Title: The B-RNS-GSS formalism in heterotic supergravity backgrounds

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Series: Quantum Fields and Strings

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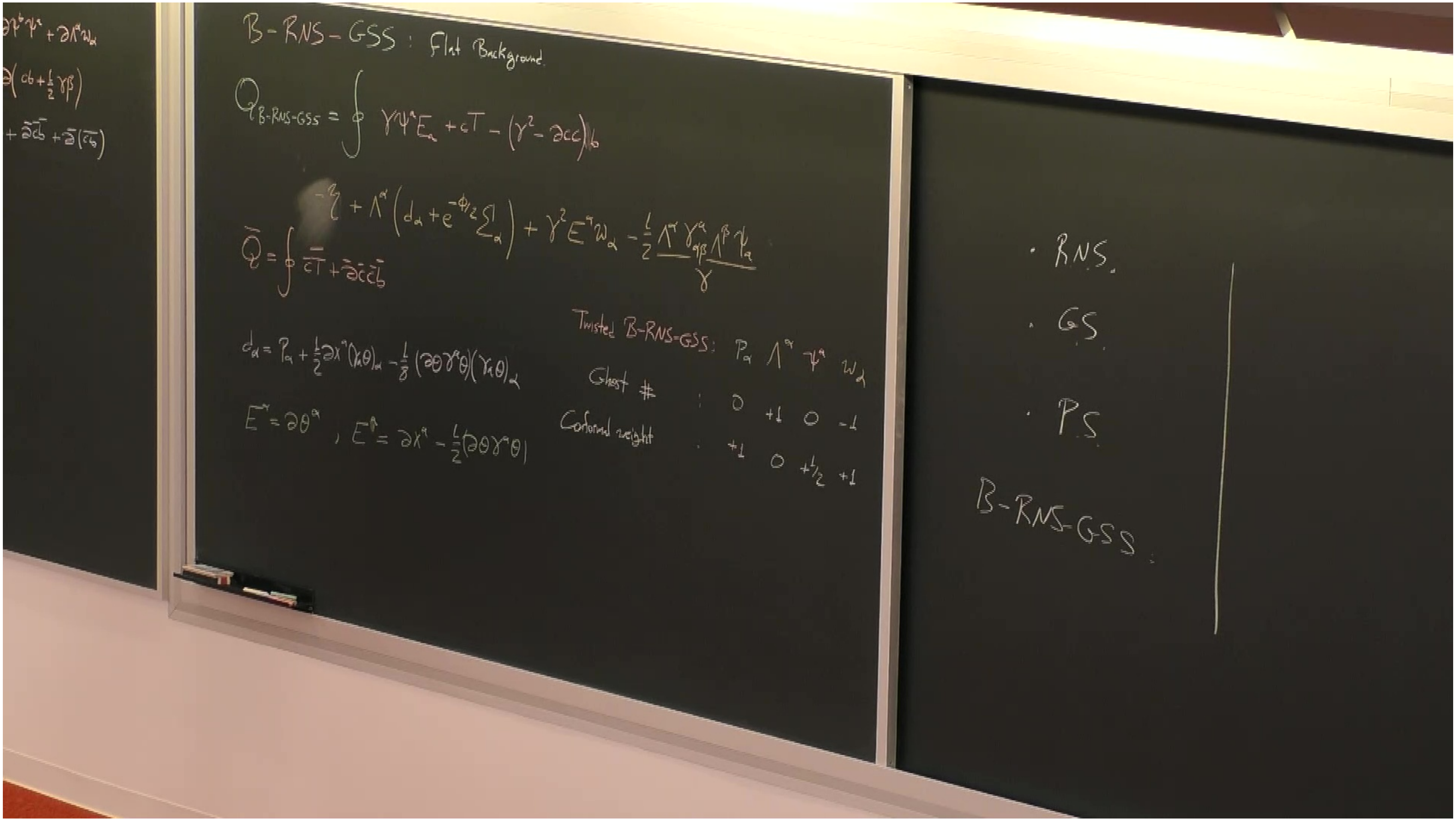
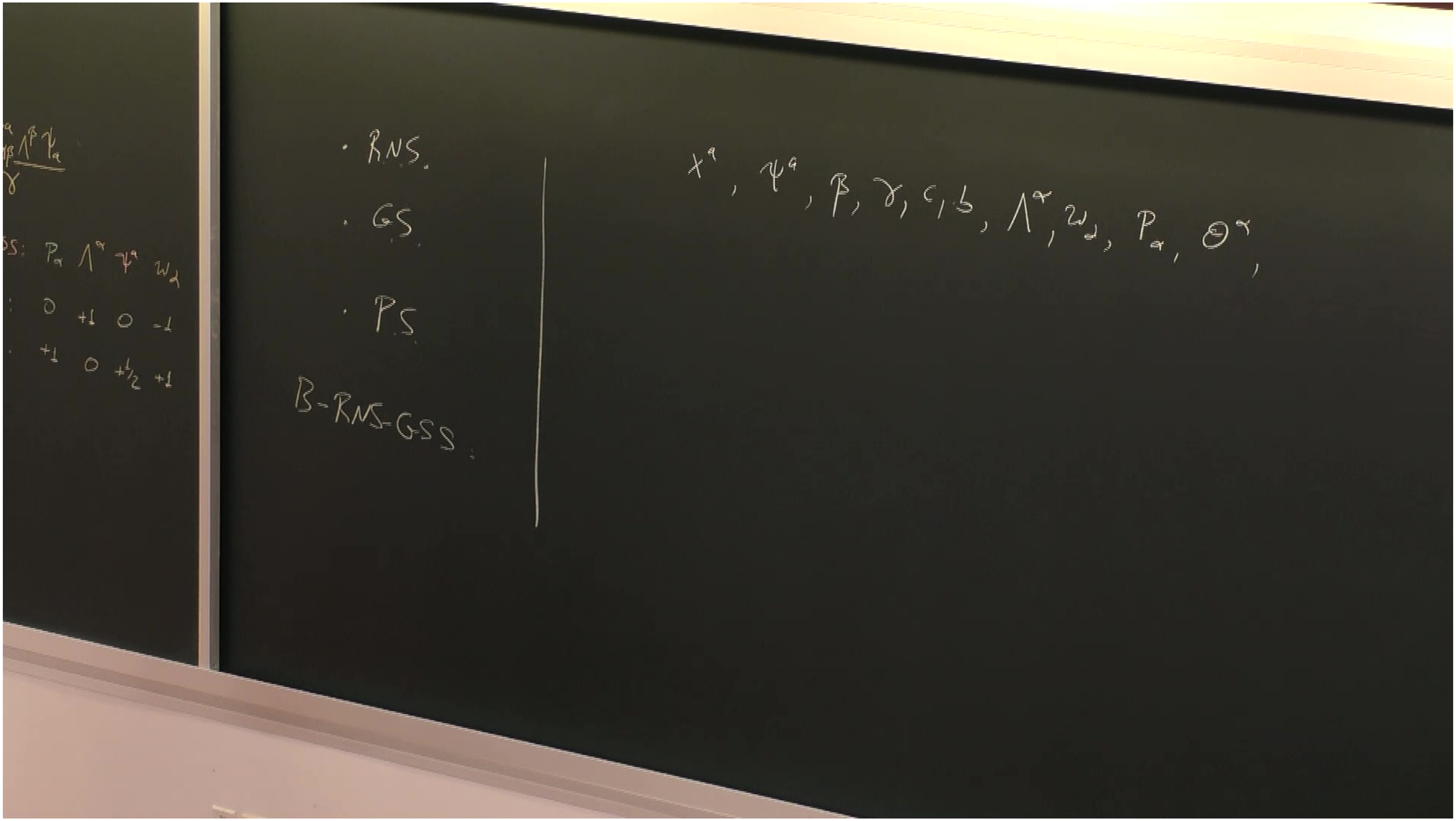
Abstract: A new approach for the first quantization of superstrings, called B-RNS-GSS formalism, is being constructed. It consists of quantizing embeddings of super surfaces into superspaces. As in the classical theory of super-embeddings, it has twistor-like variables. In this talk, besides motivating the need for such a formalism, I will review the work done in hep-th: 2211.06899, where the hetetoric supergravity equations of motion were derived from BRST nilpotency.

Zoom link: https://pitp.zoom.us/j/98656433153?pwd=NjlpcUtITDAwWlgycUtUZUVsZ3QrQT09


B-RNS-GSS : Flat Background
$Q_{B\text{-}RNS\text{-}GSS} = \oint \gamma\Psi^a E_a + cT - (\gamma^2 - \partial cc) b$
$+ \Lambda^\alpha (d_\alpha + e^{-\phi/2}\Sigma_\alpha) + \gamma^2 E^\alpha w_\alpha - \frac{1}{2}\frac{\Lambda^\alpha \gamma^a_{\alpha\beta}\Lambda^\beta \psi_a}{\gamma}$
$\bar{Q} = \oint \bar{c}\bar{T} + \bar{\partial}\bar{c}\bar{c}\bar{b}$
$d_\alpha = P_\alpha + \frac{1}{2}\partial x^a (\gamma_a\theta)_\alpha - \frac{1}{8}(\partial\theta\gamma^a\theta)(\gamma_a\theta)_\alpha$
$E^\alpha = \partial\theta^\alpha$, $E^a = \partial x^a - \frac{1}{2}(\partial\theta\gamma^a\theta)$
Twisted B-RNS-GSS: P_α Λ^α ψ^a w_α
Ghost # : 0 +1 0 -1
Conformal weight : +1 0 +1/2 +1
· RNS.
· GS.
· PS.
B-RNS-GSS :



· RNS
· GS
· PS
B-RNS-GSS :
x^a , ψ^a , β , γ , c , b , Λ^α , w_α , p_α , θ^α ,
p_α Λ^α ψ^a w_α
0 +1 0 -1
+1 0 +1/2 +1

$\gamma, c, b, \Lambda^\alpha, \omega_\alpha, p_\alpha, \Theta^\alpha,$

MFS

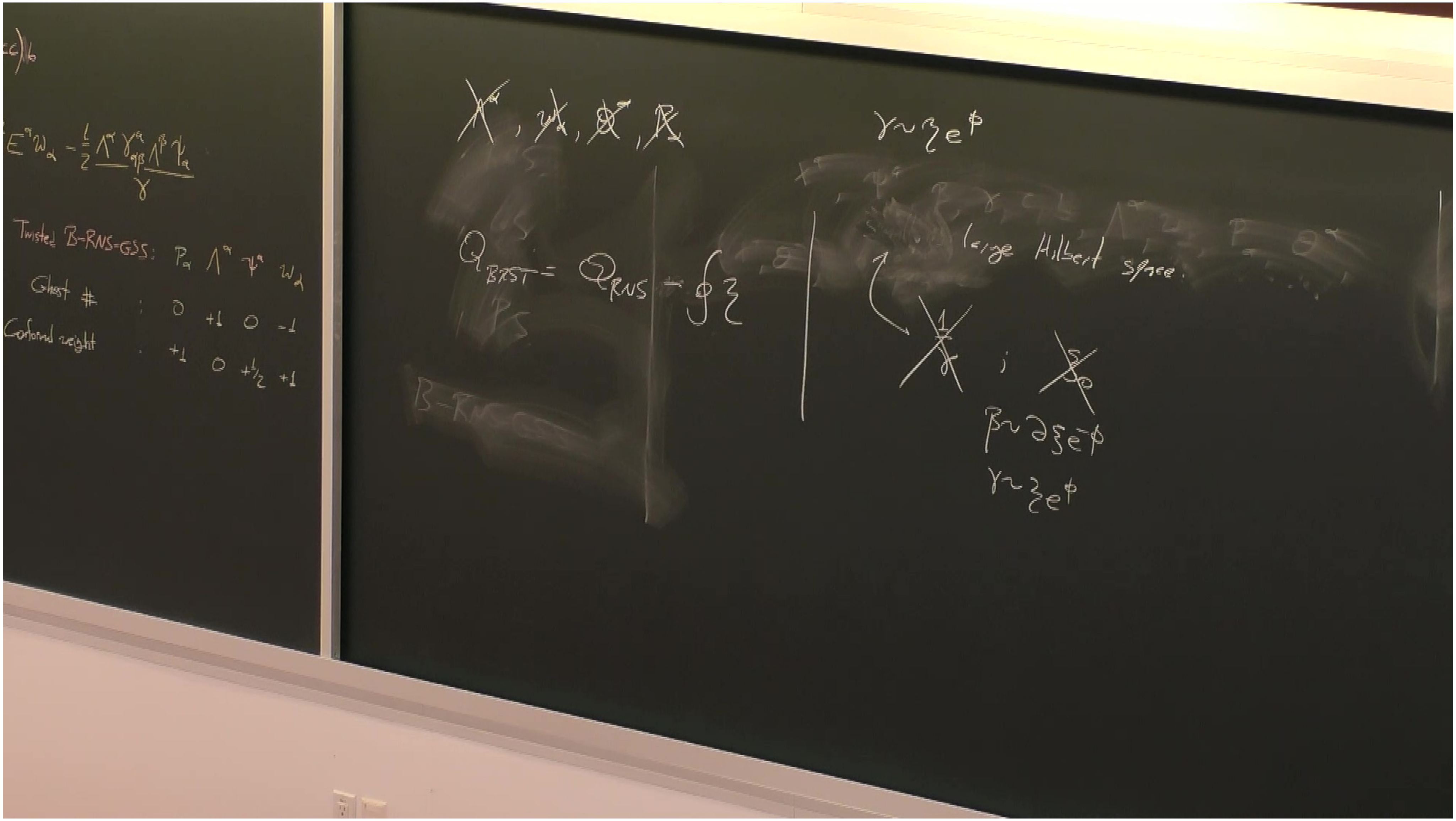
$\beta \sim \partial\xi e^{-\phi}$

$\gamma \sim \xi e^{\phi}$

c.w.

$\psi^a \sim e^{a\cdot H}, \quad +1/2$

$\Sigma_\alpha \sim e^{-\alpha\cdot H}, \quad +5/8$



Twisted B-RNS-GSS: P_α Λ^α ψ^α w_α
Ghost # : 0 +1 0 -1
Conformal weight : +1 0 +1/2 +1
Q_BRST = Q_RNS + ∮ξ
large Hilbert space
β ~ ∂ξ e^-φ

$\gamma \sim \eta e^{\phi}$

large Hilbert space

$\cancel{\frac{1}{\gamma}}$; $\cancel{\frac{\delta}{\delta\phi}}$

$\beta \sim \partial\xi e^{-\phi}$

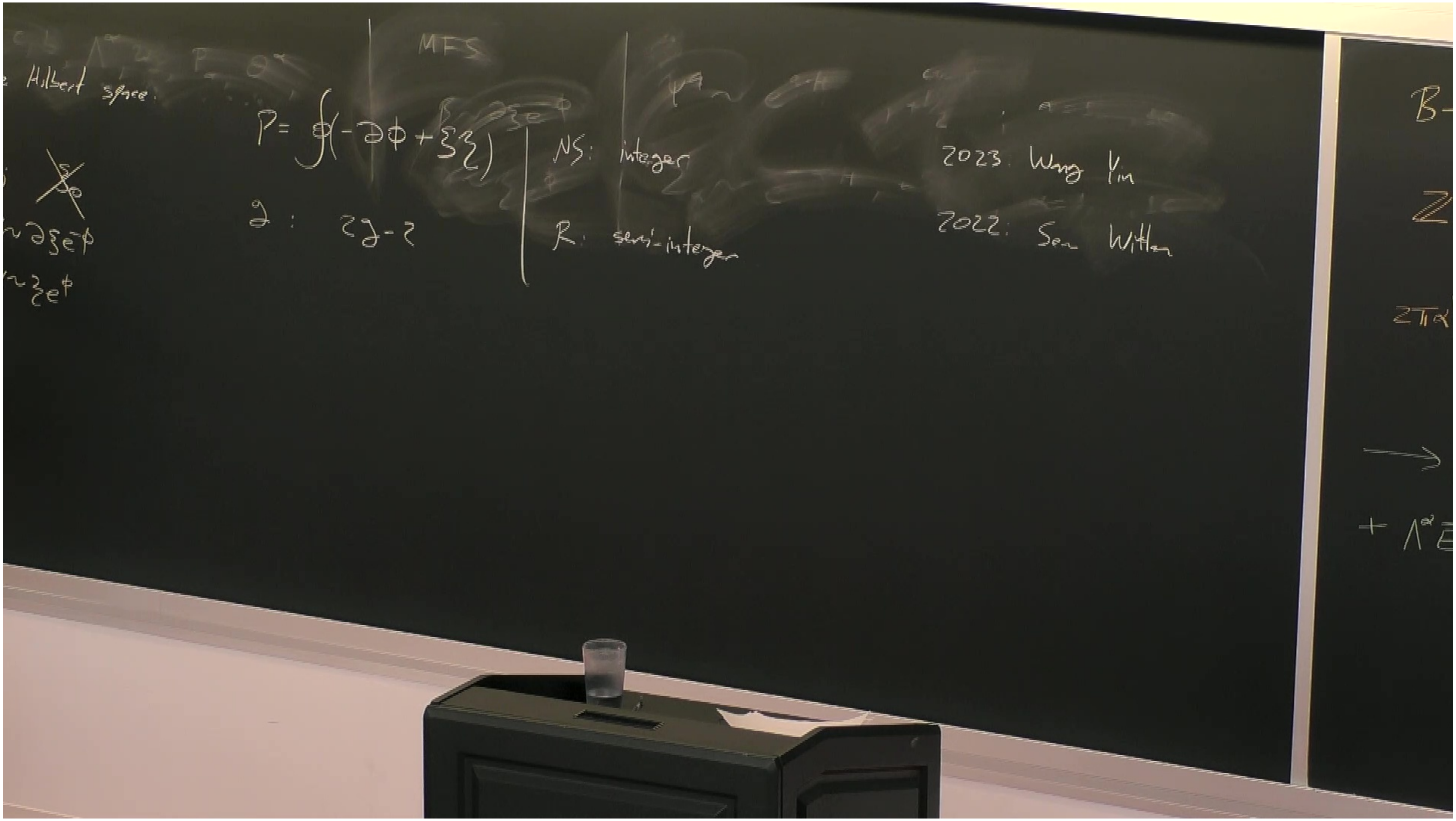
$\gamma \sim \eta e^{\phi}$

$P = \oint(-\partial\phi + \xi\eta)$

g : $2g - 2$

NS: integer

R: semi-integer


Hilbert space.
NS: integer
R: semi-integer
2023: Wang Yin
2022: Sen Witten

$$\Lambda^\alpha \quad \psi^\alpha \quad w_\alpha$$
$$+1 \quad 0 \quad -1$$
$$0 \quad +\tfrac{1}{2} \quad +1$$

$$V_{\text{Gluino}} = \frac{1}{2} \int d^2z \, e^{-\phi/2} \Sigma_\alpha W^{\alpha i j} \bar{\psi}_j \bar{\psi}_i$$

$\alpha = 1, \ldots, 16$

$\hat{\alpha} = 1, \ldots, 16$

Type II $\quad V_{RR} = \int d^2z \, e^{-\phi/2} e^{-\bar{\phi}/2} \Sigma_\alpha \bar{\Sigma}_{\hat{\alpha}} F^{\hat{\alpha}\alpha} \quad ; \quad \partial\!\!\!/ F = 0$

$\int d^2z\, e^{-\phi/2} \Sigma_\alpha W^{\alpha i j} \bar\psi_j \bar\psi_i$ $\quad \alpha = 1,\dots,16$ $\quad \hat\alpha = 1,\dots,16$

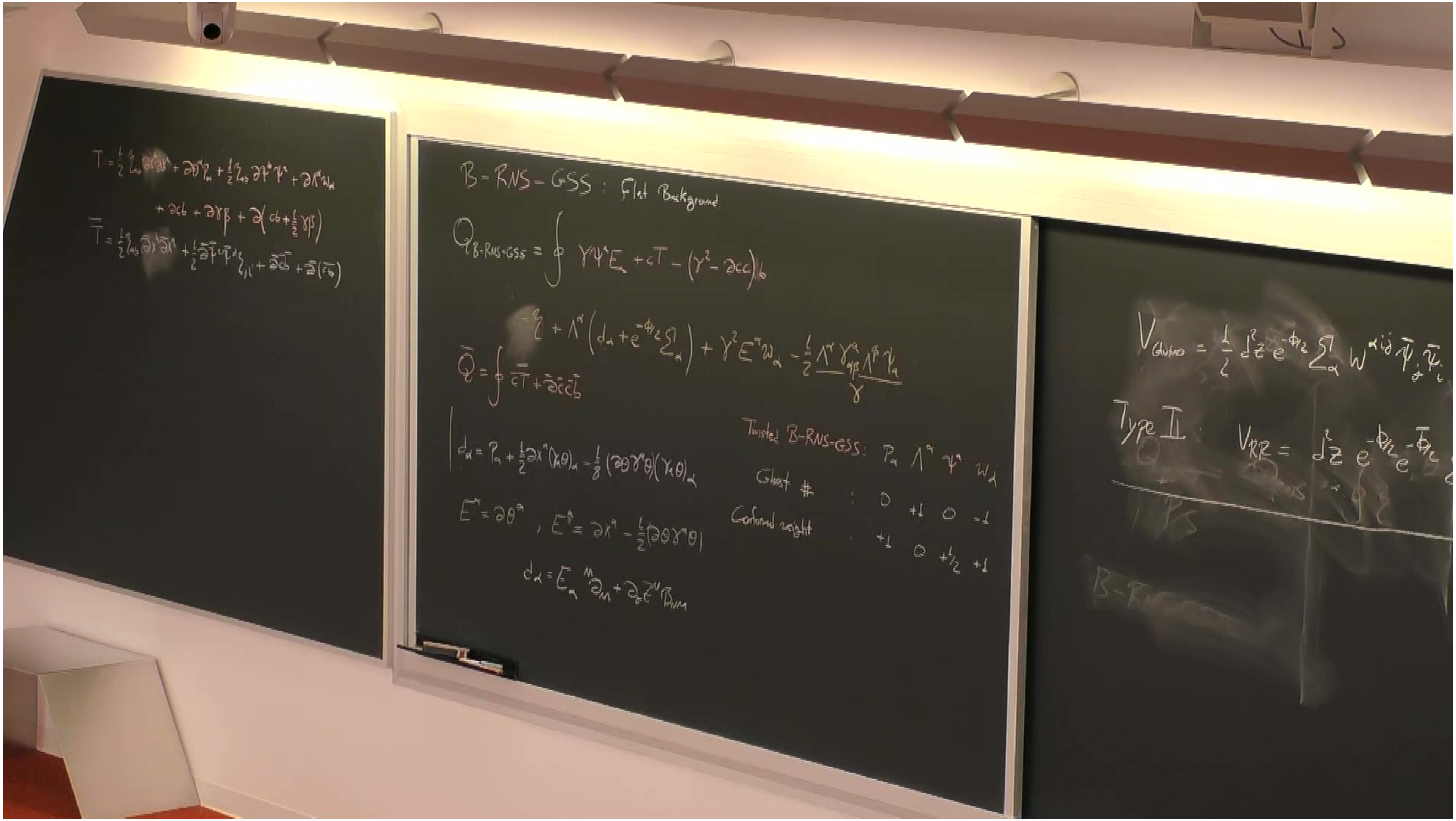
$V_{RR} = \int d^2z\, e^{-\phi/2} e^{-\bar\phi/2} \Sigma_\alpha \bar\Sigma_{\hat\alpha} F^{\hat\alpha\alpha} \quad ; \quad \not\partial F = 0$

G.S.

$\psi^a, \lambda^\alpha, w_\alpha, \gamma, \beta, c, b, P_\alpha$

d_α

$2\pi\alpha' L = \frac{1}{2} E^a \bar E^b + B_{Het} + \frac{1}{2} \partial \bar\psi^i \bar\psi \partial z_{ji}$


B-RNS-GSS : Flat Background
Twisted B-RNS-GSS:
Ghost #
Conformal weight
Type II

$$\int d^2z\, e^{-\phi/2} \sum_\alpha W^{\alpha i j} \bar\psi_j \bar\psi_i$$

$\alpha = 1, \dots, 16$

$\hat\alpha = 1, \dots, 16$

$$V_{RR} = \int d^2z\, e^{-\phi/2} e^{-\bar\phi/2} \sum_\alpha \sum_{\hat\alpha} F^{\hat\alpha\alpha} \quad ; \quad \partial\!\!\!/ F = 0$$

G.S.

MFS

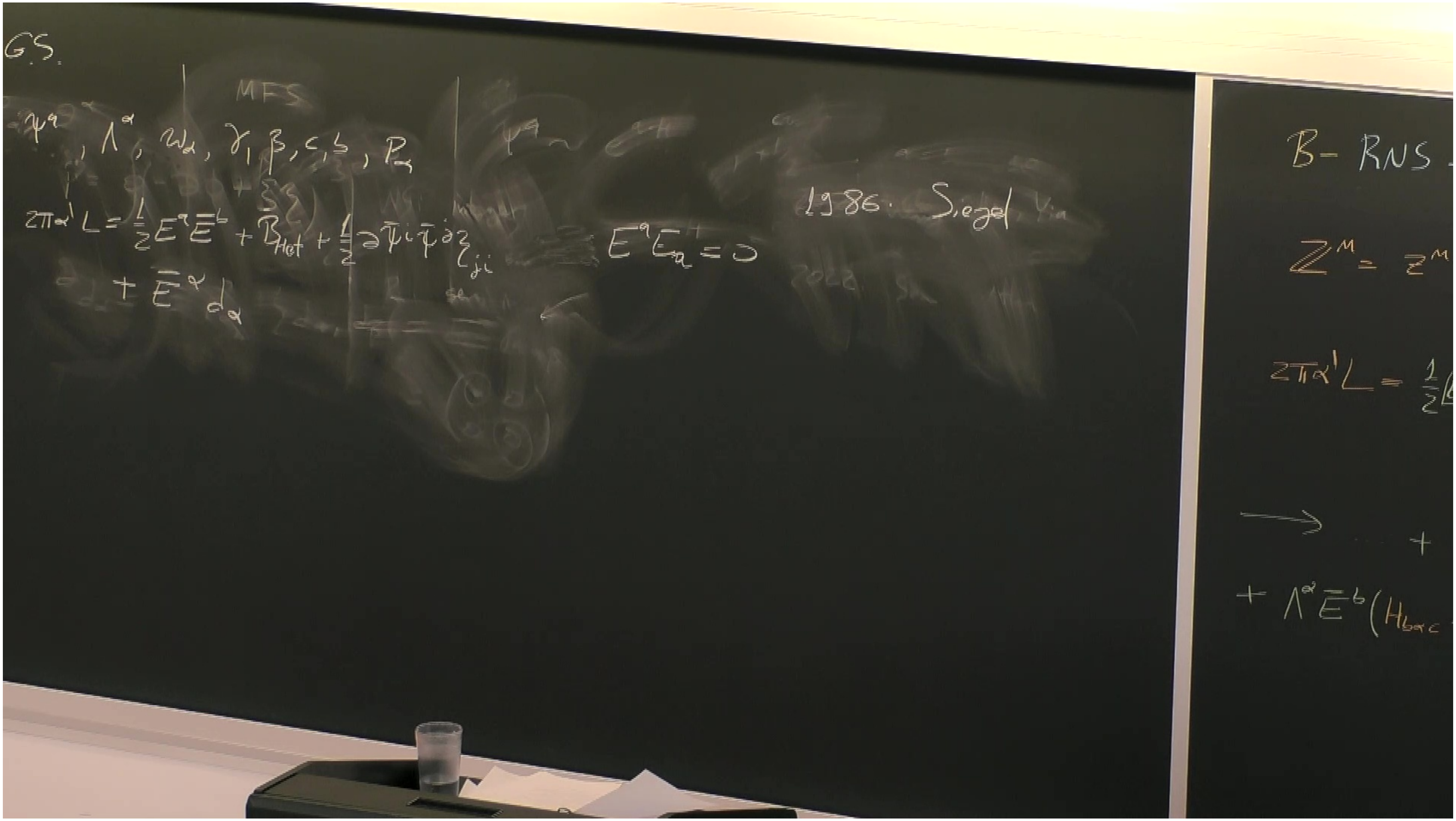
$$\psi^a, \; \Lambda^\alpha, \; \omega_\alpha, \; \gamma, \beta, c, b, \; P_a$$

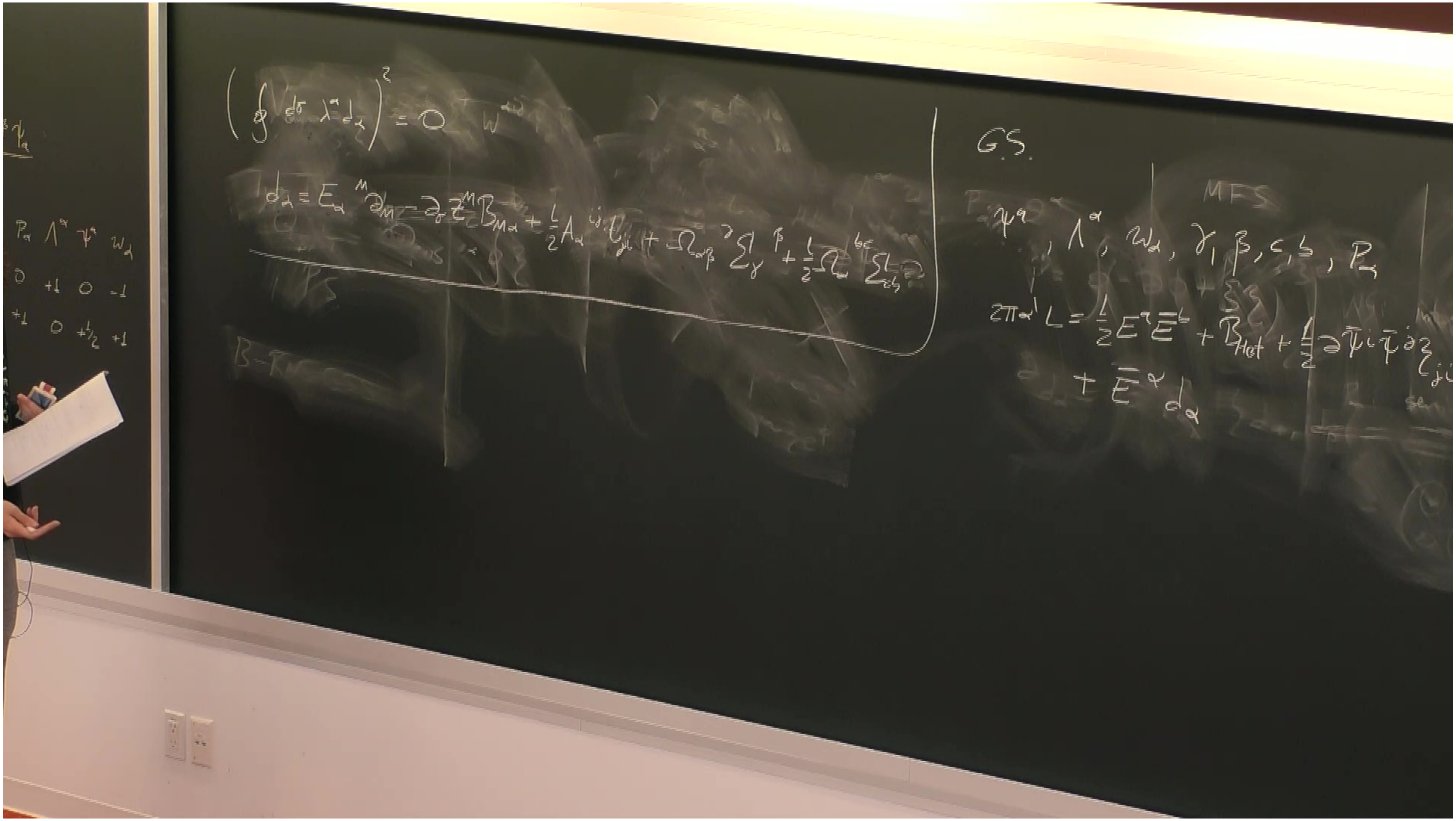
$$2\pi\alpha' L = \frac{1}{2} E^a \bar{E}^b + B_{Het} + \frac{1}{2} \partial\bar\psi^i \bar\psi^j \partial z_{ji}$$

$$E^a E_a = 0$$

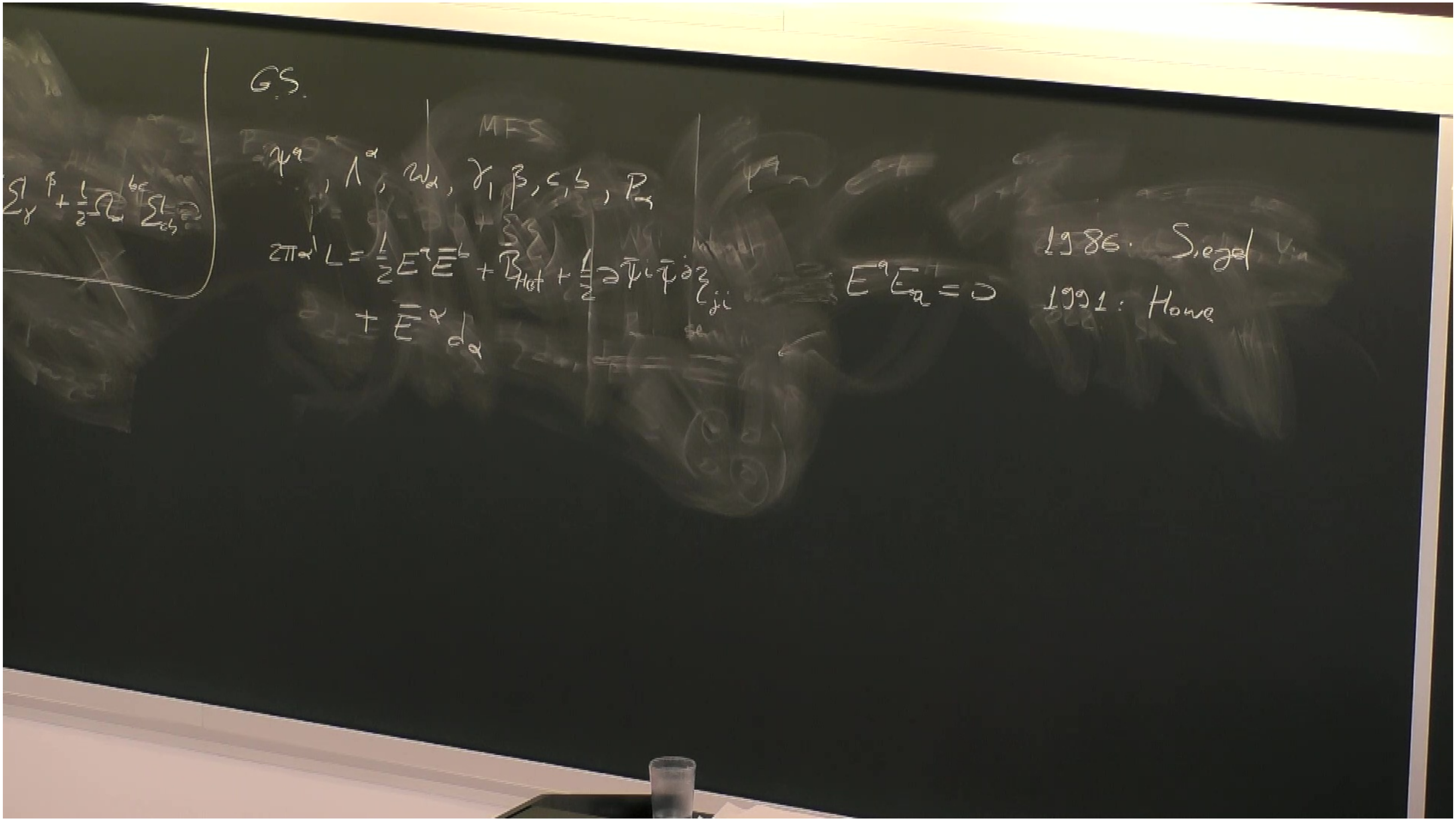
$$d_\alpha = 0 \quad ; \quad \{d_\alpha, d_\beta\} = E^a \gamma_{a\,\alpha\beta}$$

$$= \begin{pmatrix} \circledcirc & 0 \\ 0 & \circledcirc \end{pmatrix}$$


G.S.
MFS
$\psi^a, \Lambda^\alpha, w_\alpha, \gamma, \beta, c, b, P_\alpha$
$2\pi\alpha' L = \frac{1}{2} E^a \bar{E}^b + \mathcal{B}_{Het} + \frac{1}{2}\partial\bar{\psi}^i\bar{\psi}\partial\xi_{ji}$
$+ \bar{E}^\alpha d_\alpha$
$E^a E_a = 0$
1986. Siegel
B- RNS
$Z^M = z^M$
$2\pi\alpha' L = \frac{1}{2}$
$+ \Lambda^\alpha \bar{E}^b (H_{b\alpha c}$



G.S.
MFS

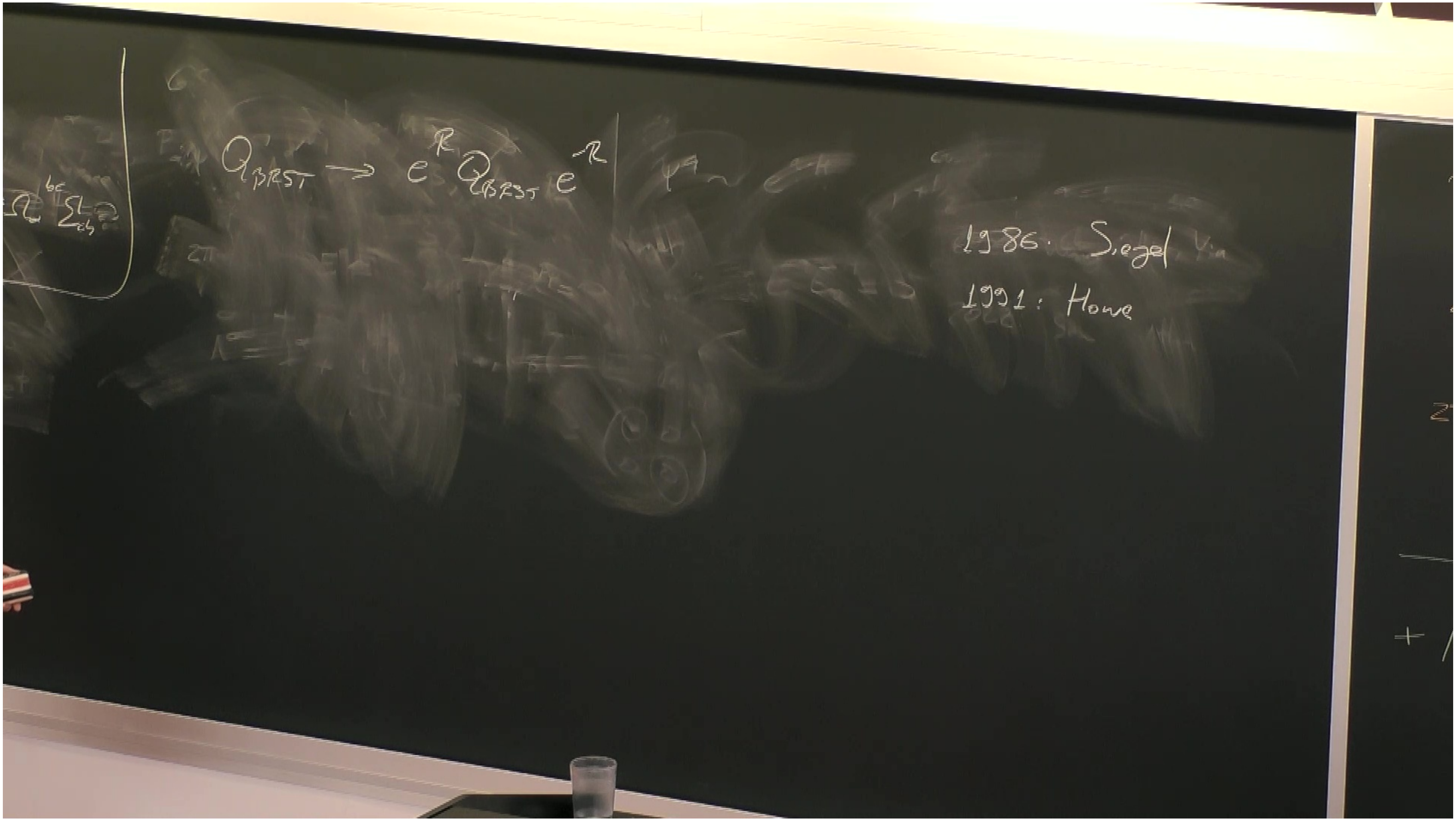

G.S.
MFS
1986: Siegel
1991: Howe

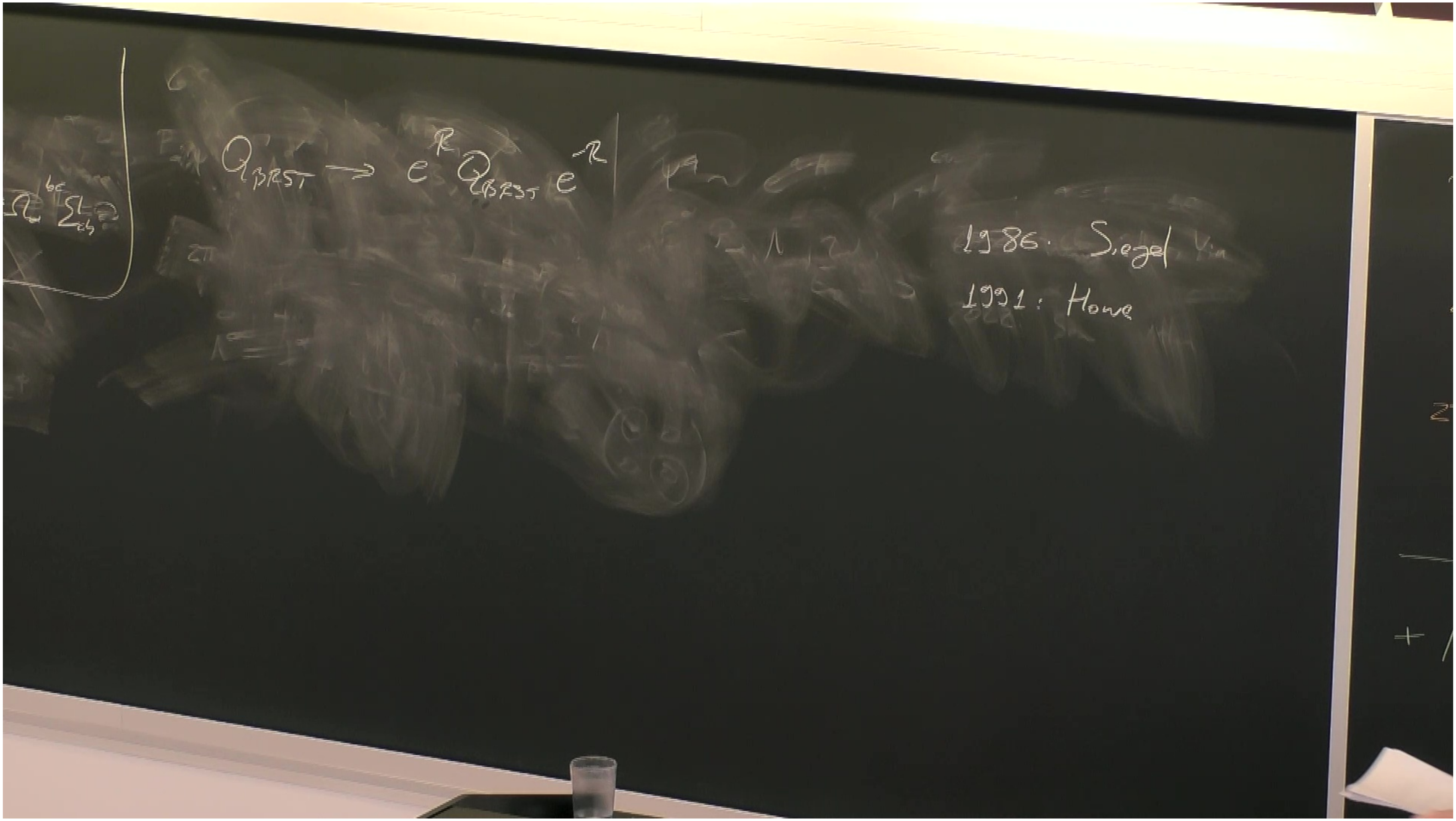
$$\Lambda^\alpha \to \lambda^\alpha, \quad \lambda^\alpha \gamma^a_{\alpha\beta} \lambda^\beta = 0$$

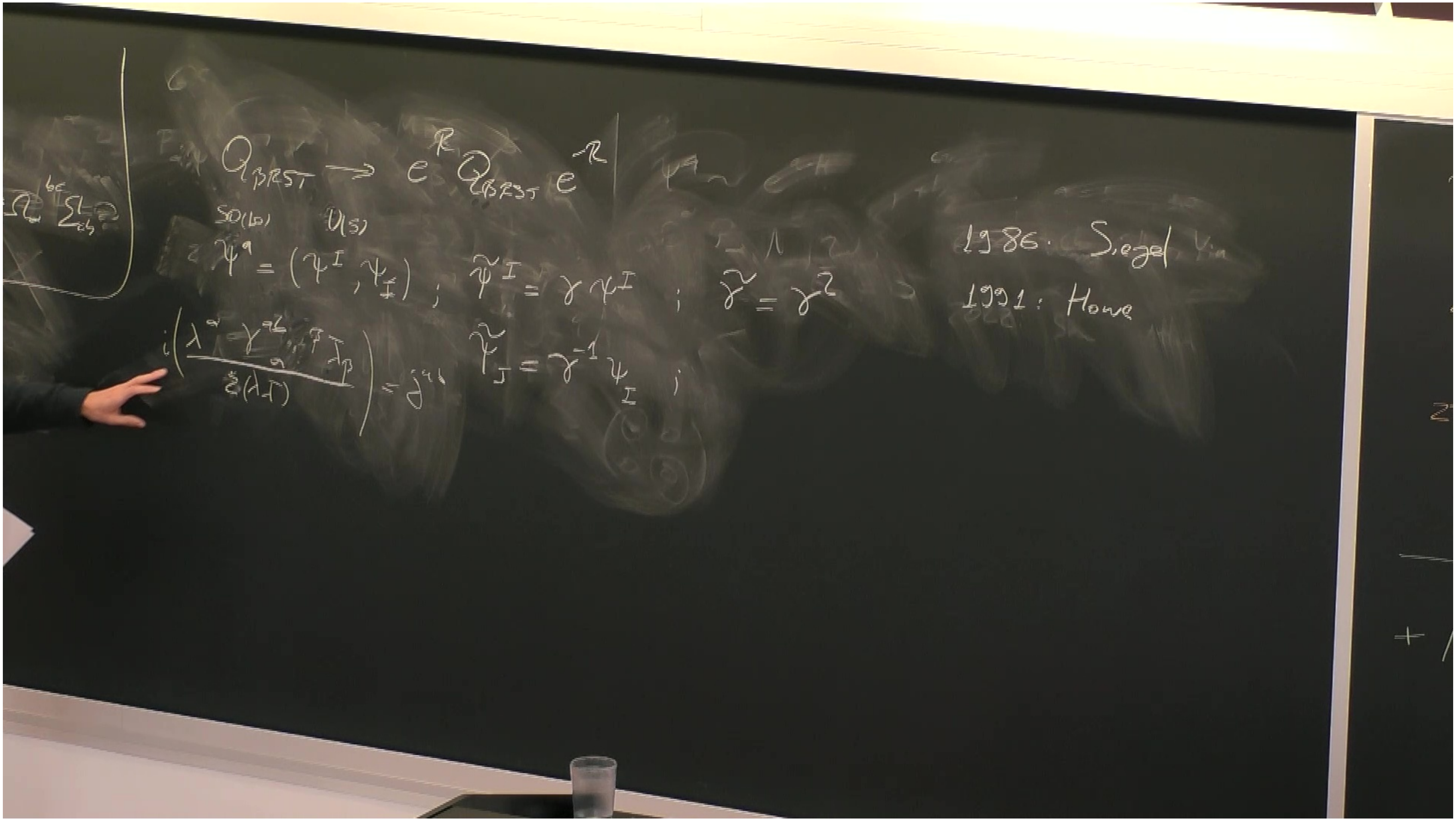
$$\Lambda^\alpha = \lambda^\alpha + \frac{u^{I} (\gamma_I \bar\lambda)^\alpha}{2(\lambda\bar\lambda)}, \quad I = 1, \ldots, 5$$

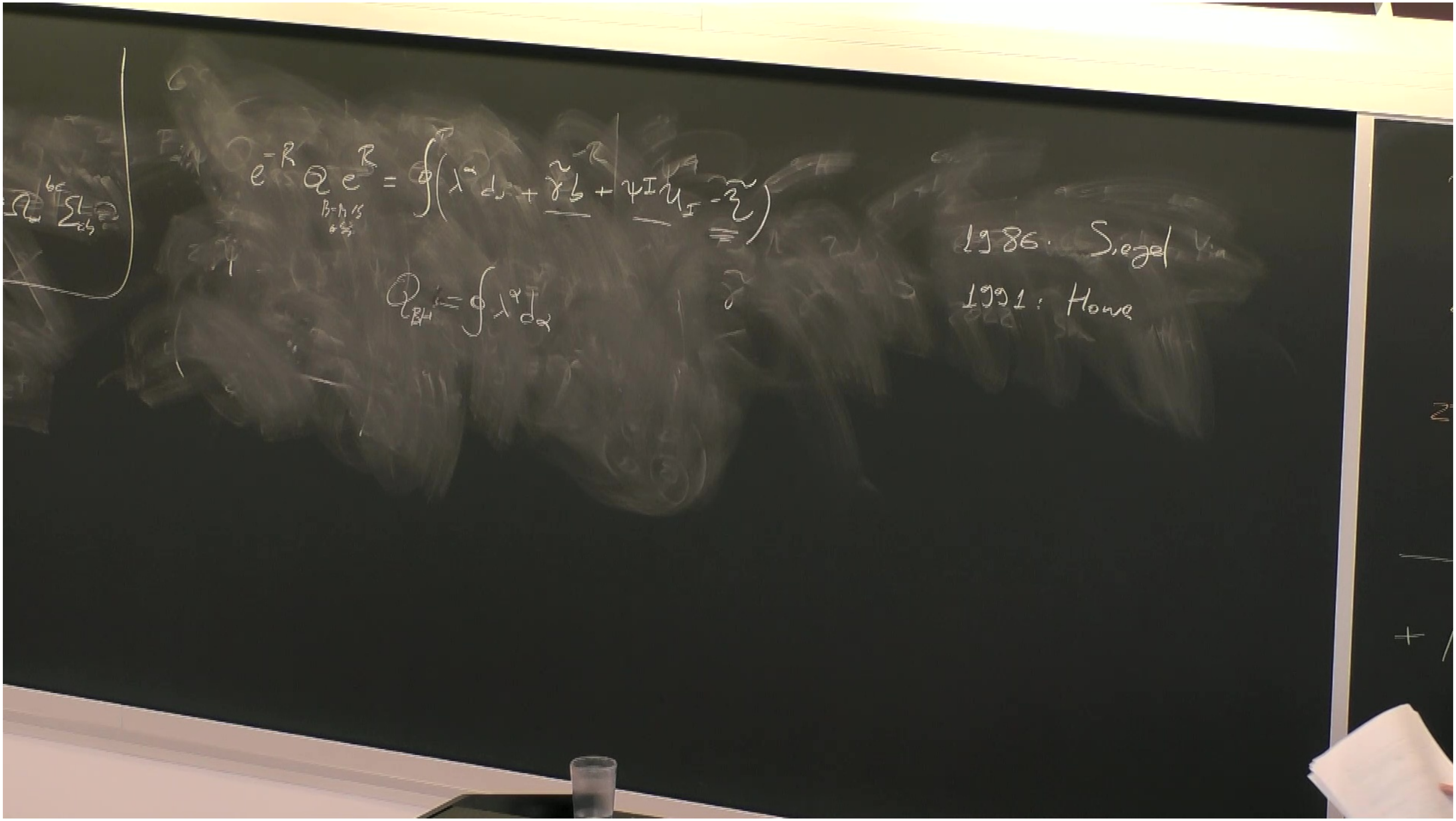
1986: Siegel

1991: Howe


Q_BRST → e^R Q_BRST e^-R
1986: Siegel
1991: Howe

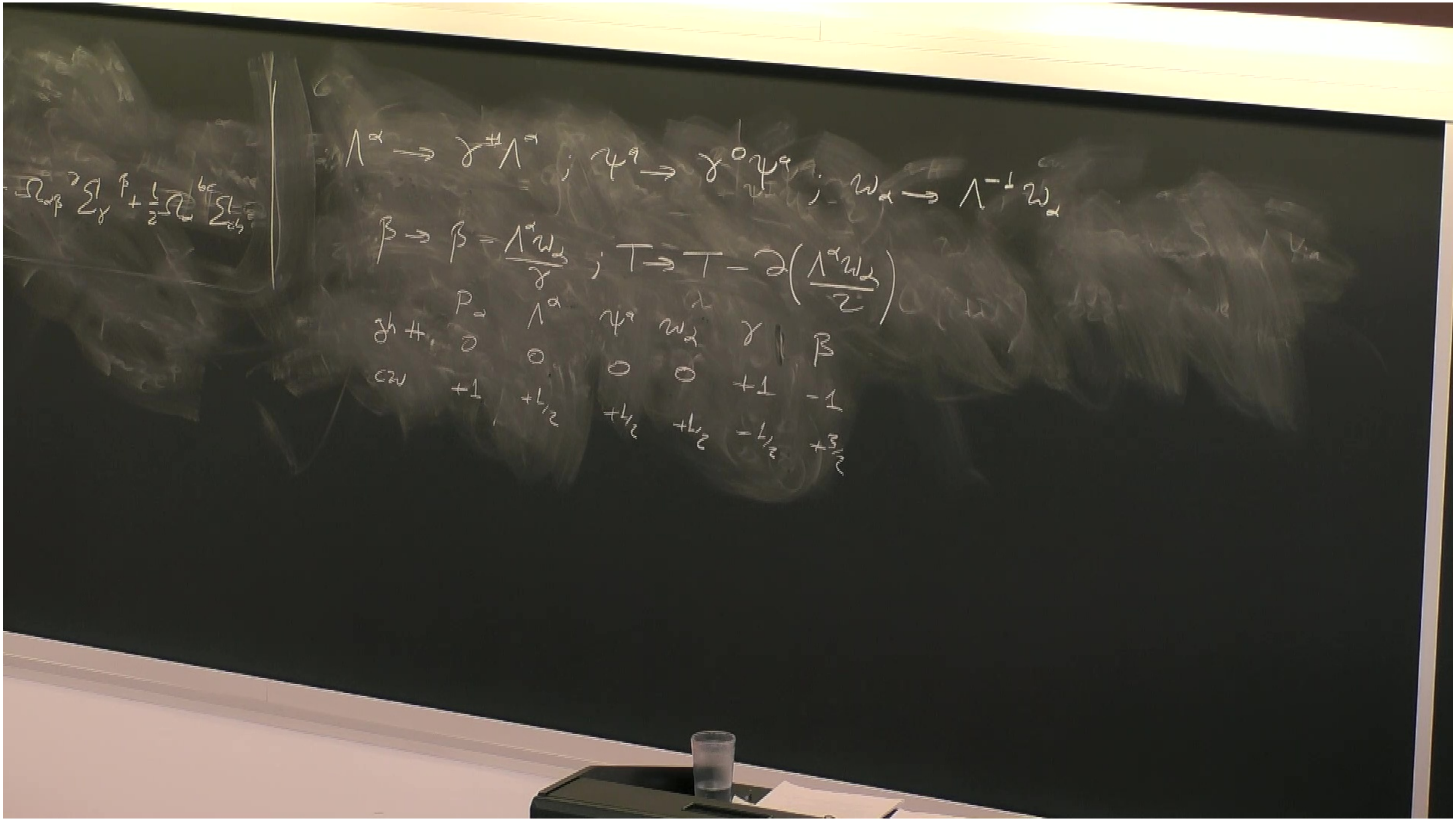

$Q_{BRST} \to e^{R} Q_{BRST} e^{-R}$
1986: Siegel
1991: Howe


Q_BRST → e^R Q_BRST e^-R
SO(10) U(5)
ψ^a = (ψ^I, ψ_I) ; ψ̃^I = γ ψ^I ; γ̃ = γ^2
ψ̃_J = γ^-1 ψ_I ;
1986: Siegel
1991: Howe


$e^{-B} Q e^{B} = \oint(\lambda^\alpha d_\alpha + \tilde{\gamma} b + \psi^I u_I - \tilde{\xi})$
$Q_{BH} = \oint \lambda^\alpha d_\alpha$
1986: Siegel
1991: Howe

$$Qb = T$$

$$b = S^{\alpha}\bar{\partial}\bar{\lambda}_{\alpha} + \frac{\bar{\lambda}_{\alpha} G^{\alpha}}{\lambda\bar{\lambda}} + \frac{\bar{\lambda}_{\alpha}\Gamma_{\beta} H^{\beta\alpha}}{(\lambda\bar{\lambda})^{2}} \pm \cdots \; \mathcal{O}((\lambda\bar{\lambda})^{-4})$$


$\Omega_{\alpha\beta}{}^{\gamma}\Sigma_{\gamma}{}^{\beta} + \frac{1}{2}\Omega^{bc}\Sigma_{cb}$
$\Lambda^\alpha \to \gamma^{\#}\Lambda^\alpha$; $\psi^a \to \gamma^0\psi^a$; $\omega_\alpha \to \Lambda^{-1}\omega_\alpha$
$\beta \to \beta - \frac{\Lambda^\alpha\omega_\alpha}{\gamma}$; $T \to T - \partial\left(\frac{\Lambda^\alpha\omega_\alpha}{2}\right)$
p_α Λ^α ψ^a ω_α γ β
gh # 0 0 0 0 +1 −1
cw +1 +1/2 +1/2 +1/2 −1/2 +3/2

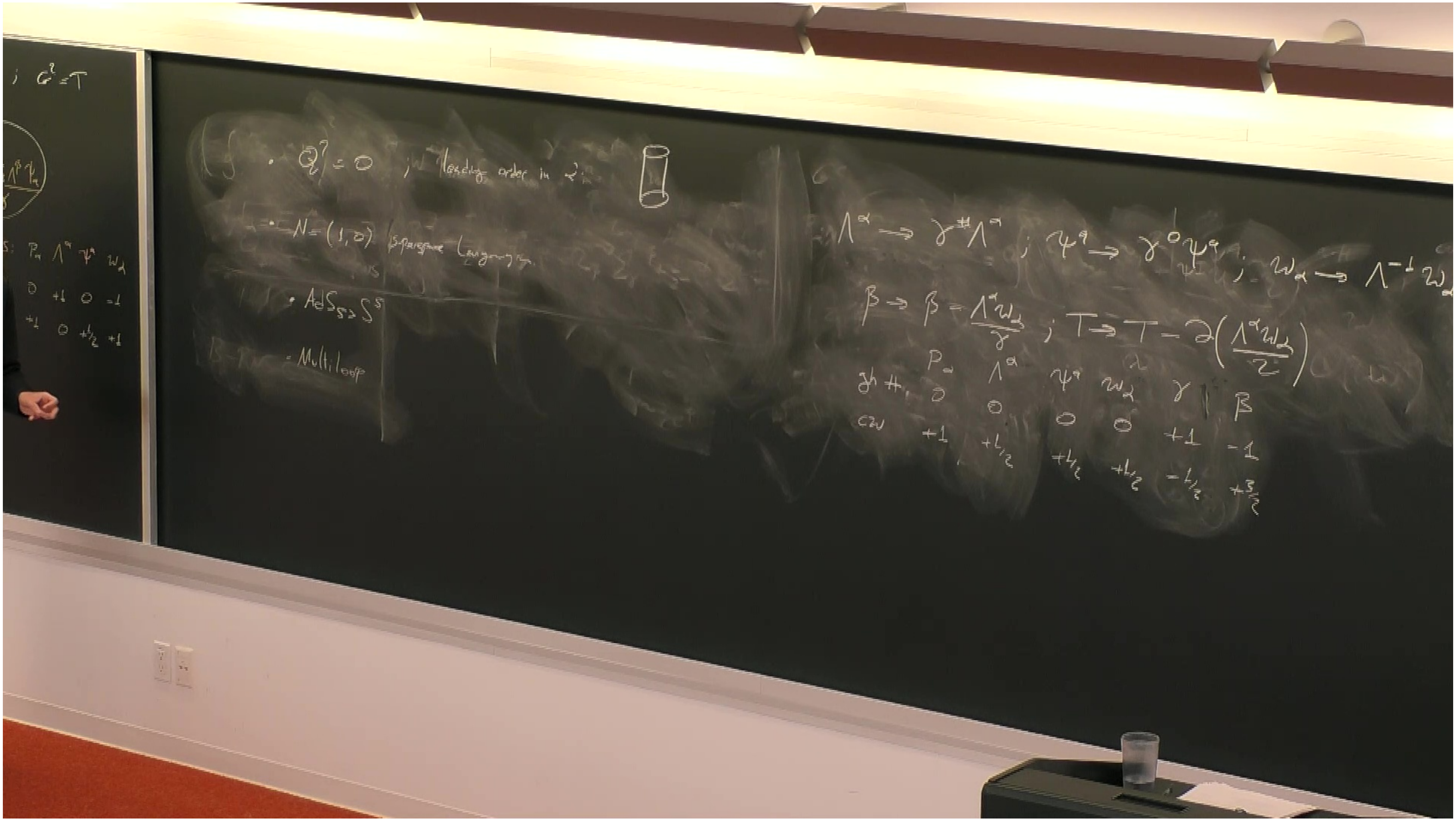
• $Q^2 = 0$; in leading order in λ:

• $N=(1,0)$ superspace Lagrangian.

$\Lambda^\alpha \to \gamma^{\pm 1}\Lambda^\alpha$; $\psi^a \to \gamma^0 \psi^a$; $w_\alpha \to$

$\beta \to \beta - \frac{\Lambda^\alpha w_\alpha}{\gamma}$; $T \to T - \partial\left(\frac{\Lambda^\alpha w_\alpha}{\gamma}\right)$

	P_α	Λ^α	ψ^a	w_α	γ	β
gh #.	0	0	0	0	+1	−1
czu	+1	+1/2	+1/2	+1/2	−1/2	+3/2


; G² = T
• Q² = 0 ; leading order in λ
• N = (1,0) superspace Lagrangians
• AdS₅ × S⁵
• Multiloop
Λ^α → γ^{±1} Λ^α ; ψ^a → γ^0 ψ^a ; w_α → Λ^{-1} w_α
β → β − Λ^α w_α / γ ; T → T − ∂(Λ^α w_α / γ)
P_α Λ^α ψ^a w_α γ β
gh #: 0 0 0 0 +1 −1
+1 +1/2 +1/2 +1/2 −1/2 +3/2