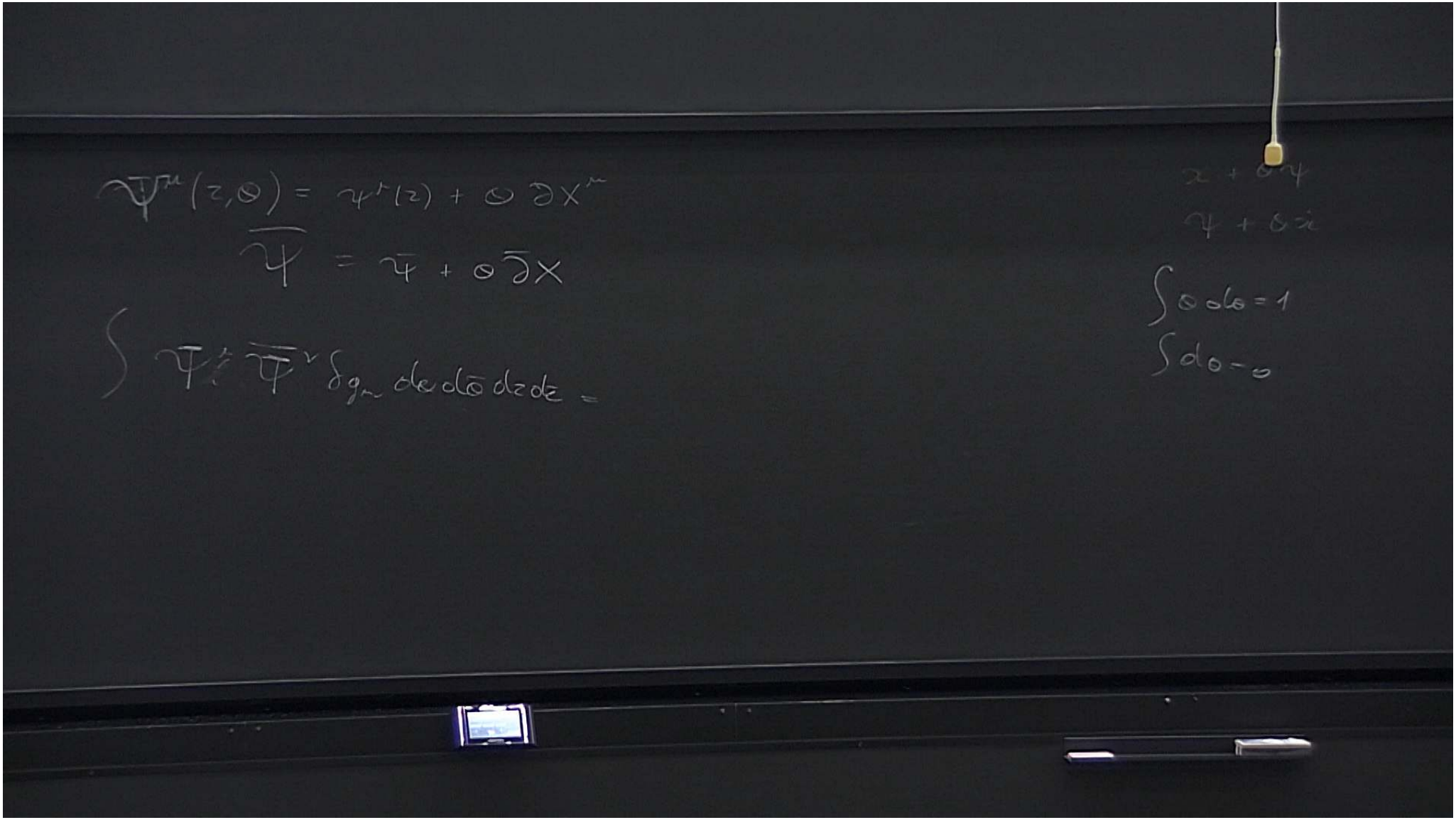

NS NS
$p^2 = 0$
$\psi^{\mu}_{-\frac{1}{2}} \bar{\psi}^{\nu}_{-\frac{1}{2}} |p\rangle \otimes |0\rangle_{NSNS} \otimes |y\rangle$
$g^{\mu\nu}, B^{\mu\nu}, \phi$

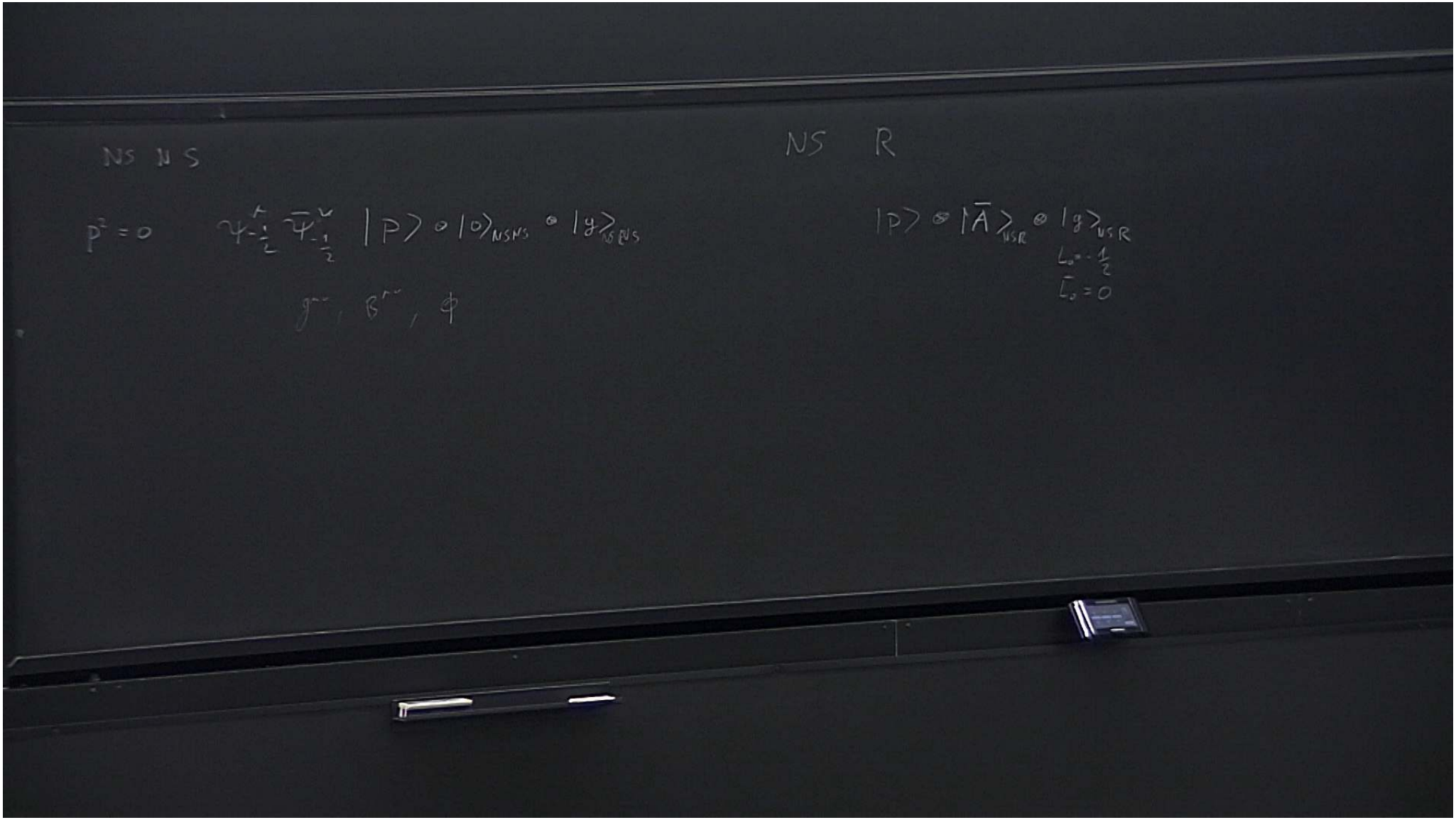


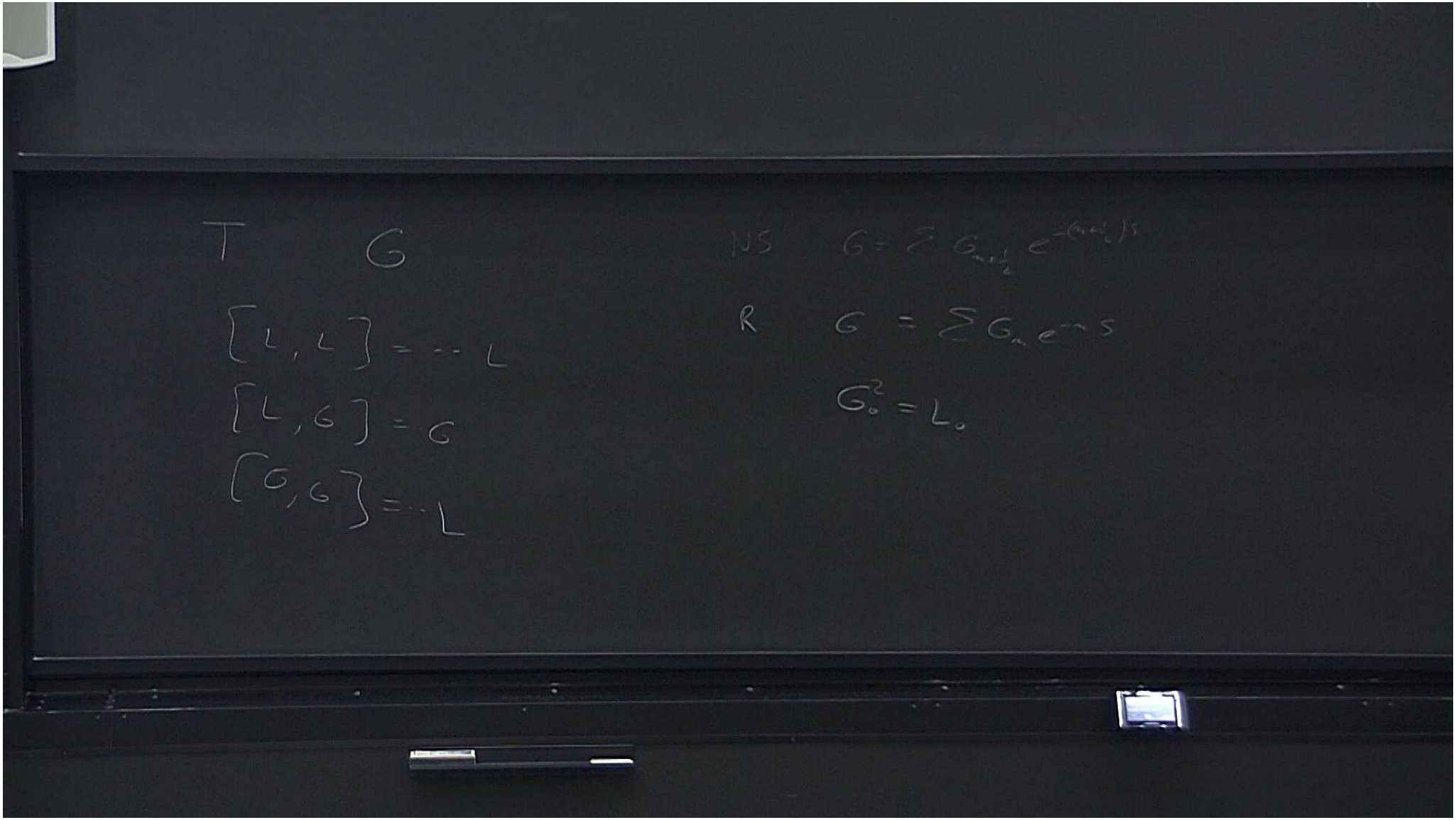
$$V \subset \bar{c} \quad \rightarrow \quad \int V \, dz \, d\bar{z}$$

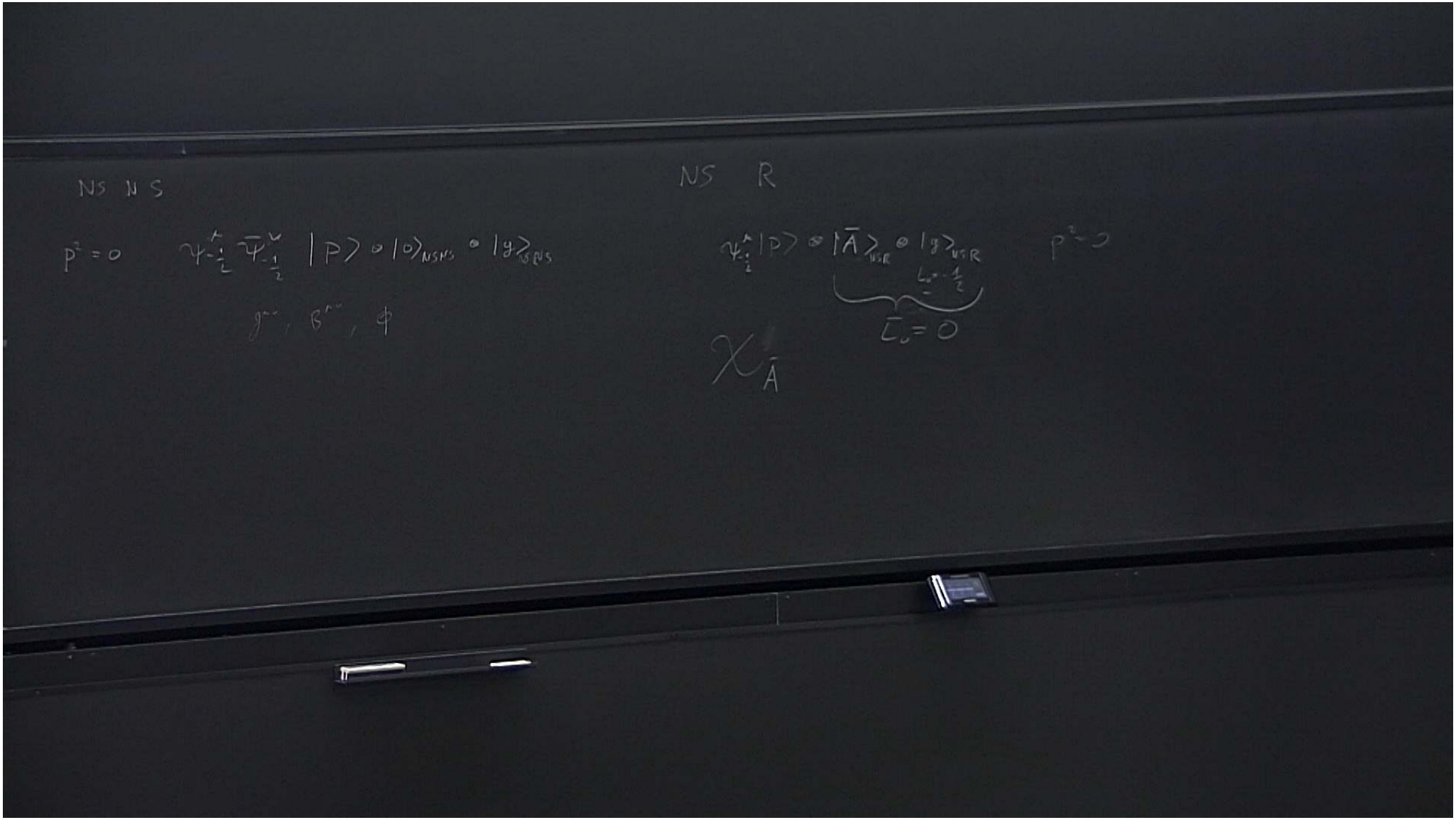
$$V \subset \bar{c} \quad \longrightarrow \quad \int V(z,\bar{z},\theta,\bar{\theta}) \, dz \, d\bar{z} \, d\theta \, d\bar{\theta}$$

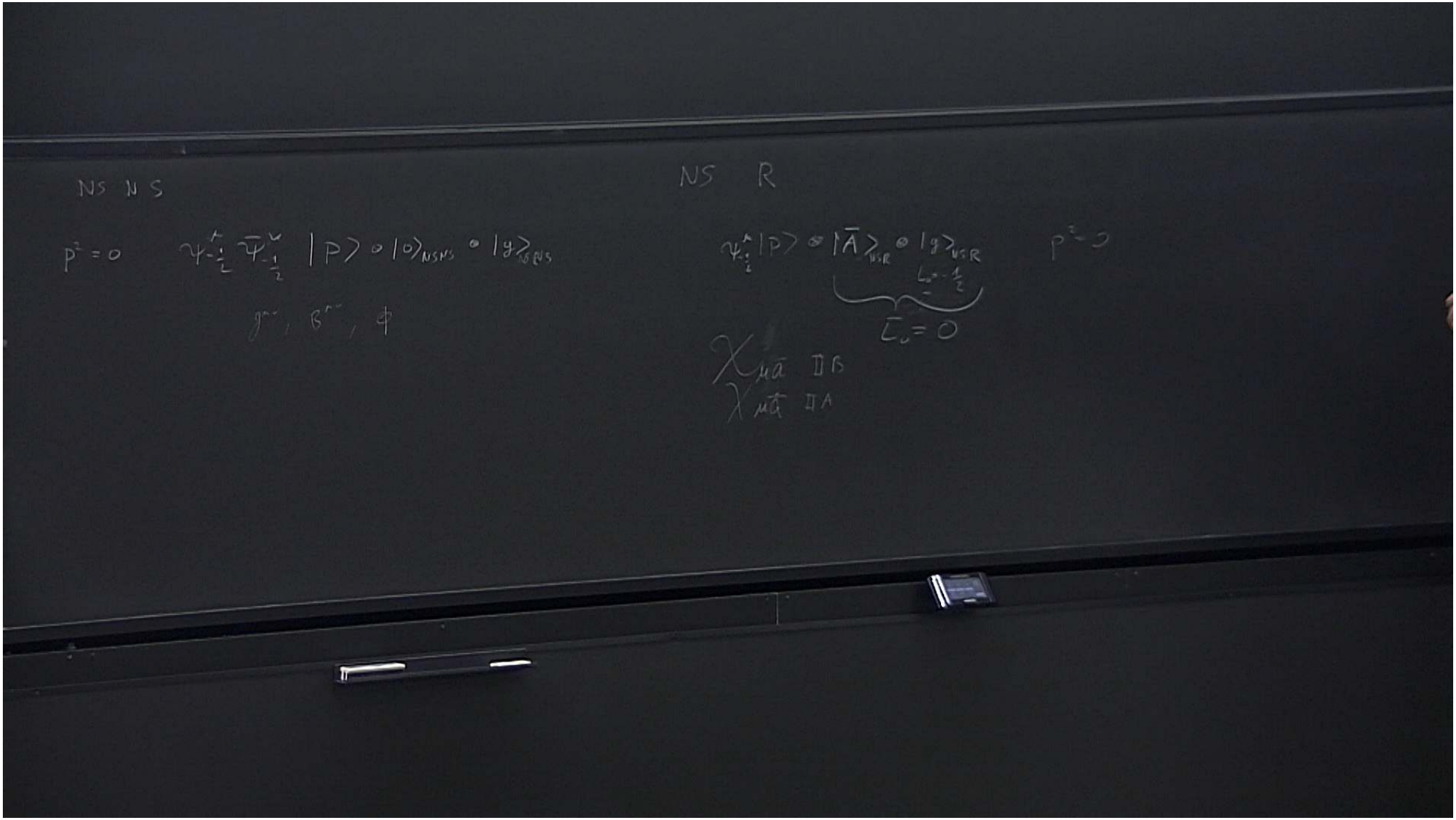
$$\Psi^{\mu}(z,\theta) = \psi^{\mu}(z) + \theta \, \partial X^{\mu}$$

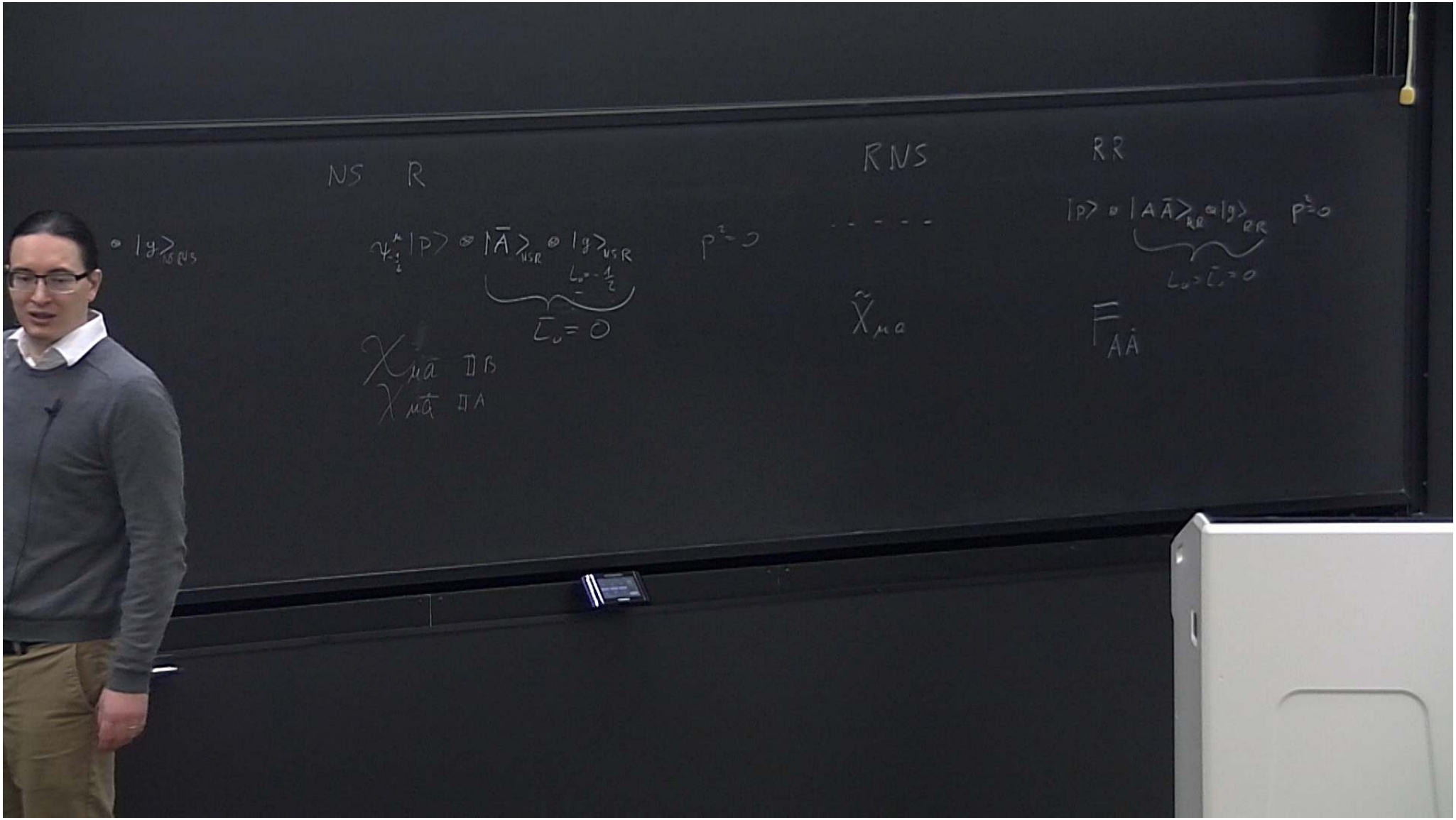

$\Psi^\mu(z,\theta) = \psi^\mu(z) + \theta\,\partial X^\mu$
$\bar{\Psi} = \bar{\psi} + \theta\,\bar{\partial} X$
$\int \Psi^\mu \bar{\Psi}^\nu g_{\mu\nu}\, dz\, d\bar{z}\, dz\, d\theta =$
$x + \theta\psi$
$\psi + \theta\partial x$
$\int \theta\, d\theta = 1$
$\int d\theta = 0$

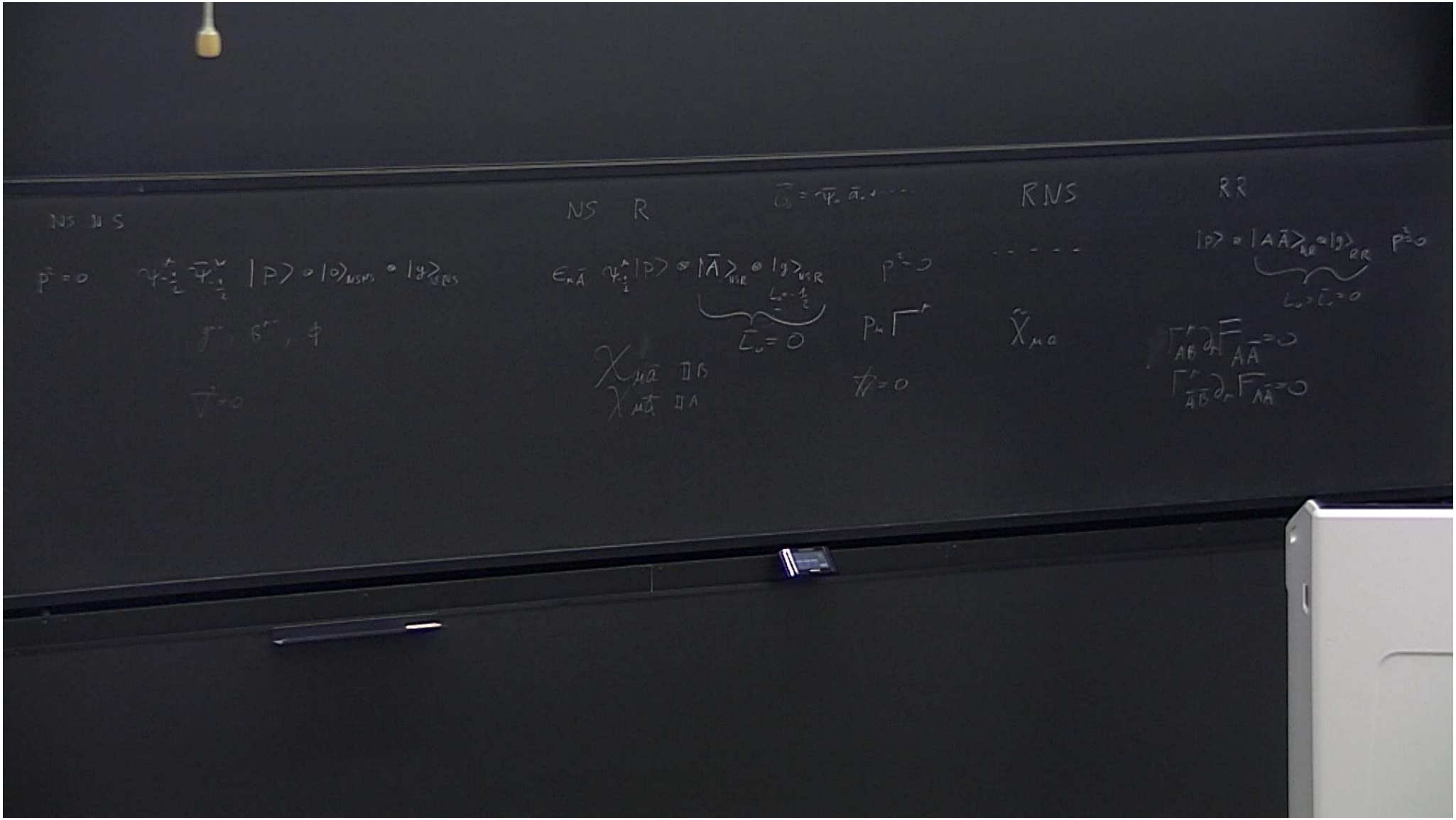

NS NS
$p^2 = 0$
$\psi^{\mu}_{-\frac{1}{2}} \bar{\psi}^{\nu}_{-\frac{1}{2}} |p\rangle \otimes |0\rangle_{NSNS} \otimes |g\rangle_{NSNS}$
$g^{\mu\nu}, B^{\mu\nu}, \phi$
NS R
$|p\rangle \otimes |\bar{A}\rangle_{NSR} \otimes |g\rangle_{NSR}$
$L_0 = \frac{1}{2}$
$\bar{L}_0 = 0$

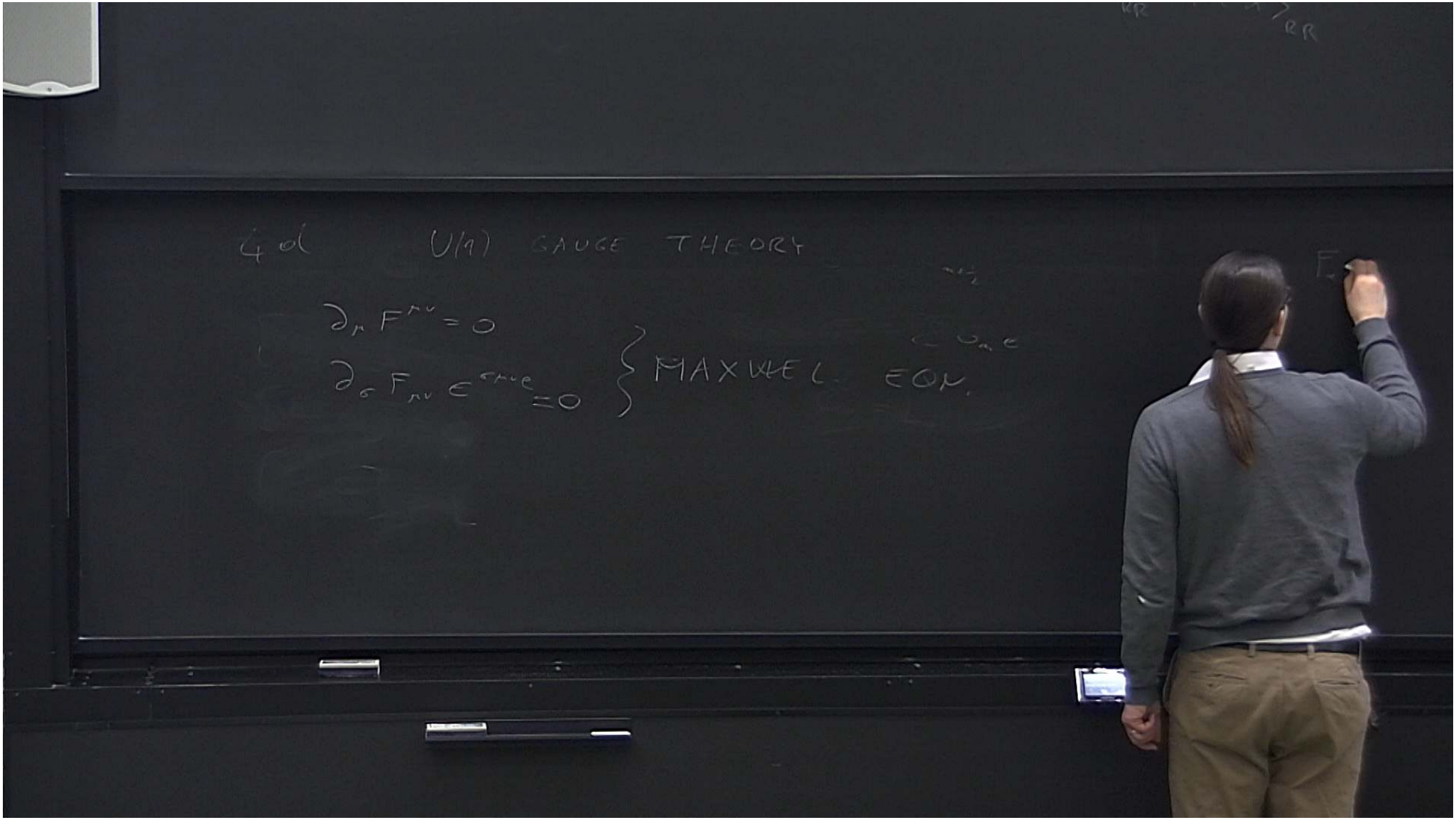

T G
[L, L] = ... L
[L, G] = G
[G, G] = ... L
NS G = Σ G_{n+1/2} e^{-(n+1/2)s}
R G = Σ G_n e^{-ns}
G_0^2 = L_0

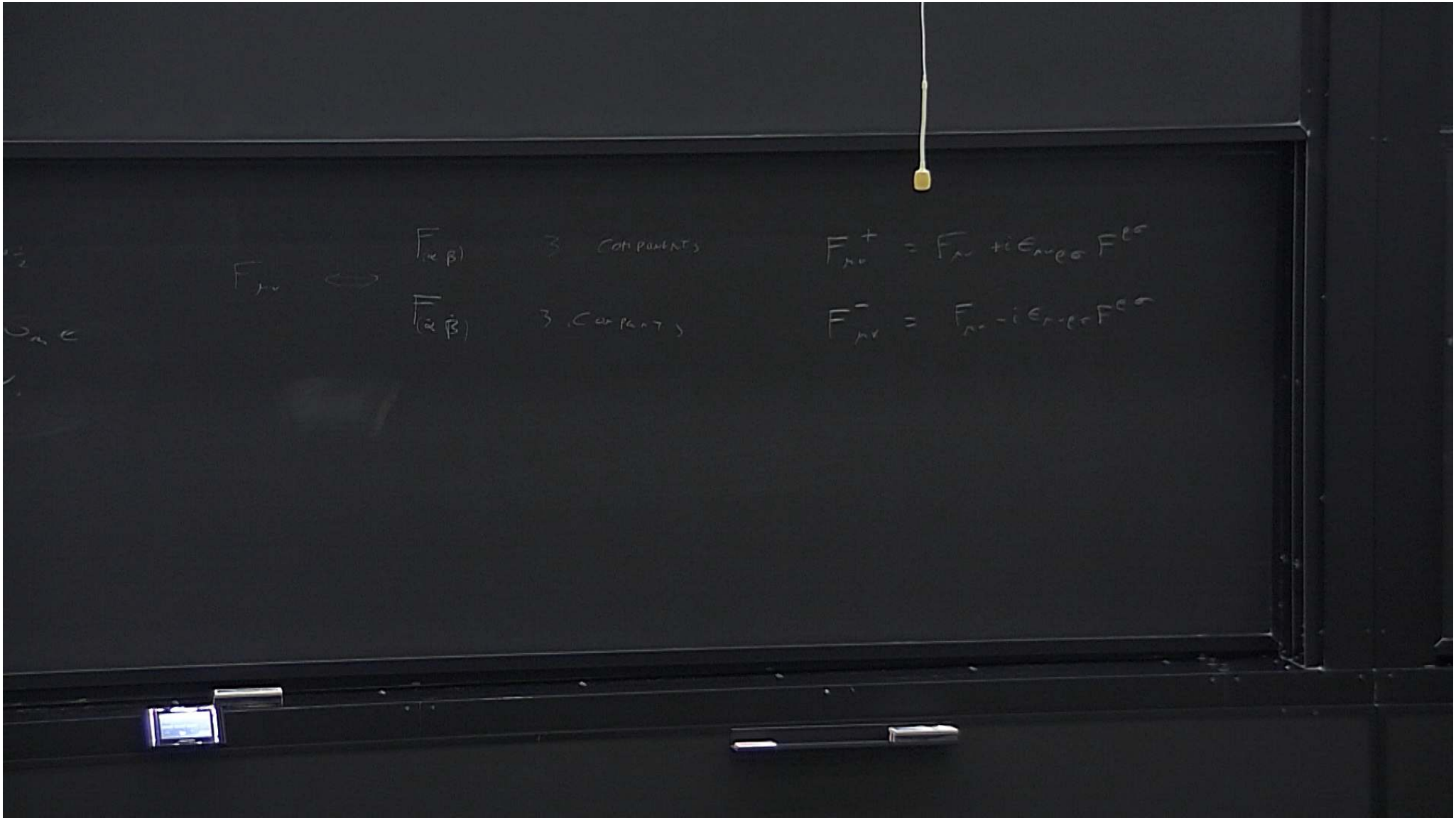

NS NS
$p^2 = 0$
$\psi^{\mu}_{-\frac{1}{2}} \bar{\psi}^{\nu}_{-\frac{1}{2}} |p\rangle \otimes |0\rangle_{NSNS} \otimes |g\rangle_{NSNS}$
$g^{\mu\nu}, B^{\mu\nu}, \phi$
NS R
$\psi^{\mu}_{-\frac{1}{2}} |p\rangle \otimes |\bar{A}\rangle_{NSR} \otimes |g\rangle_{NSR}$
$L_0 = -\frac{1}{2}$
$\bar{L}_0 = 0$
$\chi^{\mu}_{\bar{A}}$

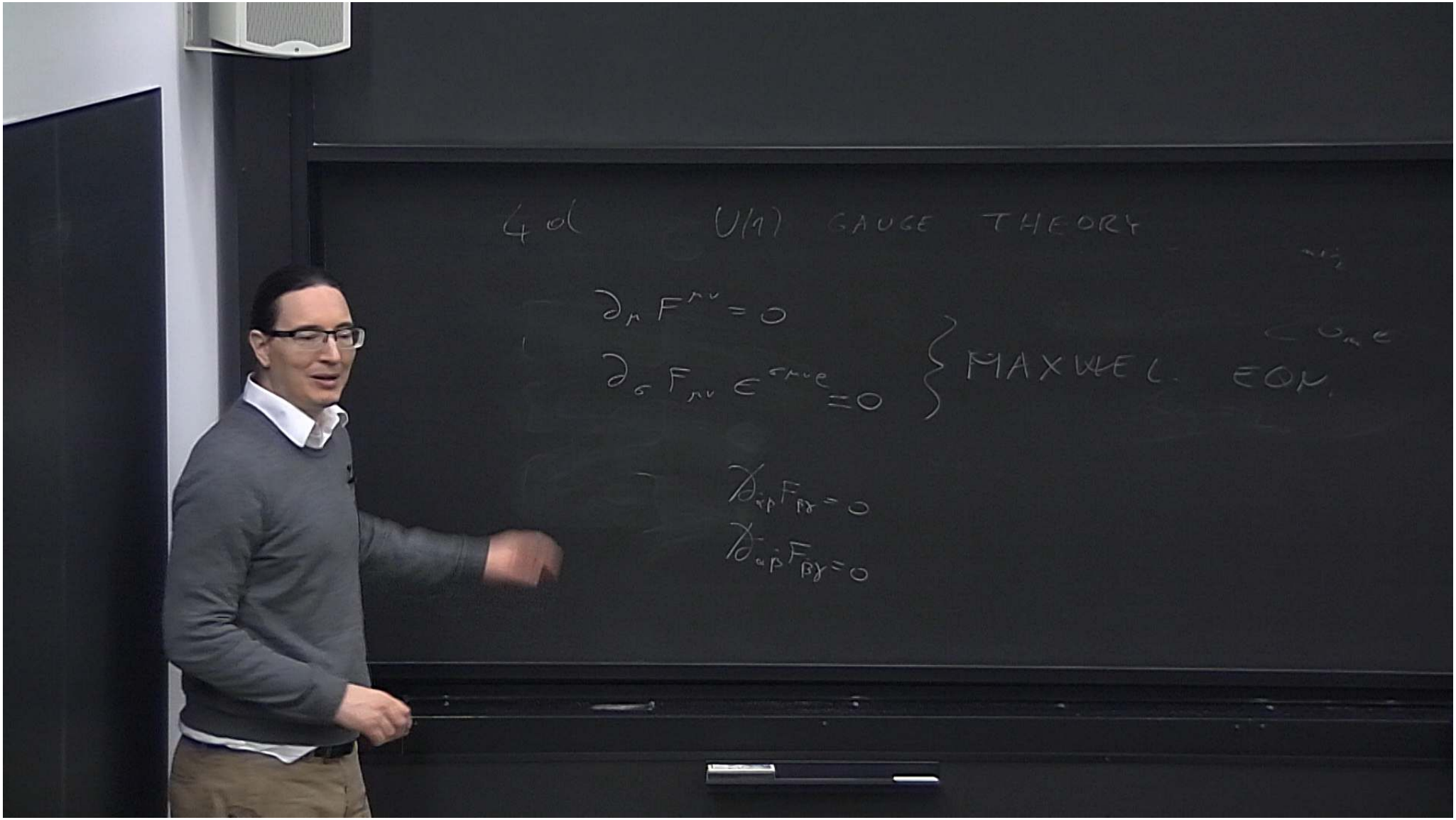

NS NS
$p^2 = 0$
$\psi_{-\frac{1}{2}}^{\mu} \tilde{\psi}_{-\frac{1}{2}}^{\nu} |p\rangle \otimes |0\rangle_{NSNS} \otimes |g\rangle_{NSNS}$
$g^{\mu\nu}, B^{\mu\nu}, \phi$
NS R
$\psi_{-\frac{1}{2}}^{\mu} |p\rangle \otimes |\bar{A}\rangle_{NSR} \otimes |g\rangle_{NSR}$
$L_0 = -\frac{1}{2}$
$\bar{L}_0 = 0$
$p^2 = 0$
$\chi_{\mu\dot{\alpha}}$ IIB
$\chi_{\mu\dot{\alpha}}$ IIA

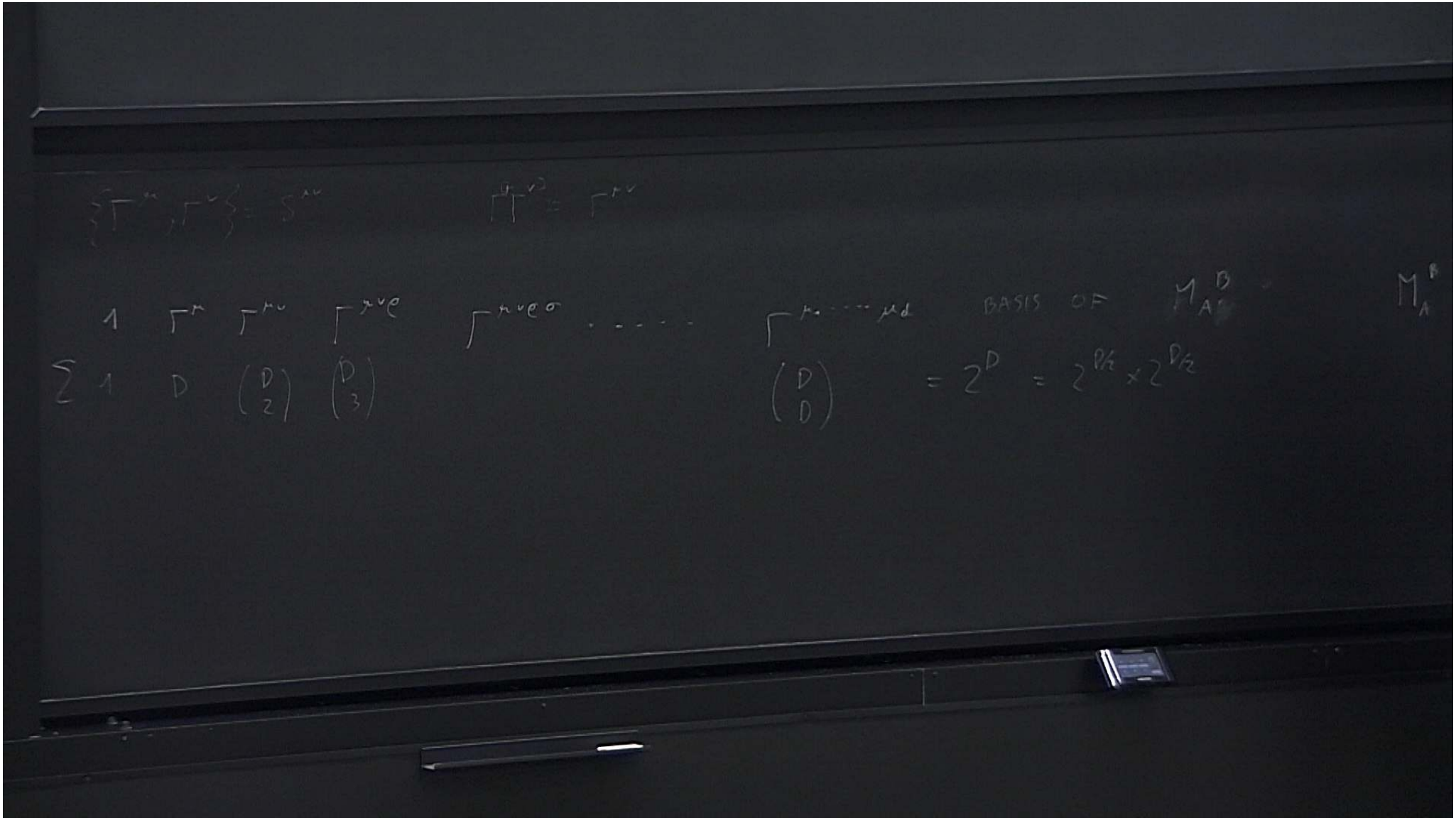

NS R
RNS
RR
$\otimes |g\rangle_{NS\,RNS}$
$\psi^{\mu}_{-\frac{1}{2}} |p\rangle \otimes |\bar{A}\rangle_{NSR} \otimes |g\rangle_{NSR}$
$L_0 = -\frac{1}{2}$
$\bar{L}_0 = 0$
$p^2 = 0$
$\chi_{\mu\bar{a}}$ II B
$\chi_{\mu\bar{a}}$ II A
$\tilde{\chi}_{\mu a}$
$|p\rangle \otimes |A\bar{A}\rangle_{RR} \otimes |g\rangle_{RR}$
$p^2 = 0$
$L_0 = \bar{L}_0 = 0$
$F_{A\dot{A}}$

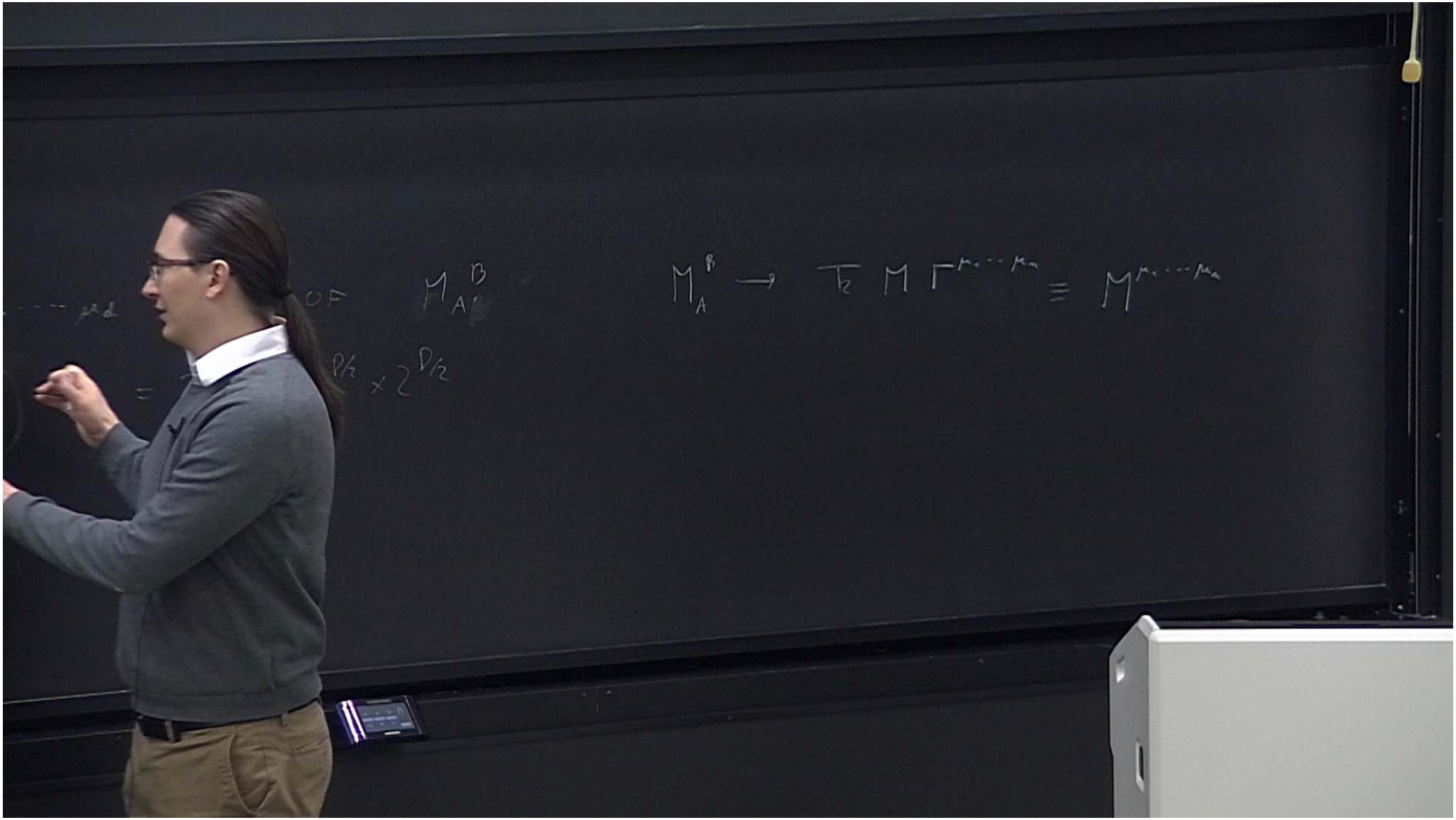

NS R
RNS
RR

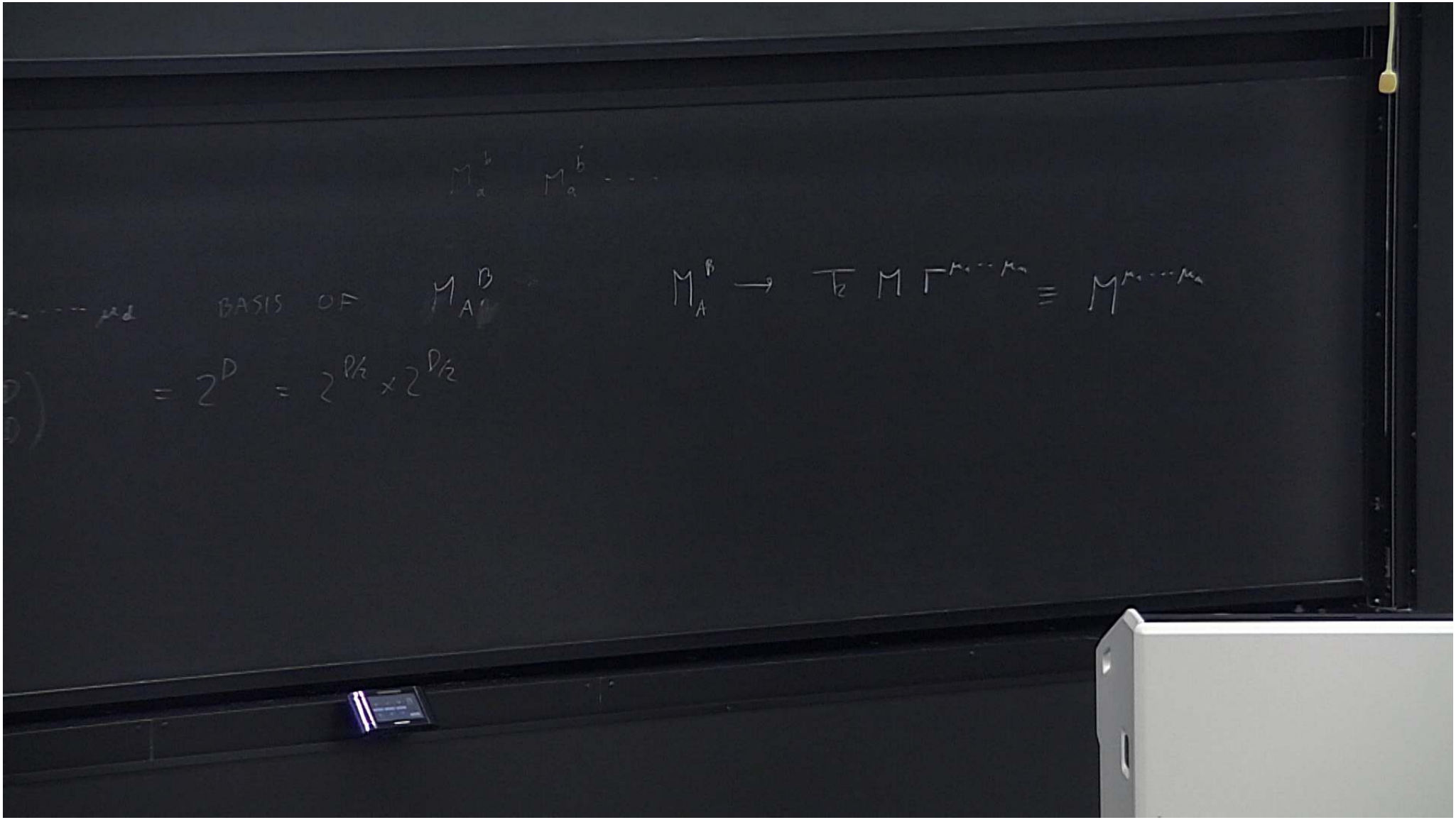

4 d
U(1) GAUGE THEORY
$\partial_\mu F^{\mu\nu} = 0$
$\partial_\sigma F_{\mu\nu} \epsilon^{\sigma\mu\nu\rho} = 0$
MAXWELL EQN.

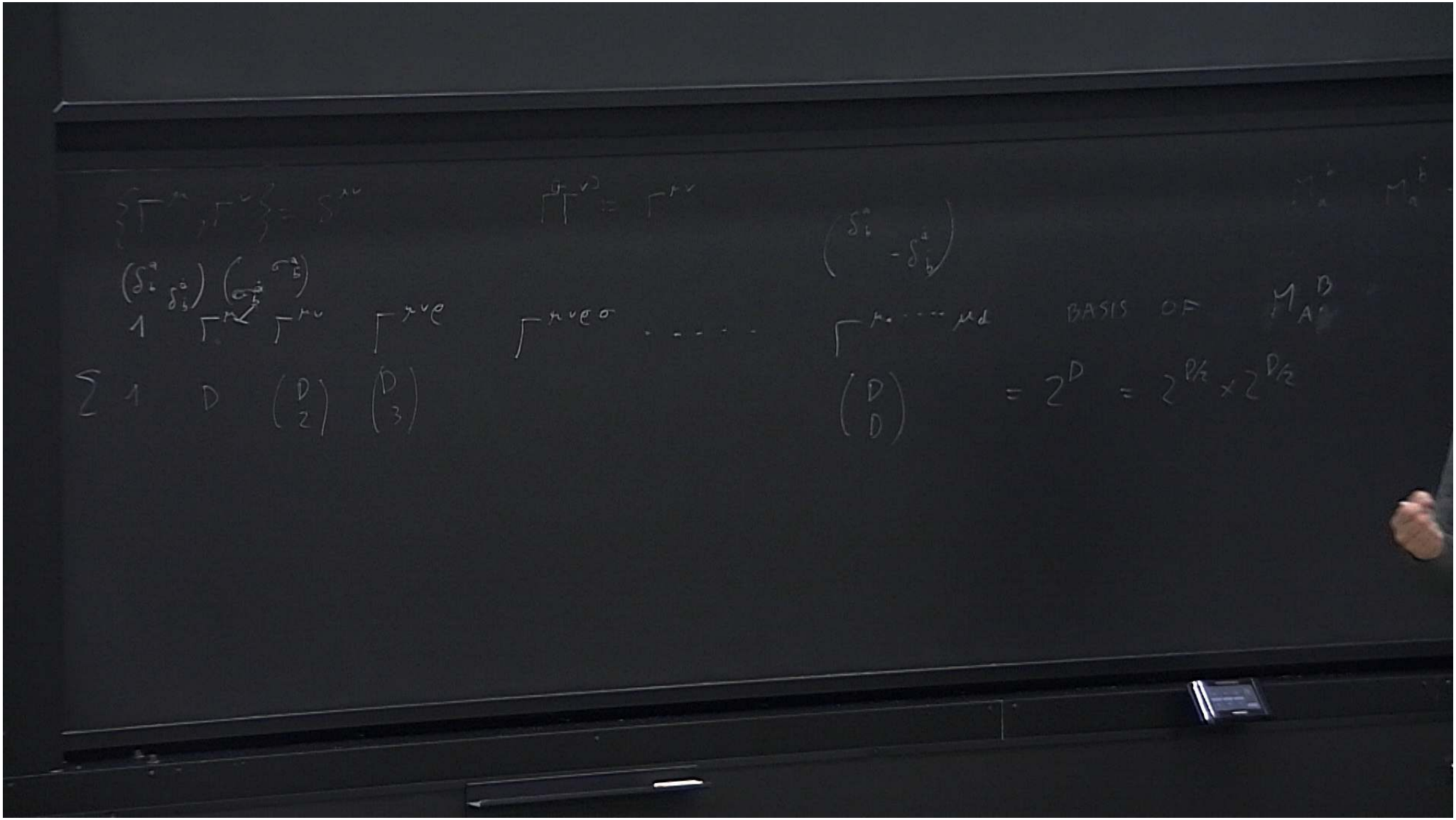

$F_{\alpha\beta}$ 3 components
$F_{(\alpha\beta)}$ 3 components
$F^{+}_{\mu\nu} = F_{\mu\nu} + i\epsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}$
$F^{-}_{\mu\nu} = F_{\mu\nu} - i\epsilon_{\mu\nu\rho\sigma}F^{\rho\sigma}$

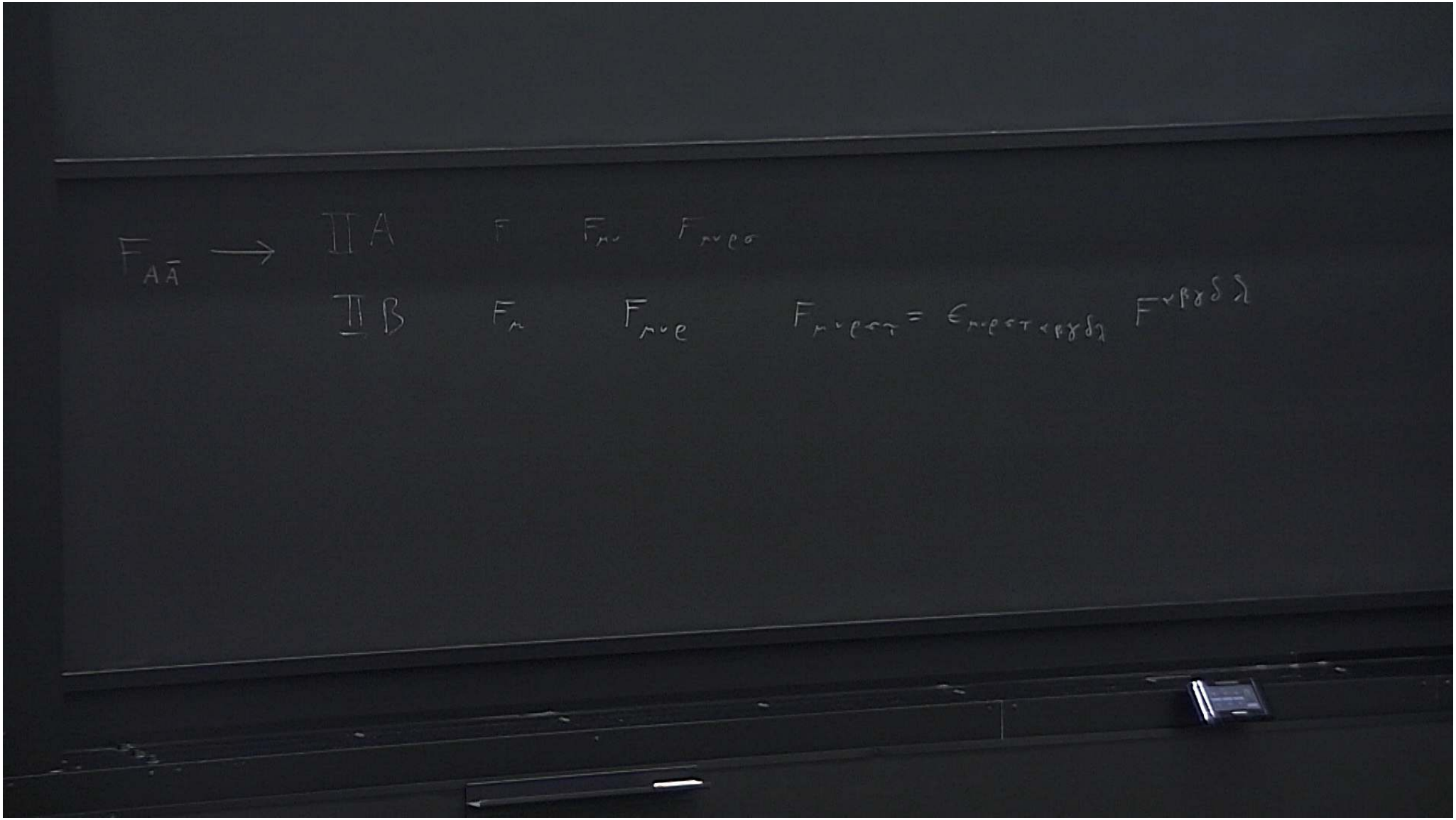

4 ol U(1) GAUGE THEORY
$\partial_\mu F^{\mu\nu} = 0$
$\partial_\sigma F_{\mu\nu} \epsilon^{\sigma\mu\nu\rho} = 0$
MAXWELL EOM.
$\partial_{[\alpha} F_{\beta\gamma]} = 0$
$\partial_{[\alpha} F_{\beta\gamma]} = 0$

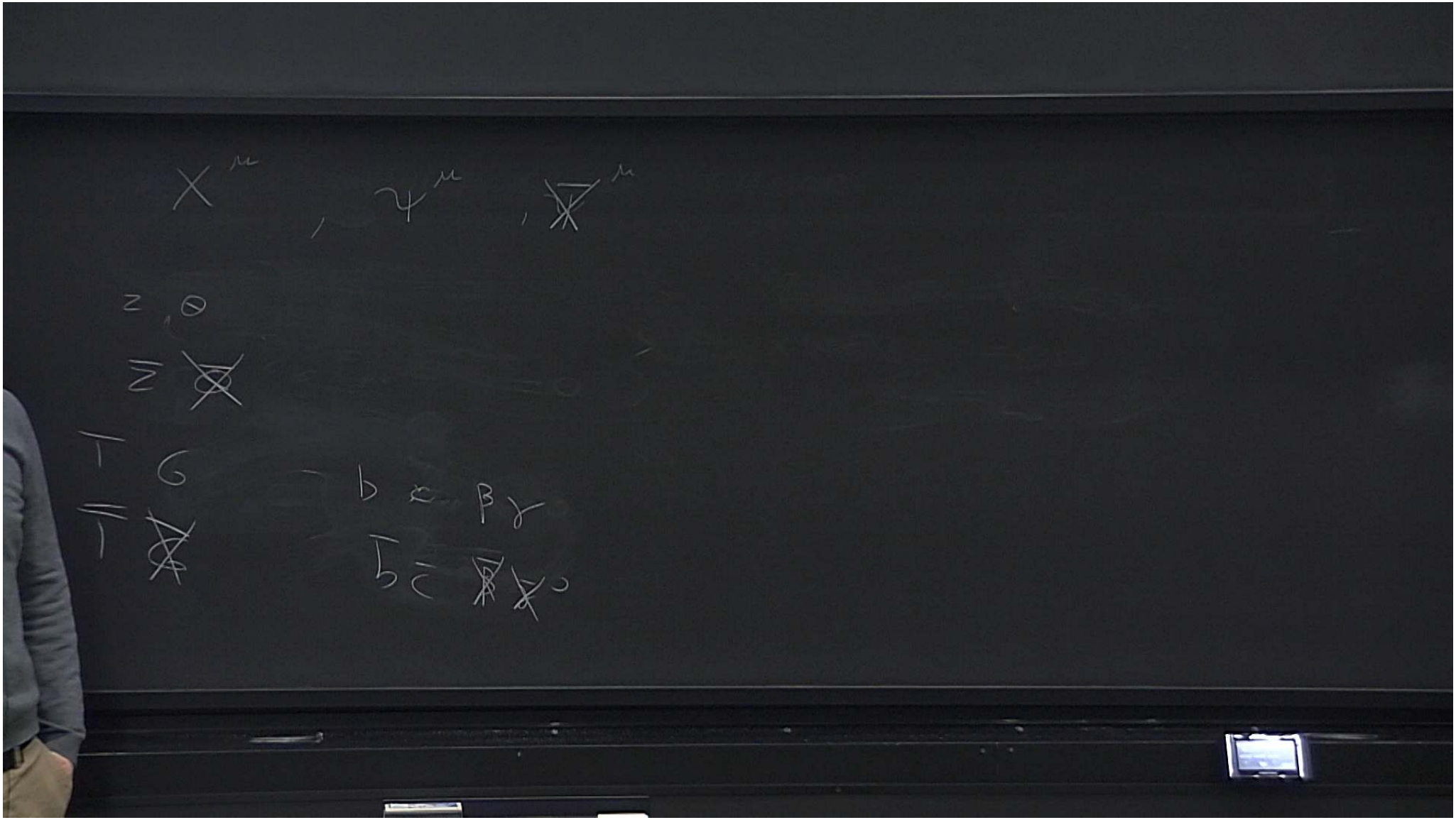

$\{\Gamma^\mu, \Gamma^\nu\} = 2\eta^{\mu\nu}$
$\Gamma^\mu \Gamma^\nu = \Gamma^{\mu\nu}$
$1 \quad \Gamma^\mu \quad \Gamma^{\mu\nu} \quad \Gamma^{\mu\nu\rho} \quad \Gamma^{\mu\nu\rho\sigma} \quad \cdots \quad \Gamma^{\mu_1 \cdots \mu_d}$ BASIS OF M_A^B
$\sum 1 \quad D \quad \binom{D}{2} \quad \binom{D}{3}$
$\binom{D}{D} = 2^D = 2^{D/2} \times 2^{D/2}$

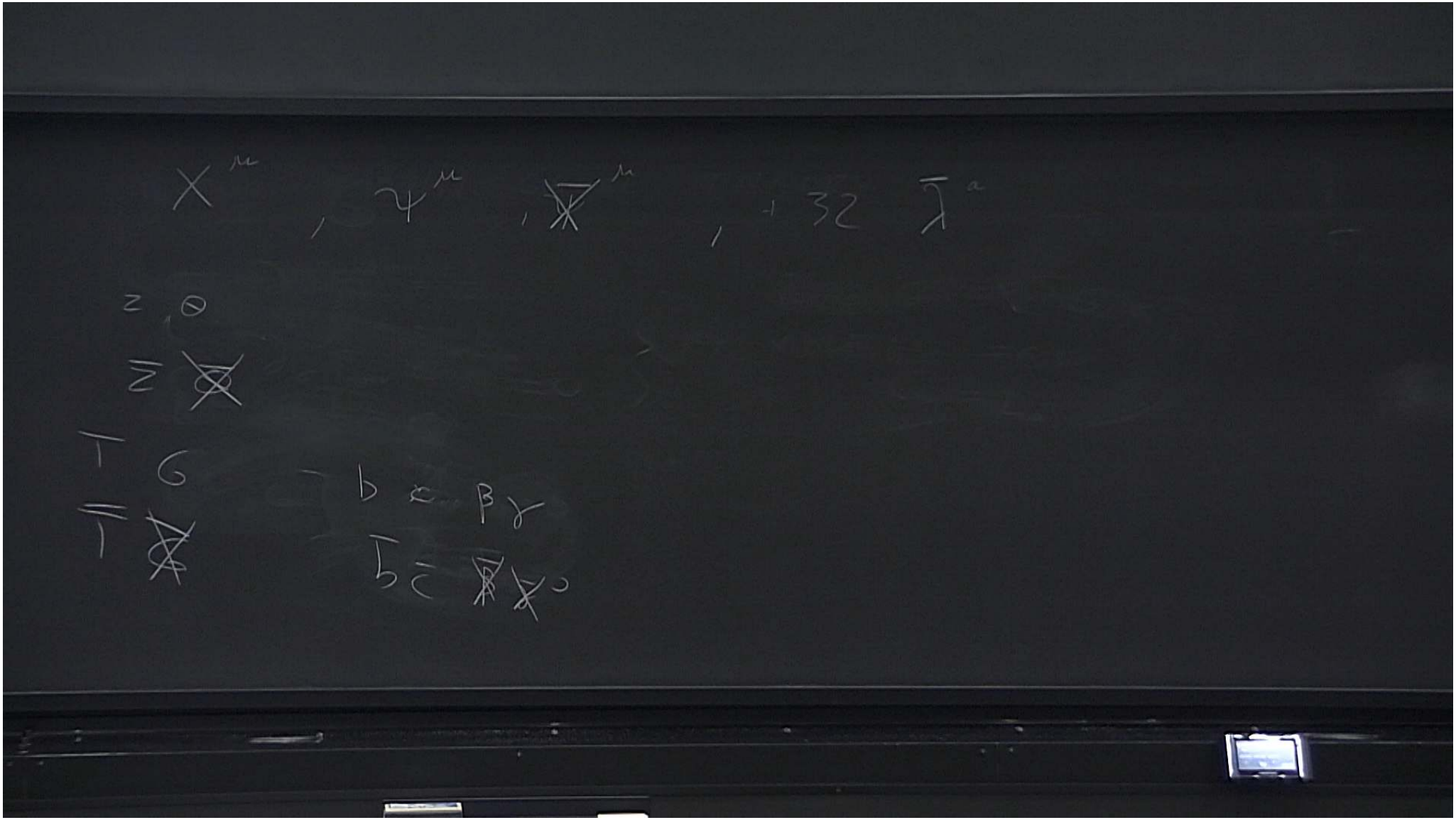

$M_A^B \to \mathrm{Tr}\, M\, \Gamma^{\mu_1 \cdots \mu_m} \equiv M^{\mu_1 \cdots \mu_m}$

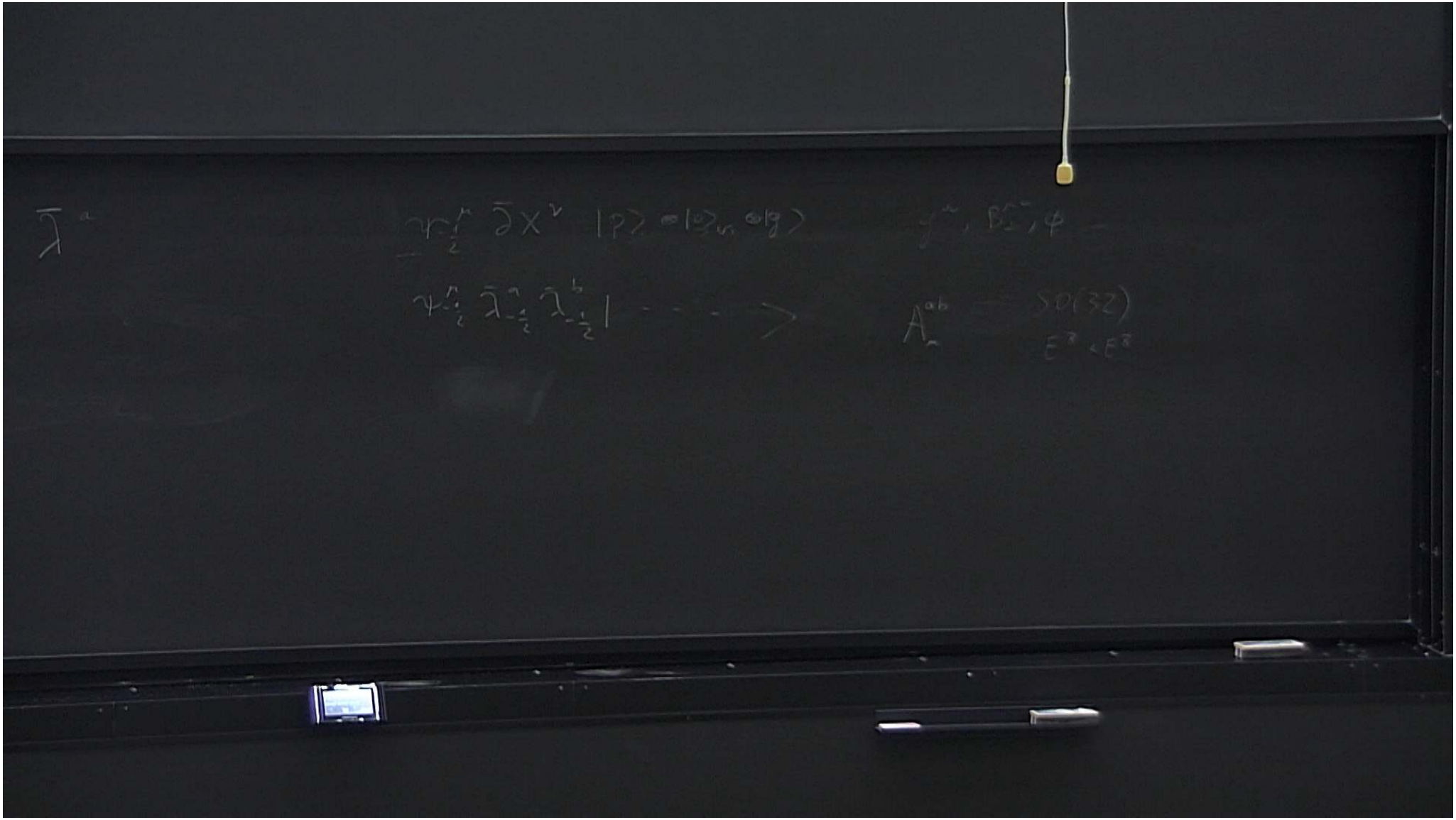

BASIS OF
$= 2^D = 2^{D/2} \times 2^{D/2}$
$M_A^B \to \Gamma_2 M \Gamma^{\mu_1 \cdots \mu_n} \equiv M^{\mu_1 \cdots \mu_n}$

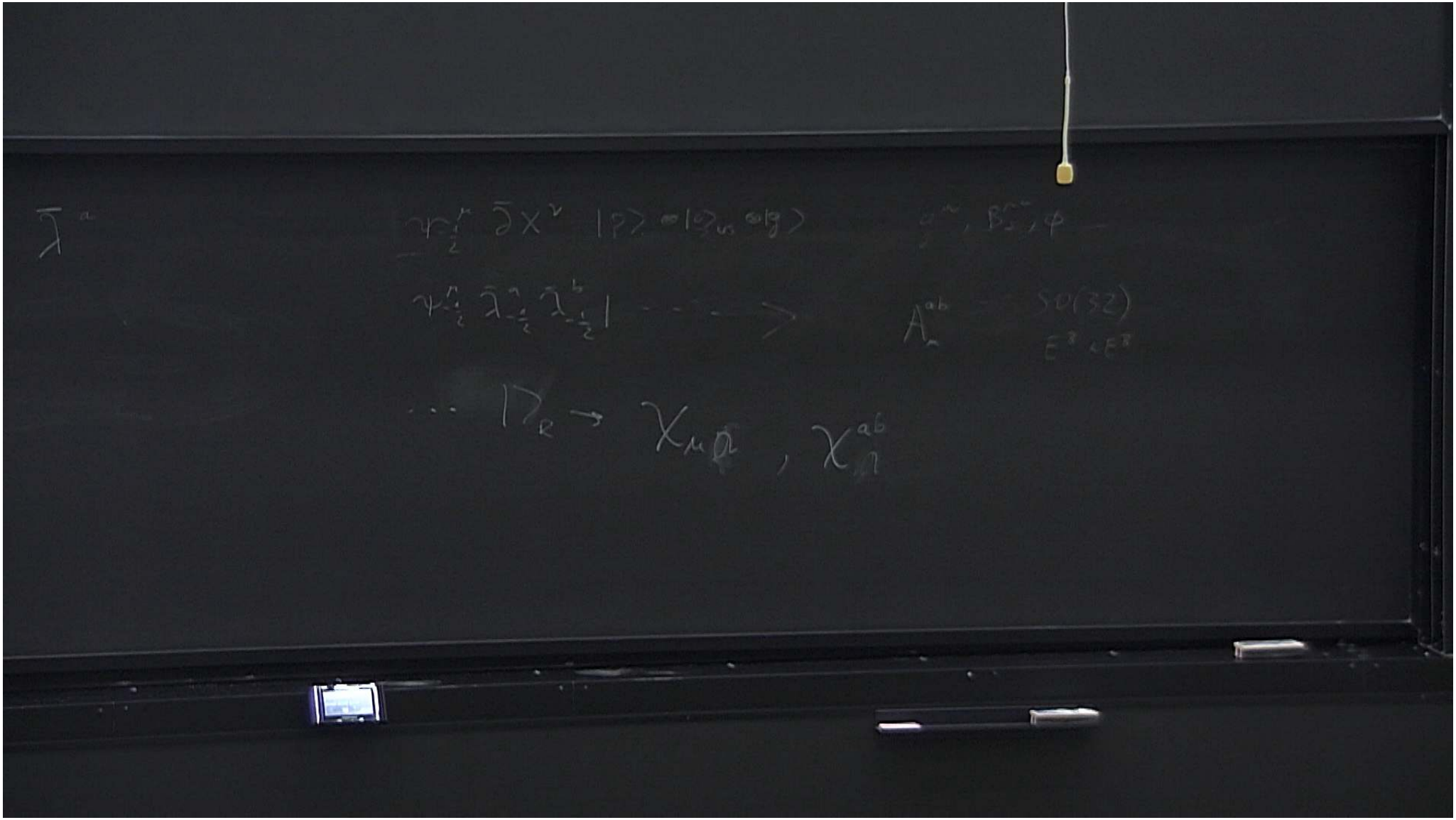

BASIS OF

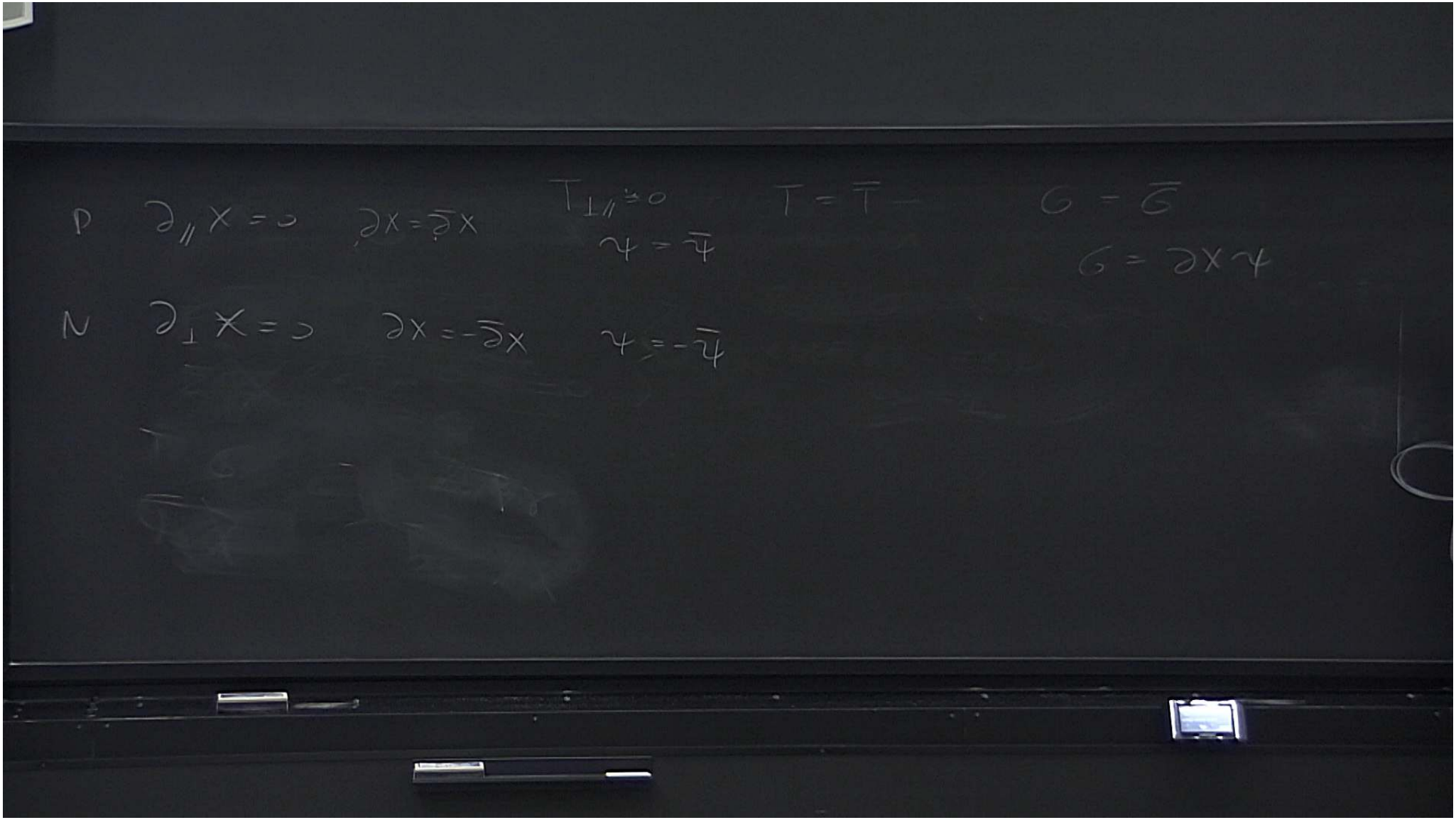

$F_{A\bar{A}} \longrightarrow$
II A
II B
$F_{\mu\nu}$
$F_{\mu\nu\rho\sigma}$
$F_{\mu\nu\rho\sigma\tau} = \epsilon_{\mu\nu\rho\sigma\tau\alpha\beta\delta\lambda} F^{\alpha\beta\delta\lambda}$

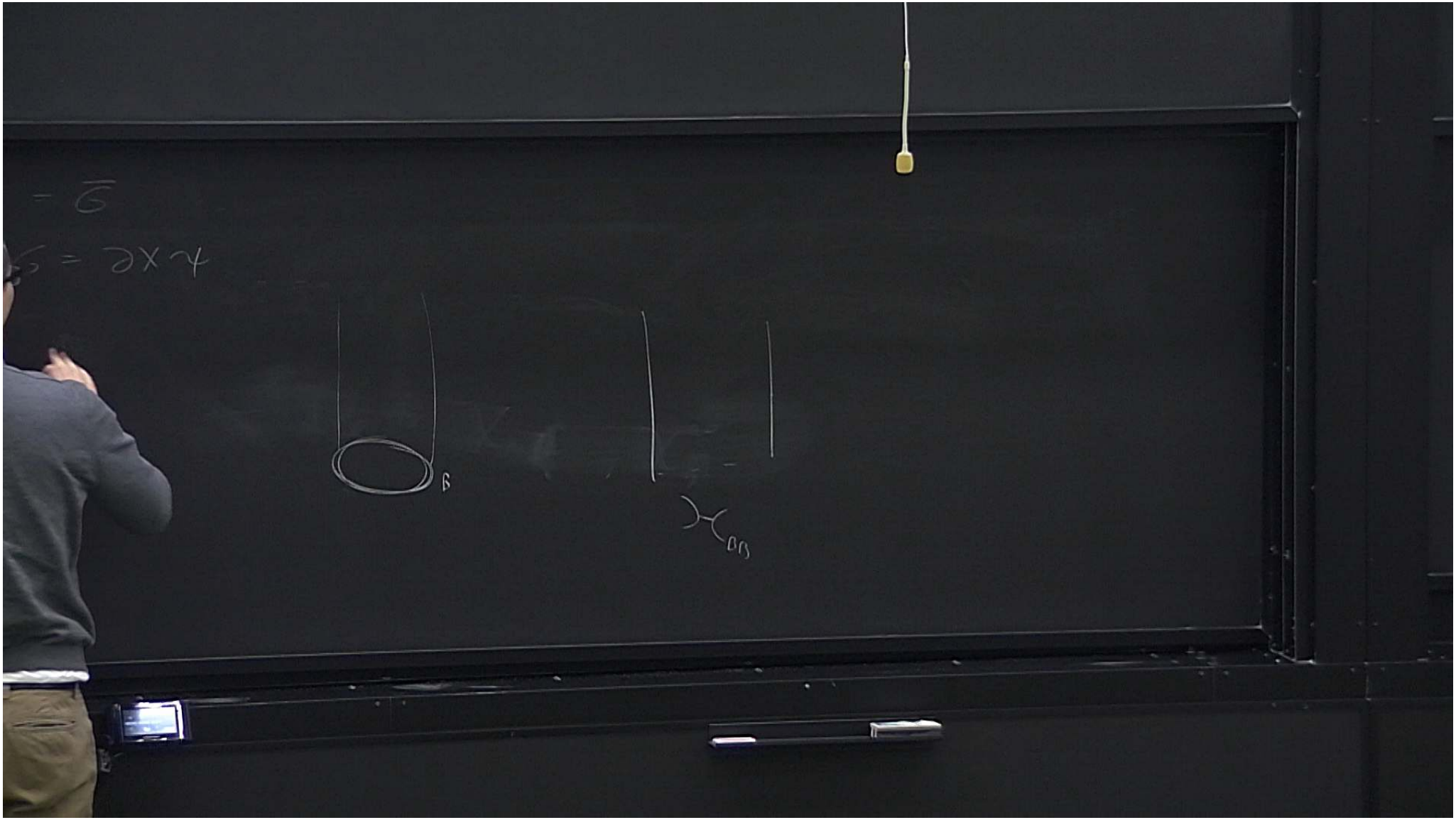


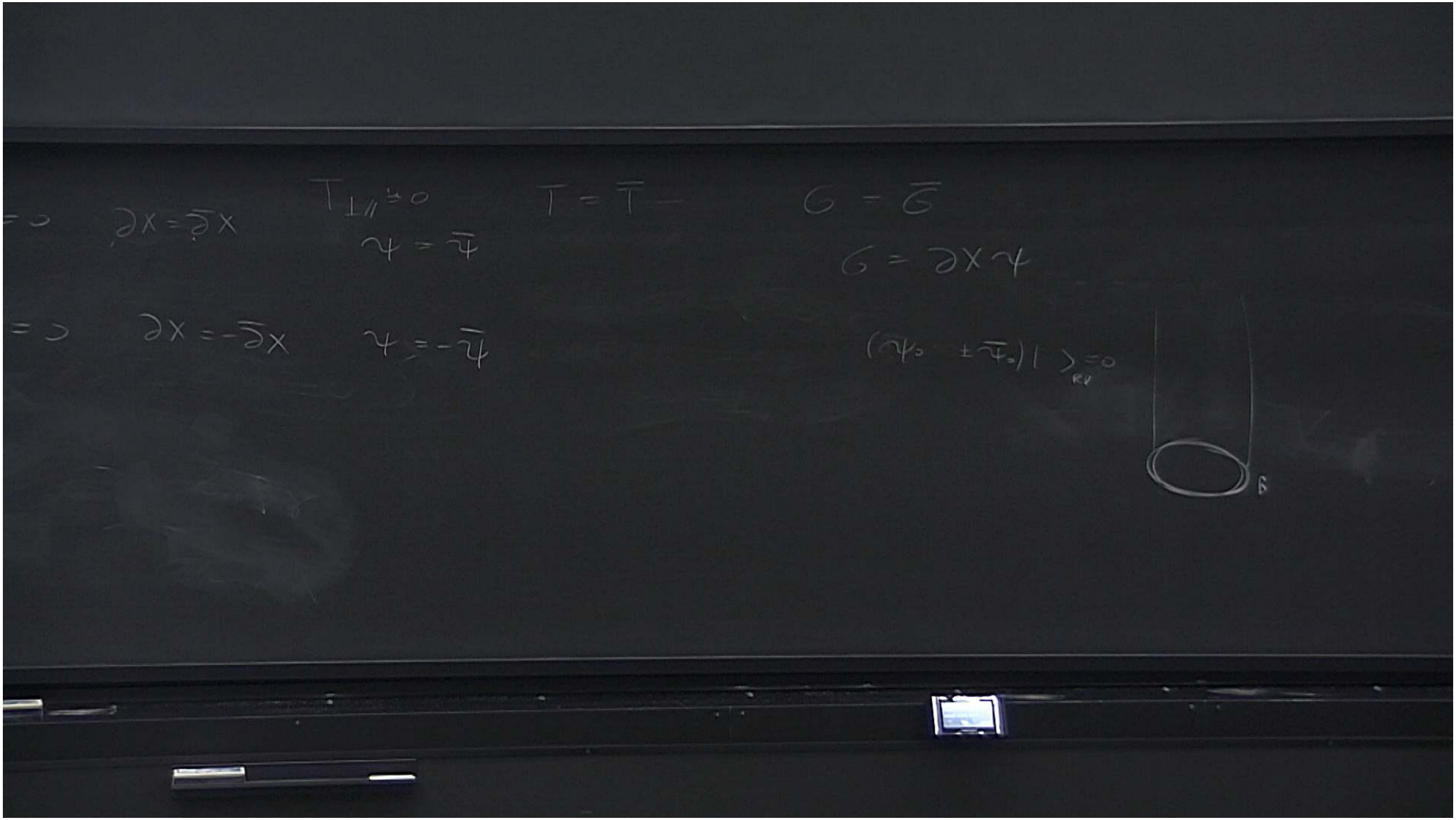


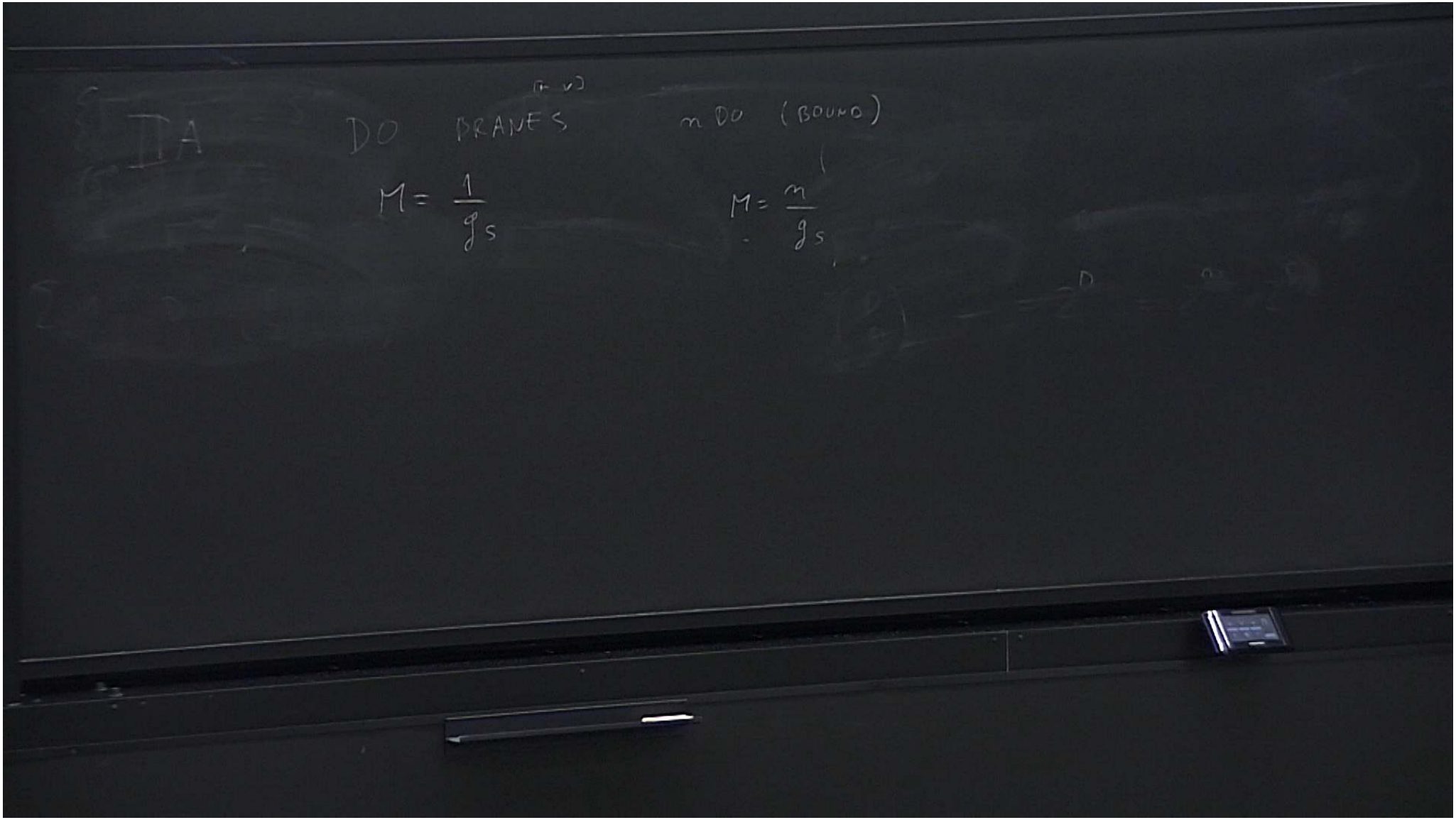

$\bar{\lambda}^a$
$\alpha_{-\frac{1}{2}}^\mu \bar{\partial} X^\nu |p\rangle = |\psi_\mu \otimes g\rangle$
$\psi_{-\frac{1}{2}}^\mu \bar{\lambda}_{-\frac{1}{2}}^a \lambda_{-\frac{1}{2}}^b | \quad ---> \quad A_-^{ab}$
$SO(32)$
$E^8 \times E^8$

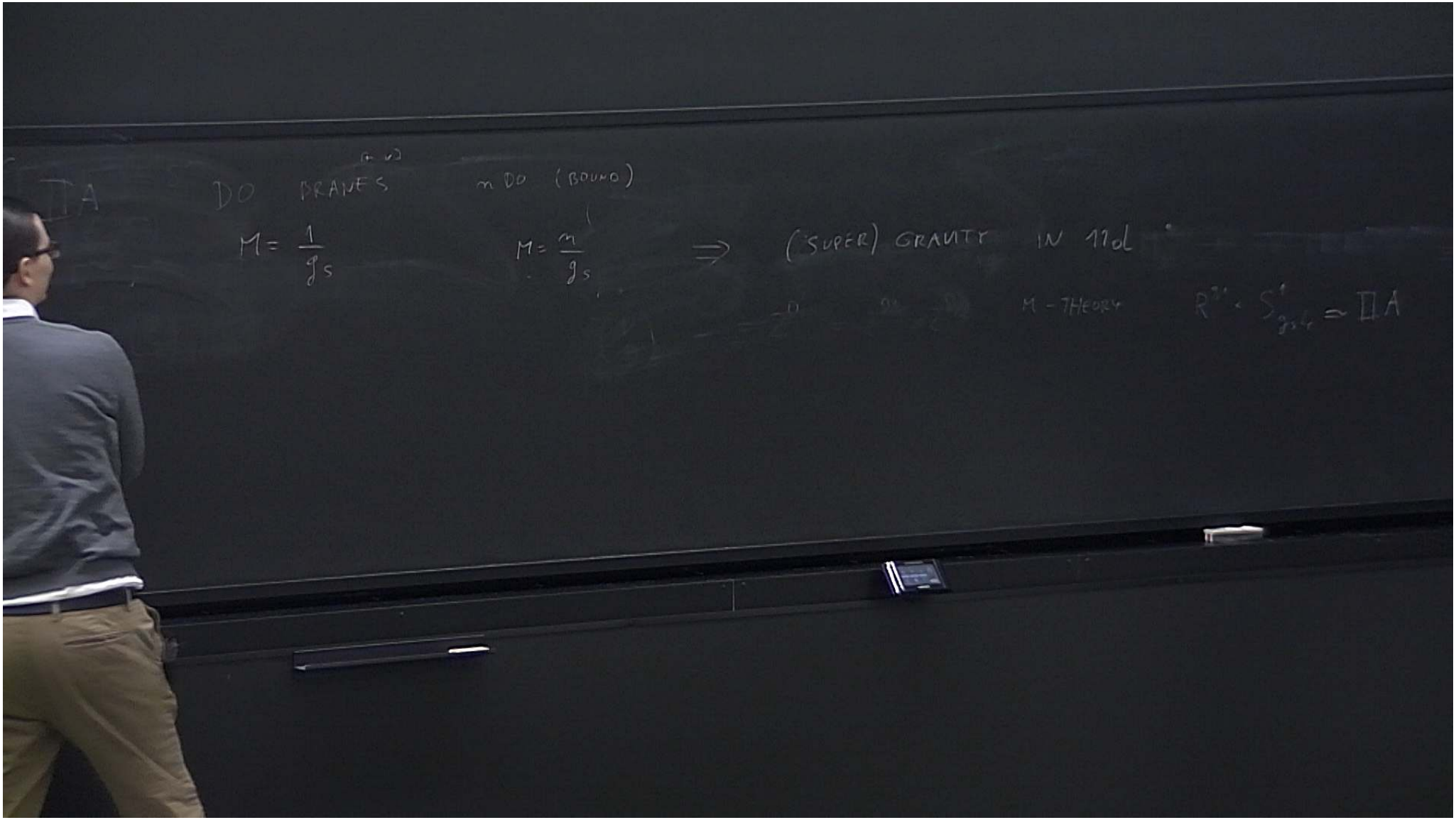

$\bar{\lambda}^a$
$\psi^\mu_{-\frac{1}{2}} \bar{\partial} X^\nu \; |p\rangle \otimes |0\rangle_{vs} \otimes |g\rangle$
$g^{\mu\nu}, B^{\mu\nu}, \phi$
$\psi^\mu_{-\frac{1}{2}} \bar{\lambda}^a_{-\frac{1}{2}} \bar{\lambda}^b_{-\frac{1}{2}} | \cdots \rangle$
A^{ab}_μ
$SO(32)$
$E^8 \times E^8$
$\ldots \; |\rangle_R \to \chi_{\mu\alpha}, \; \chi^{ab}_\alpha$

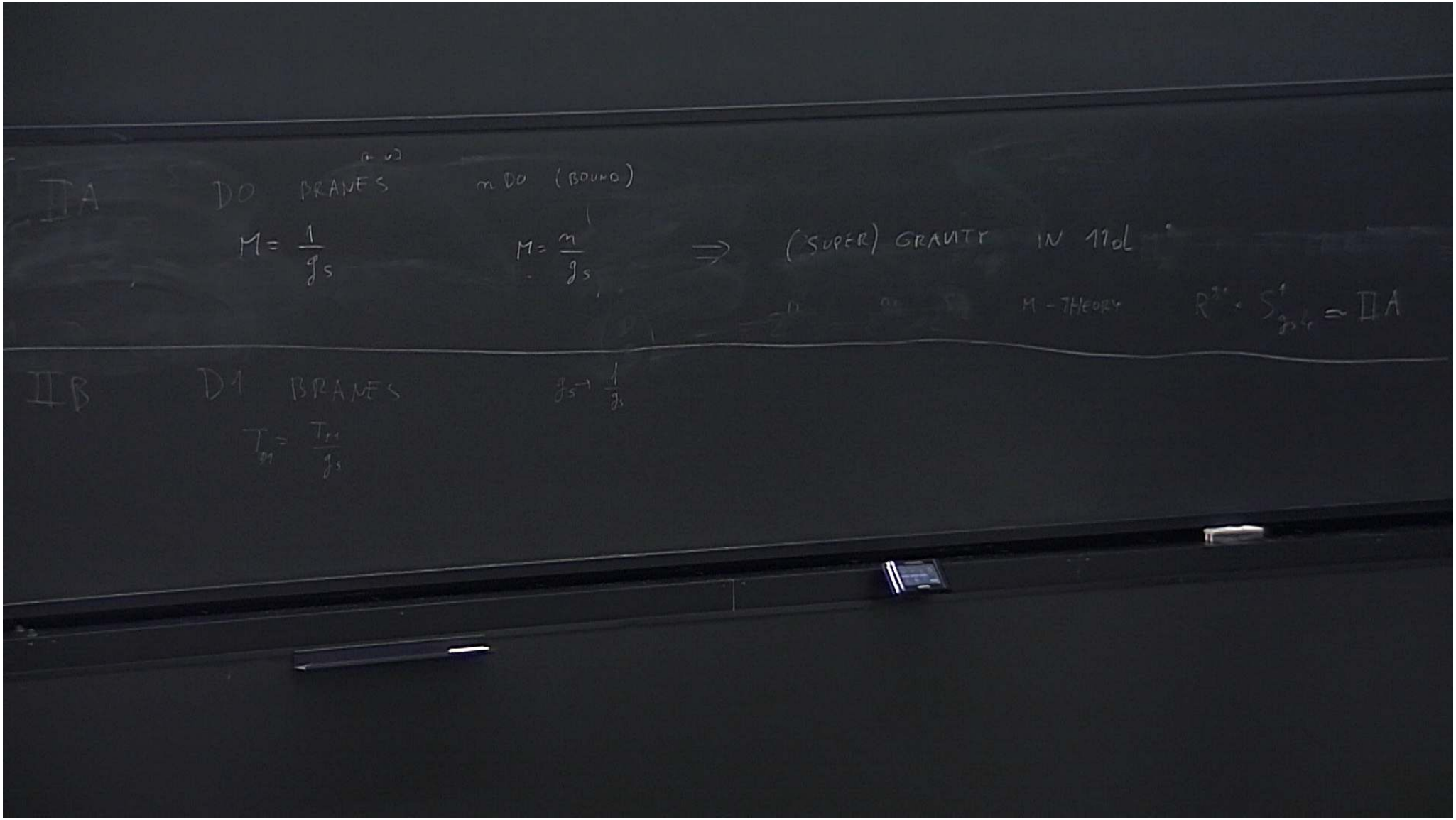

D $\partial_{\parallel} X = 0$ $\partial x = \bar{\partial} x$ $T_{\perp\parallel} = 0$ $\eta = \bar{\eta}$ $T = \bar{T}$ $G = \bar{G}$ $G = \partial X \eta$
N $\partial_{\perp} X = 0$ $\partial x = -\bar{\partial} x$ $\eta = -\bar{\eta}$




$T_{\perp\!\!\!\perp} = 0$
$T = \bar{T}$
$G = \bar{G}$
$\partial X = \bar{\partial} X$
$\psi = \bar{\psi}$
$G = \partial X \psi$
$\partial X = -\bar{\partial} X$
$\psi = -\bar{\psi}$
$(\psi_0 \pm \bar{\psi}_0)|\rangle_{RV} = 0$


DA
DO BRANES
n DO (BOUND)
$M = \frac{1}{g_s}$
$M = \frac{n}{g_s}$


IIA
DO BRANES
n DO (BOUND)
$M = \frac{1}{g_s}$
$M = \frac{n}{g_s}$
$\Rightarrow$ (SUPER) GRAVITY IN 11d
M-THEORY
$R^{10} \times S^1_{g_s \to \infty} = \text{IIA}$


IIA
D0 BRANES
n D0 (BOUND)
$M = \frac{1}{g_s}$
$M = \frac{n}{g_s}$
$\Rightarrow$ (SUPER) GRAVITY IN 11d
M-THEORY
$R^{9,1} \times S^1_{g_s \to 0} \simeq$ IIA
IIB
D1 BRANES
$g_s \to \frac{1}{g_s}$
$T_{D1} = \frac{T_{F1}}{g_s}$