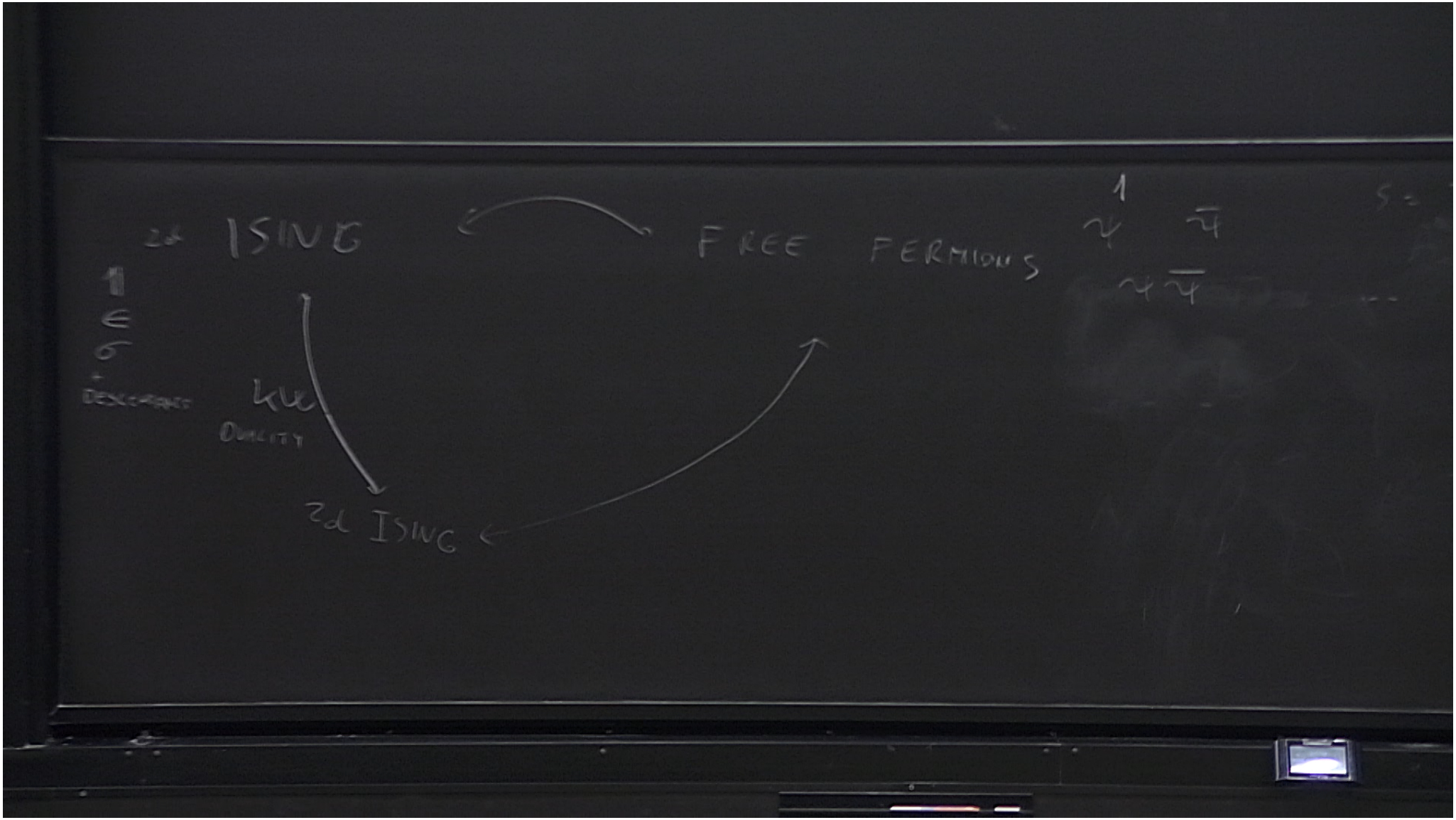
Title: PSI 2017/2018 - String Theory - Lecture 13

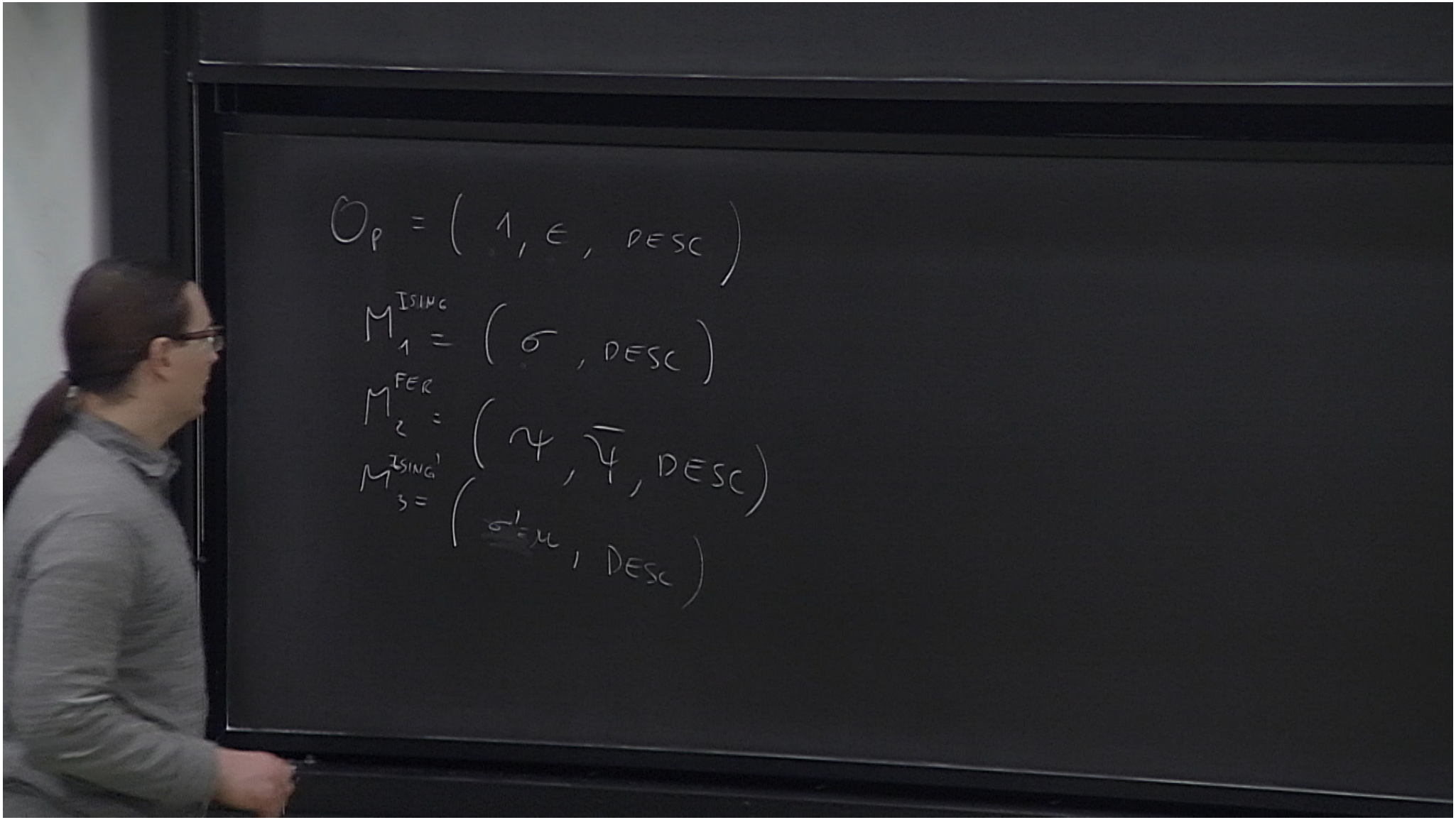
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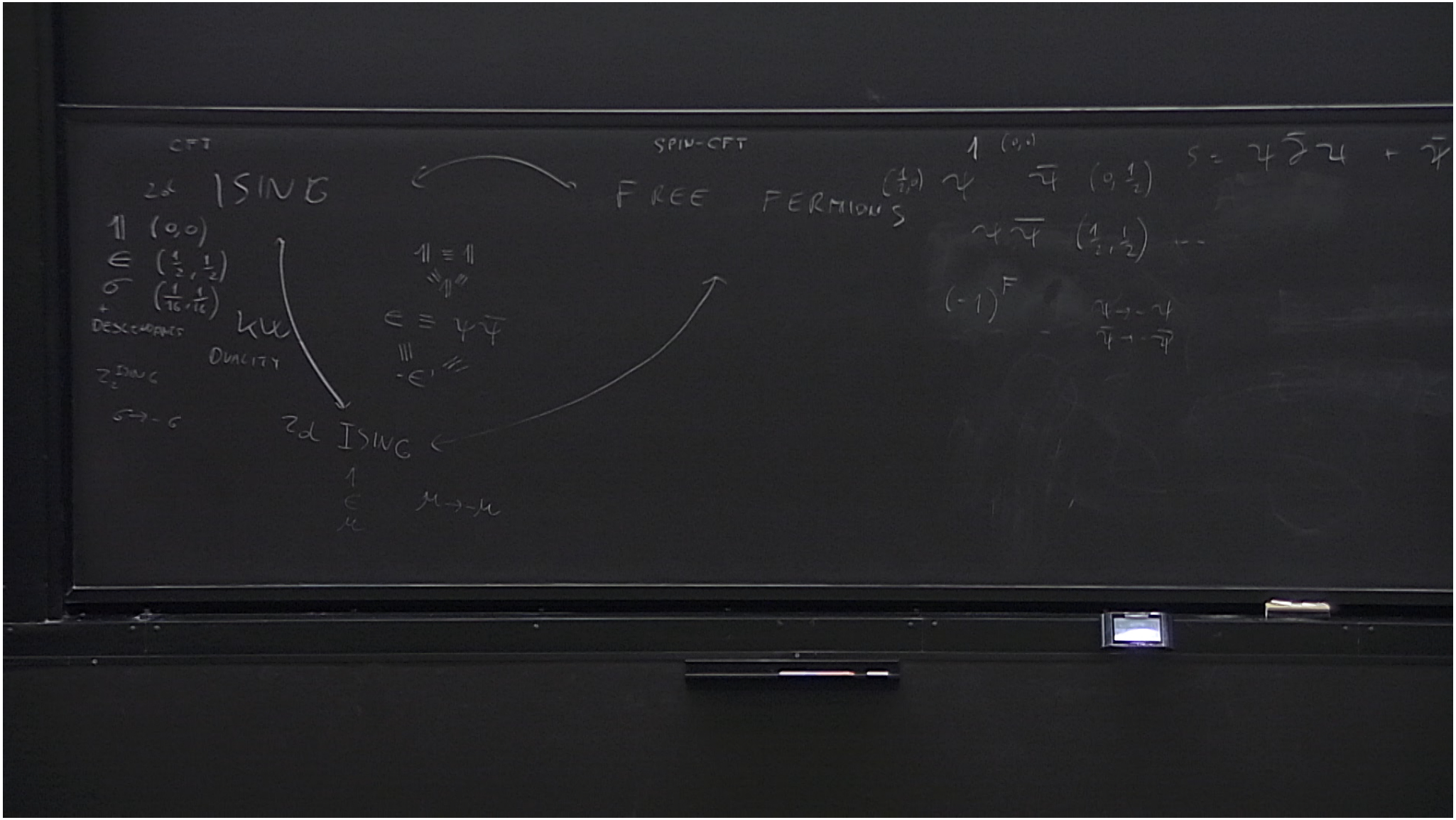
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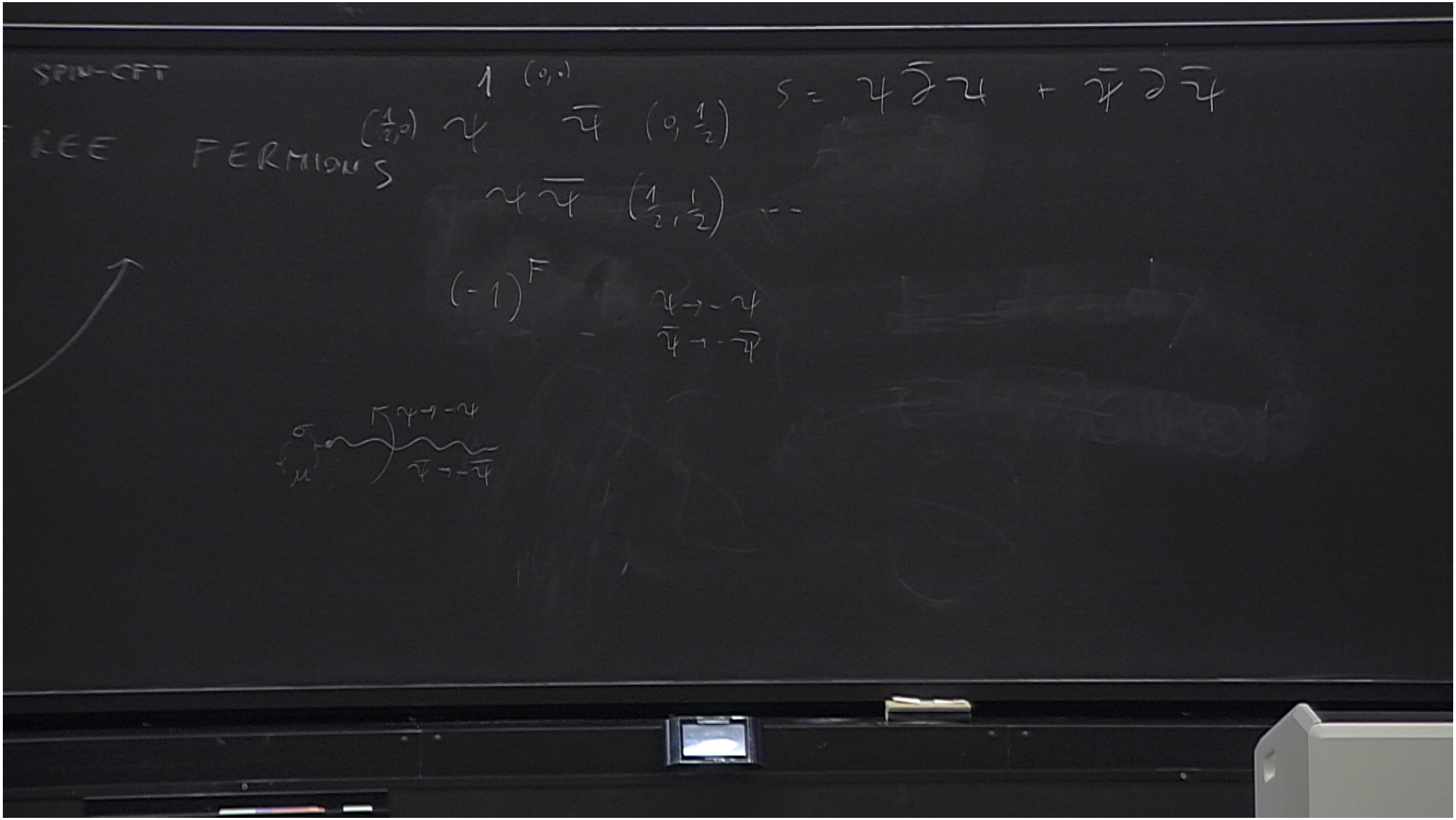
Abstract:

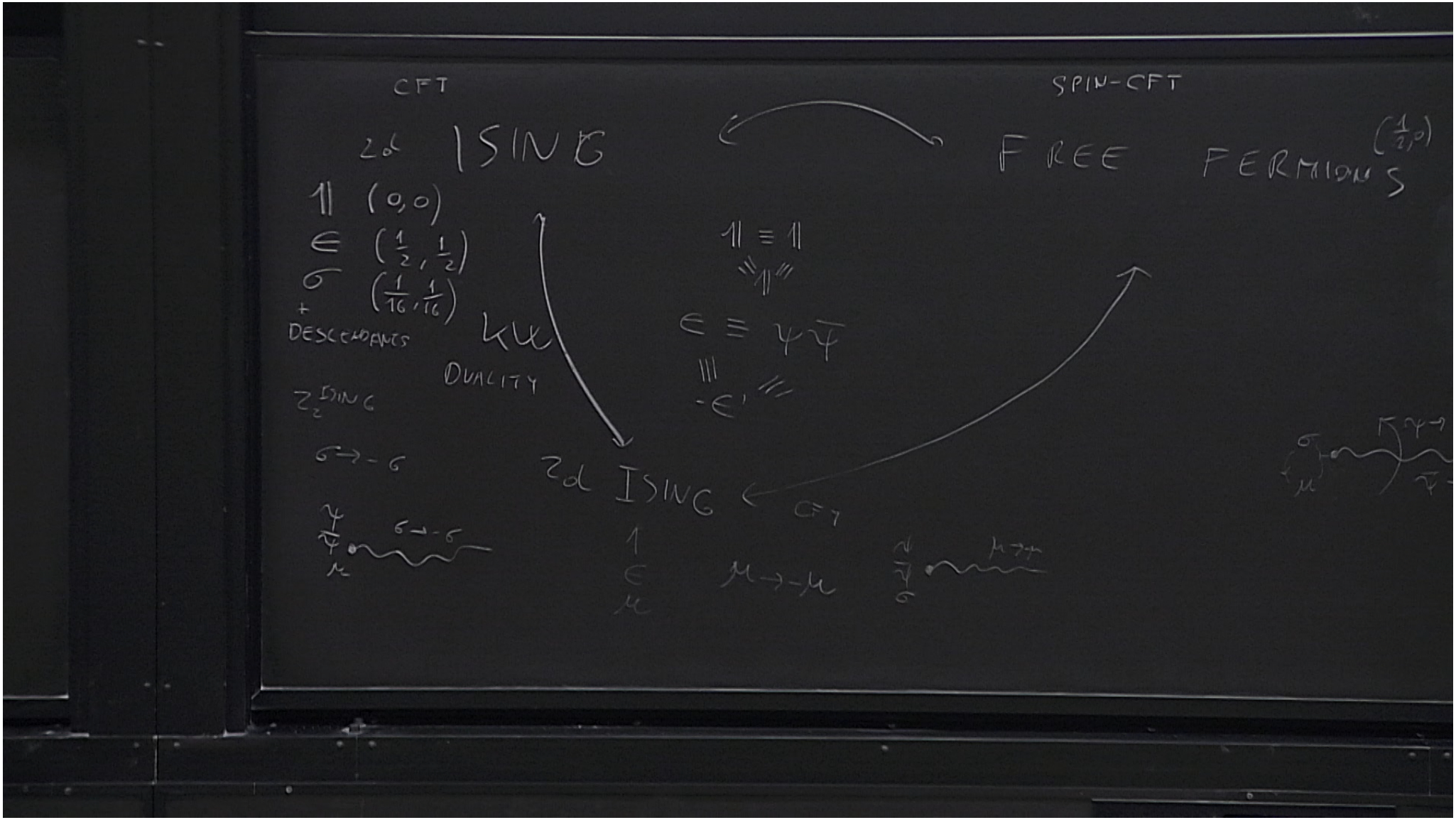

2d ISING
FREE FERMIONS
1
ε
σ
KW
DUALITY
2d ISING

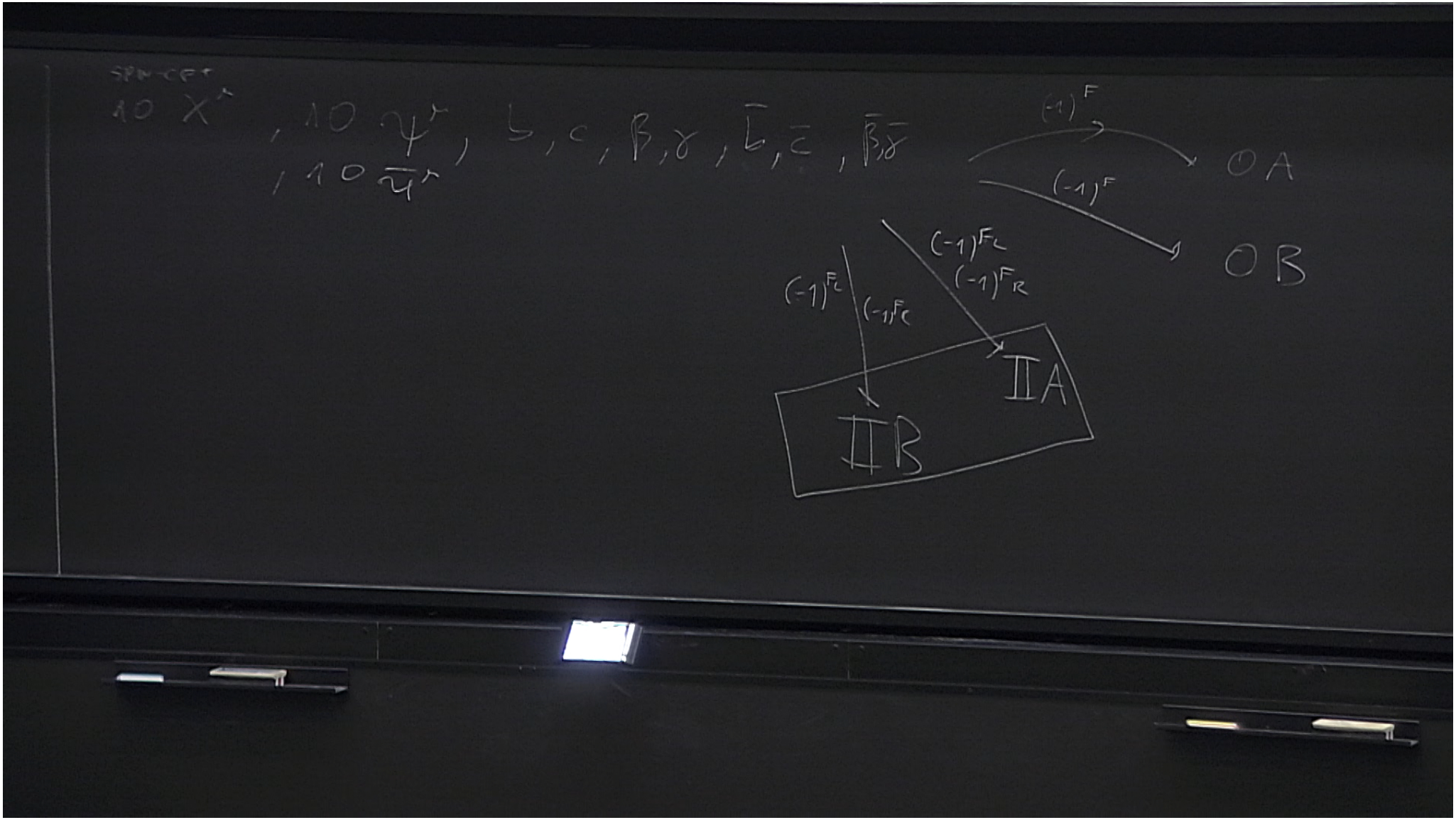


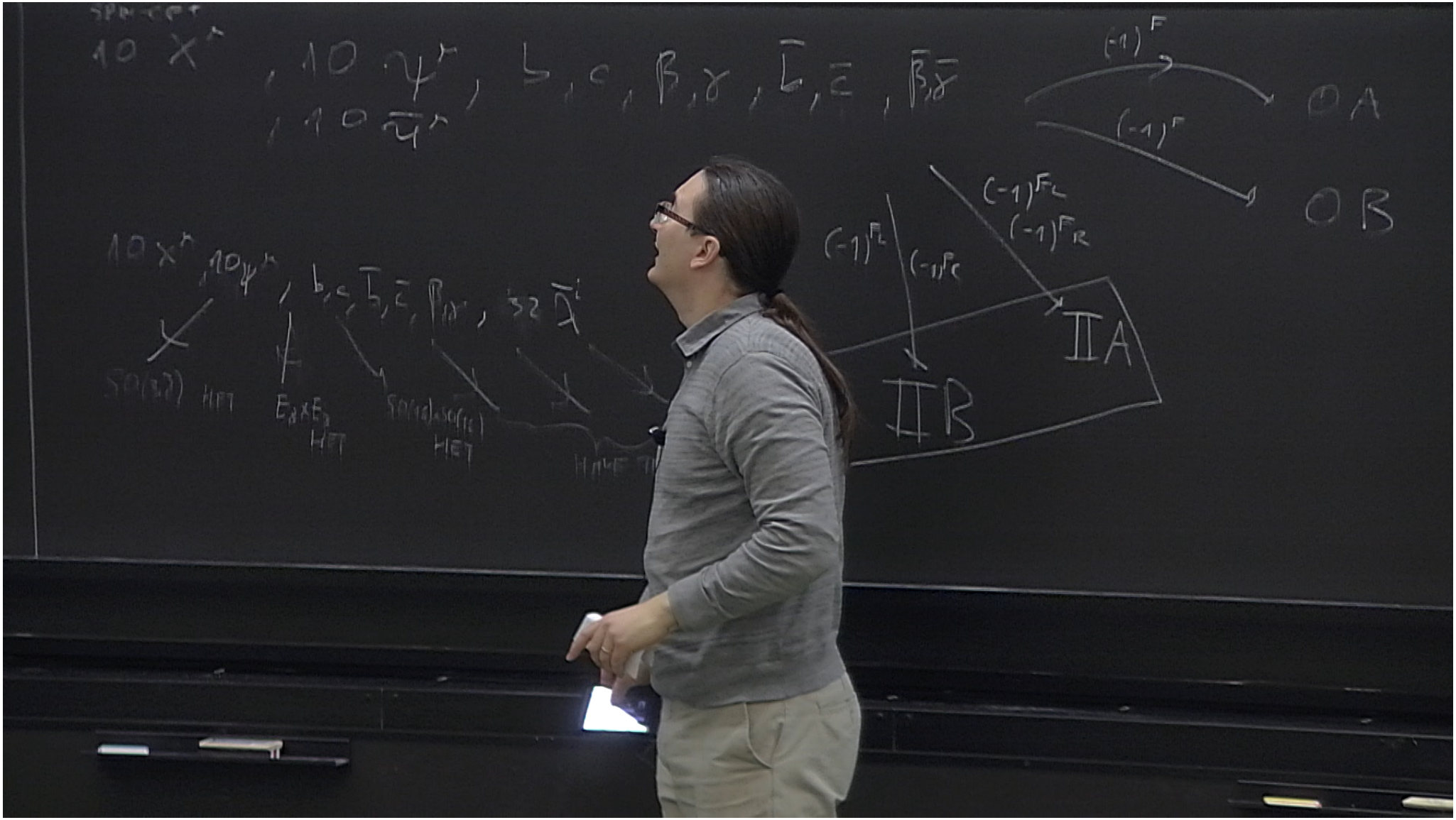

$O_p = (1, \epsilon, \text{DESC})$
$M_1^{\text{ISING}} = (\sigma, \text{DESC})$
$M_2^{\text{FER}} = (\psi, \bar{\psi}, \text{DESC})$
$M_3^{\text{ZSING}'} = (\sigma' = \mu, \text{DESC})$

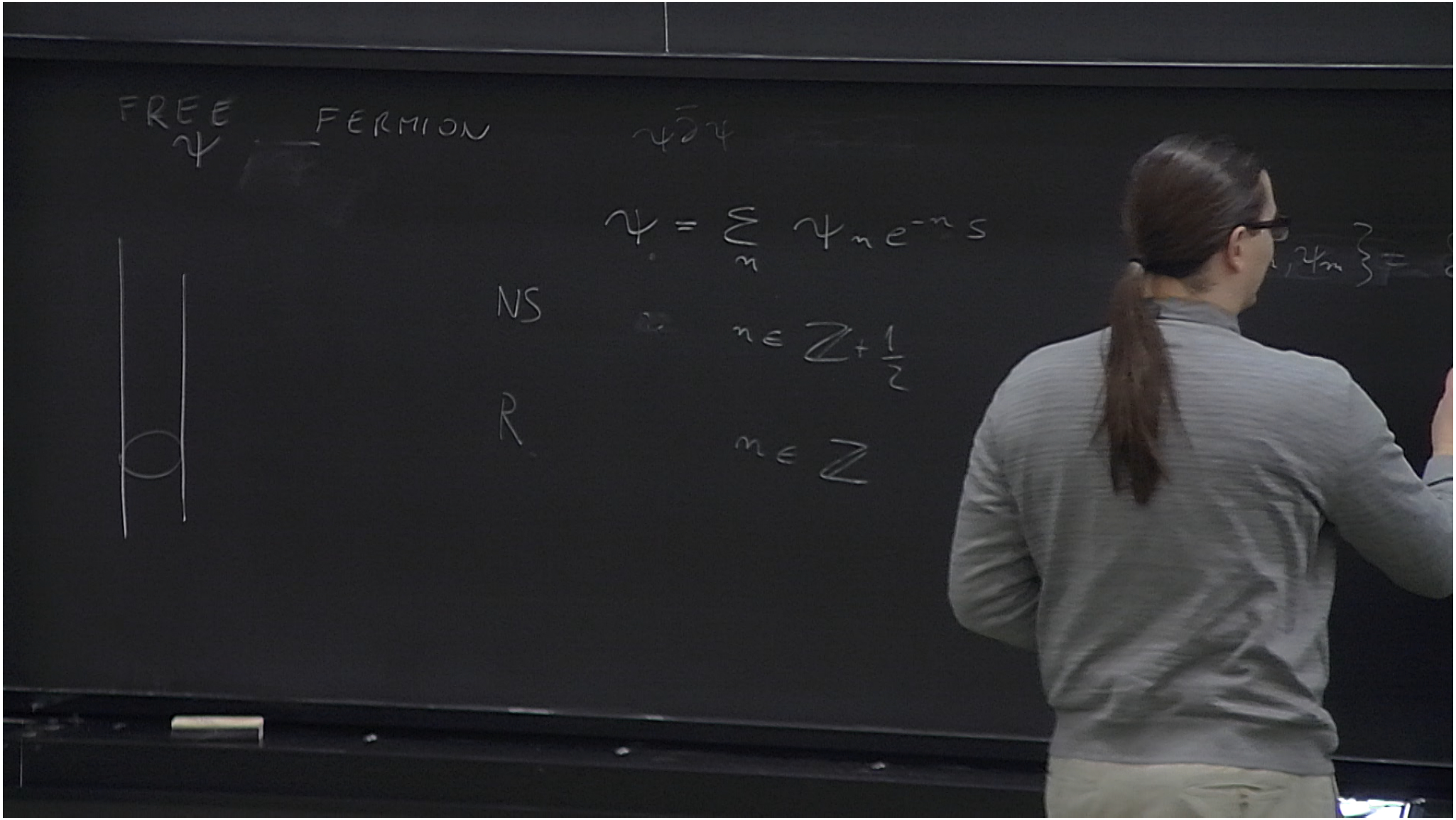

CFT
2d ISING
SPIN-CFT
FREE FERMIONS
DUALITY
2d ISING

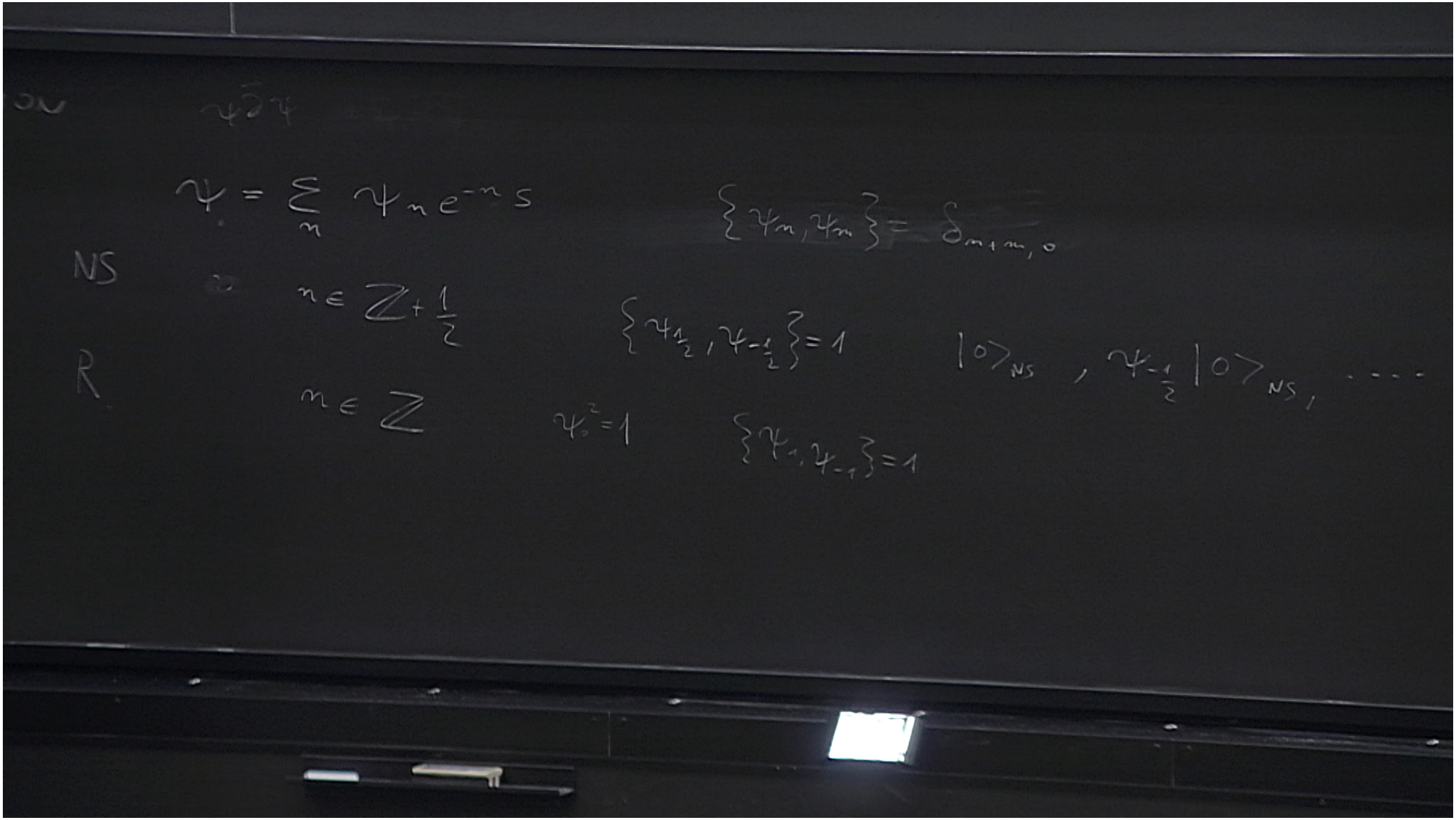

SPIN-CFT
1 (0,0)
$S = \psi \bar{\partial} \psi + \bar{\psi} \partial \bar{\psi}$
$(\frac{1}{2},0)$ ψ $\bar{\psi}$ $(0,\frac{1}{2})$
REE FERMIONS
$\psi\bar{\psi}$ $(\frac{1}{2},\frac{1}{2})$ ...
$(-1)^F$
$\psi \to -\psi$
$\bar{\psi} \to -\bar{\psi}$
$\psi \to -\psi$
$\bar{\psi} \to -\bar{\psi}$
μ


CFT
SPIN-CFT
2d ISING
FREE FERMIONS
$(\frac{1}{2},0)$
$\mathbb{1}$ $(0,0)$
ϵ $(\frac{1}{2},\frac{1}{2})$
σ $(\frac{1}{16},\frac{1}{16})$
+ DESCENDANTS
KW DUALITY
$\mathbb{1} \equiv \mathbb{1}$
$\epsilon \equiv \psi\bar{\psi}$
$-\epsilon'$
Z_2^{ISING}
$\sigma \to -\sigma$
2d ISING CFT
$\mu \to -\mu$


SPIN-CFT
10 X^μ, 10 ψ^μ, $b, c, \beta, \gamma, \bar{b}, \bar{c}, \bar{\beta}\bar{\gamma}$
10 $\tilde{\psi}^\mu$
$(-1)^F$
OA
$(-1)^F$
OB
$(-1)^{F_L}$
$(-1)^{F_R}$
$(-1)^{F_L}$
$(-1)^{F_L}$
IIA
IIB


$(-1)^F$
IIA
IIB
$(-1)^{F_L}$
$(-1)^{F_R}$


FREE FERMION
ψ
$\psi\bar{\psi}\psi$
$\psi = \sum_n \psi_n e^{-ns}$
NS
$n \in \mathbb{Z} + \frac{1}{2}$
R
$n \in \mathbb{Z}$


$\psi = \sum_n \psi_n e^{-ns}$
$\{\psi_m, \psi_m\} = \delta_{m+m,0}$
NS
$n \in \mathbb{Z} + \frac{1}{2}$
$\{\psi_{\frac{1}{2}}, \psi_{-\frac{1}{2}}\} = 1$
$|0\rangle_{NS}$, $\psi_{-\frac{1}{2}}|0\rangle_{NS}$, ...
R
$n \in \mathbb{Z}$
$\psi_0^2 = 1$
$\{\psi_1, \psi_{-1}\} = 1$

RIM-CFT

EE FERMIONS

$1\ (0,0)$

$(\frac{1}{2},0)\ \psi \quad \bar{\psi}\ (0,\frac{1}{2})$

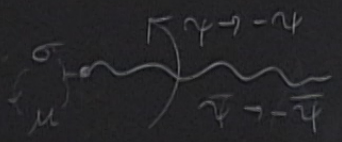
$\psi\bar{\psi}\ (\frac{1}{2},\frac{1}{2})$ ...

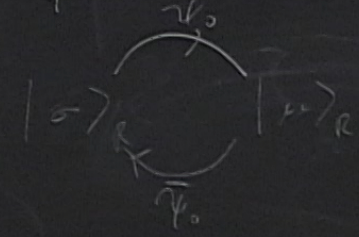
$S = \psi\partial\psi + \bar{\psi}\partial\bar{\psi}$

$(-1)^F$

$\psi \to -\psi$

$\bar{\psi} \to -\bar{\psi}$





$\psi_0^2 = 1$

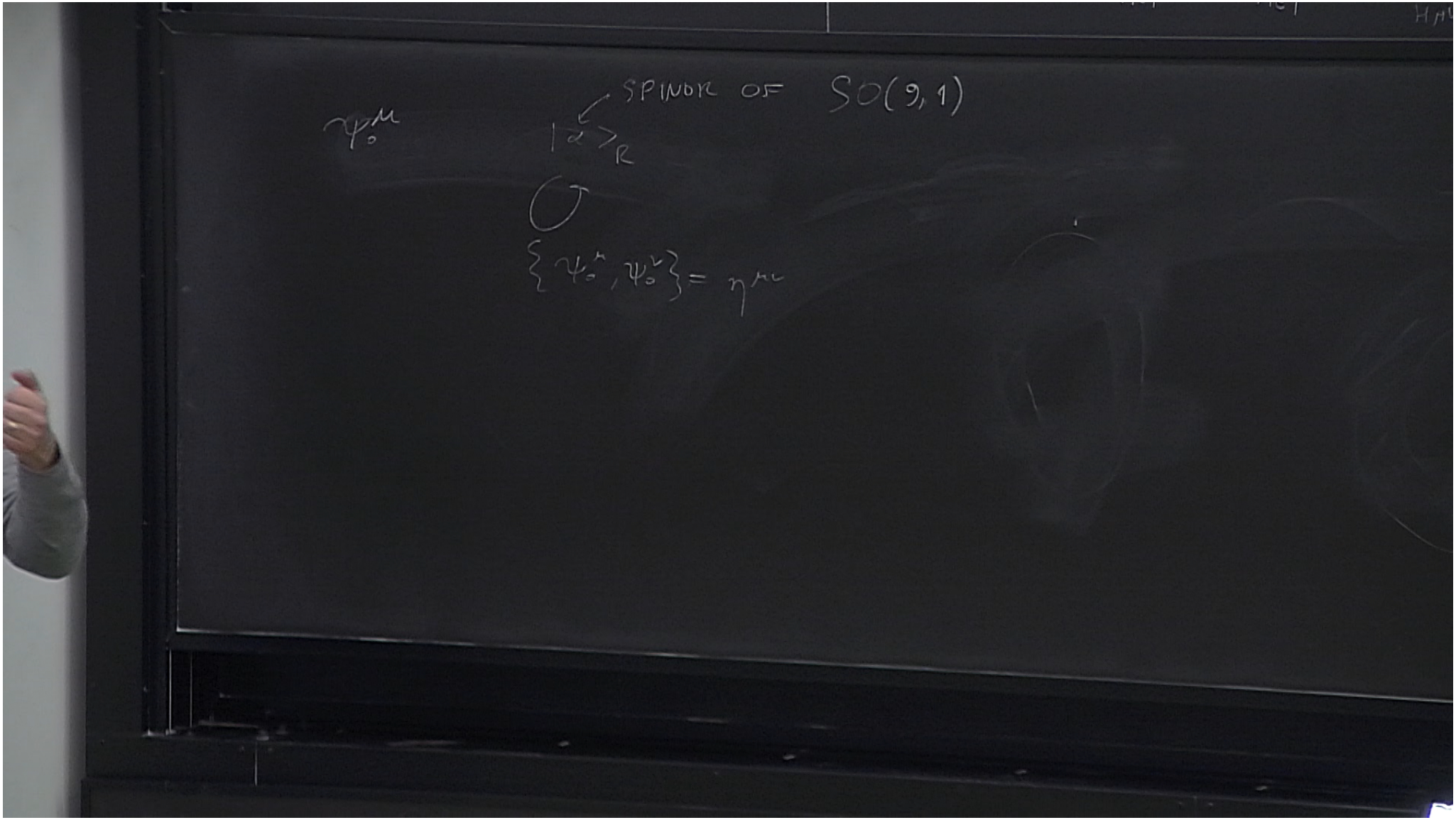
$\bar{\psi}_0^2 = 1$

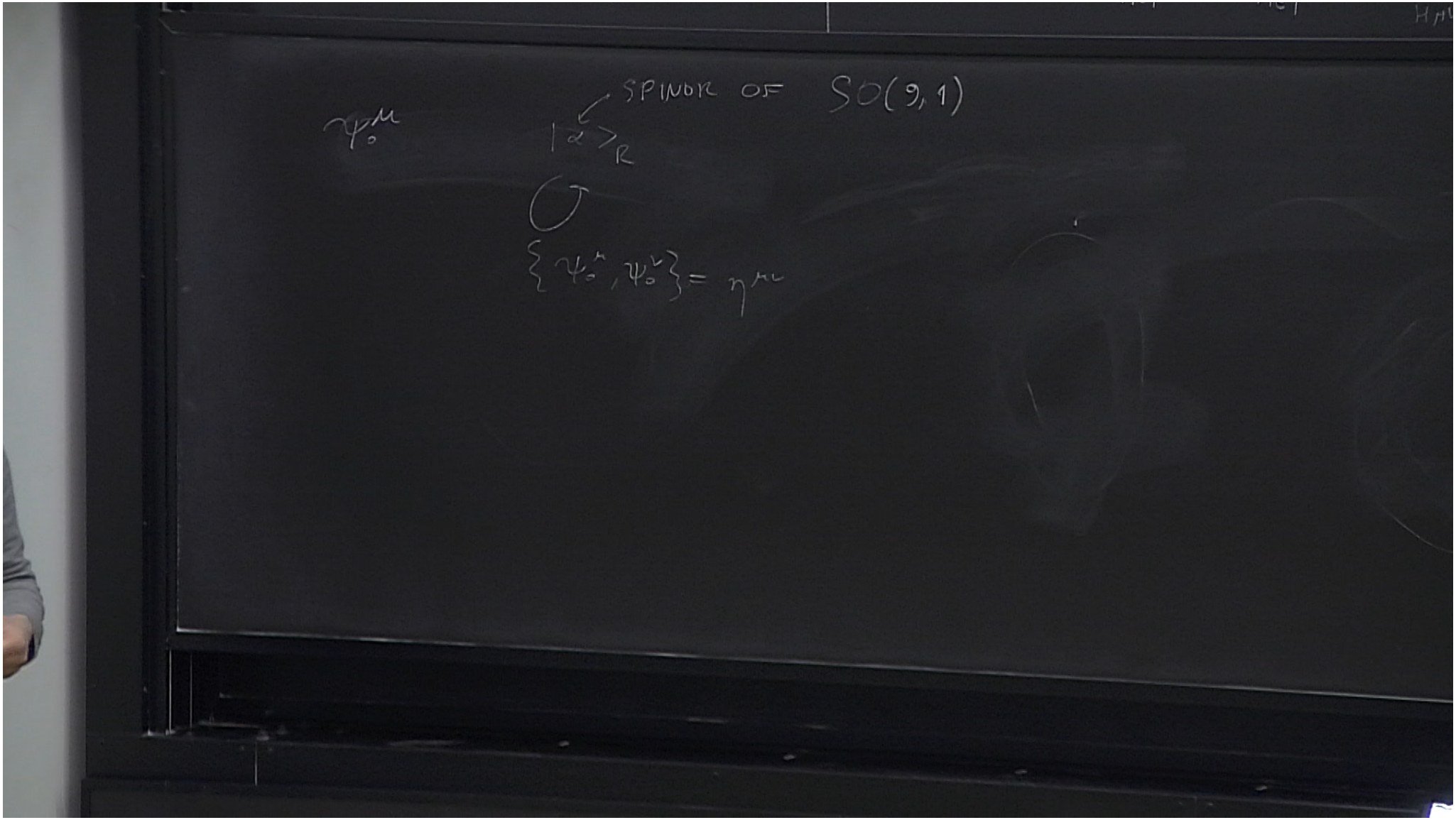
$\{\psi_0, \bar{\psi}_0\} = 0$

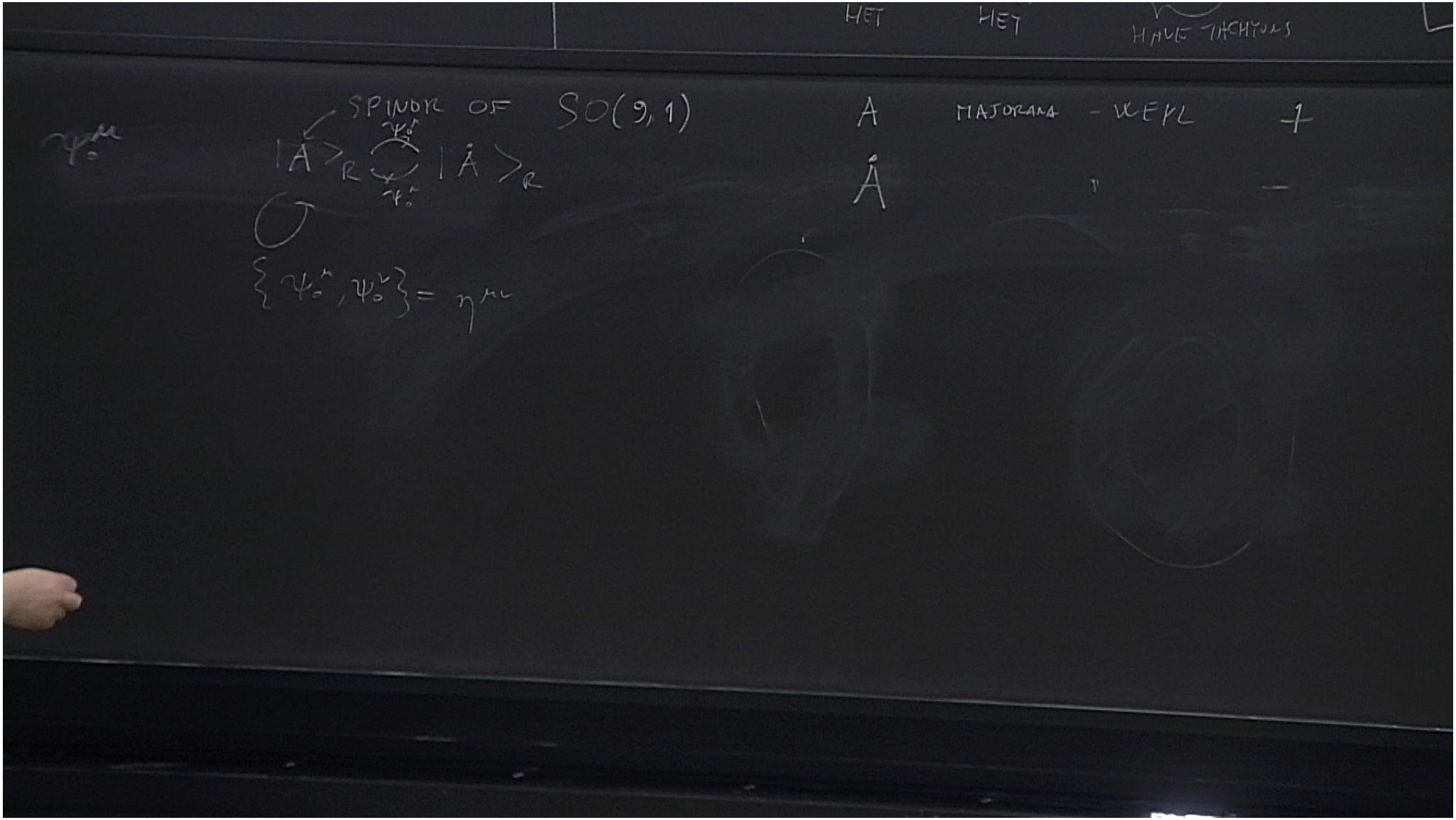
$(-1)^{F_L}$ $\psi \to$

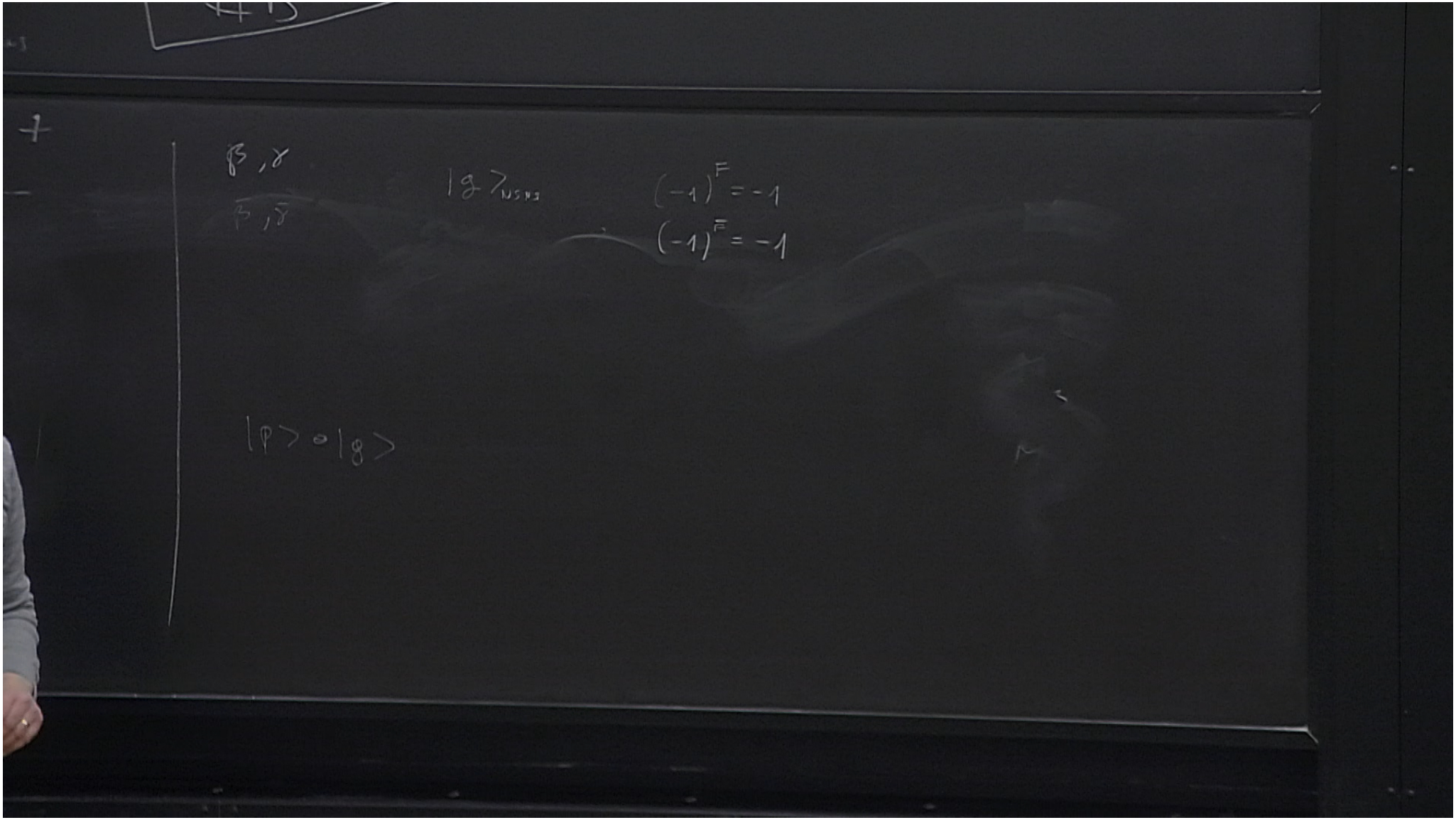
ANOMALOUS !

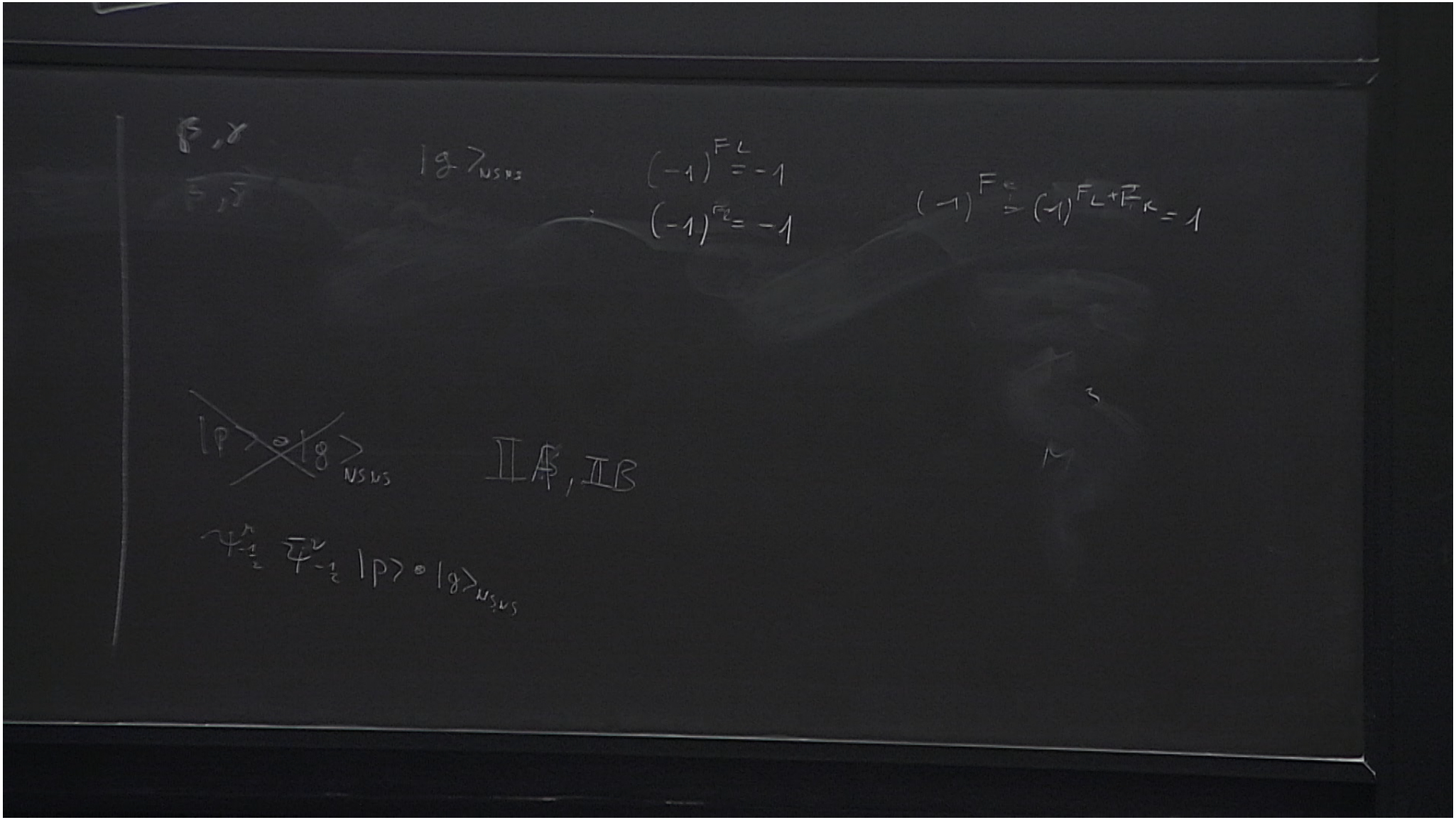
ANOMALY –

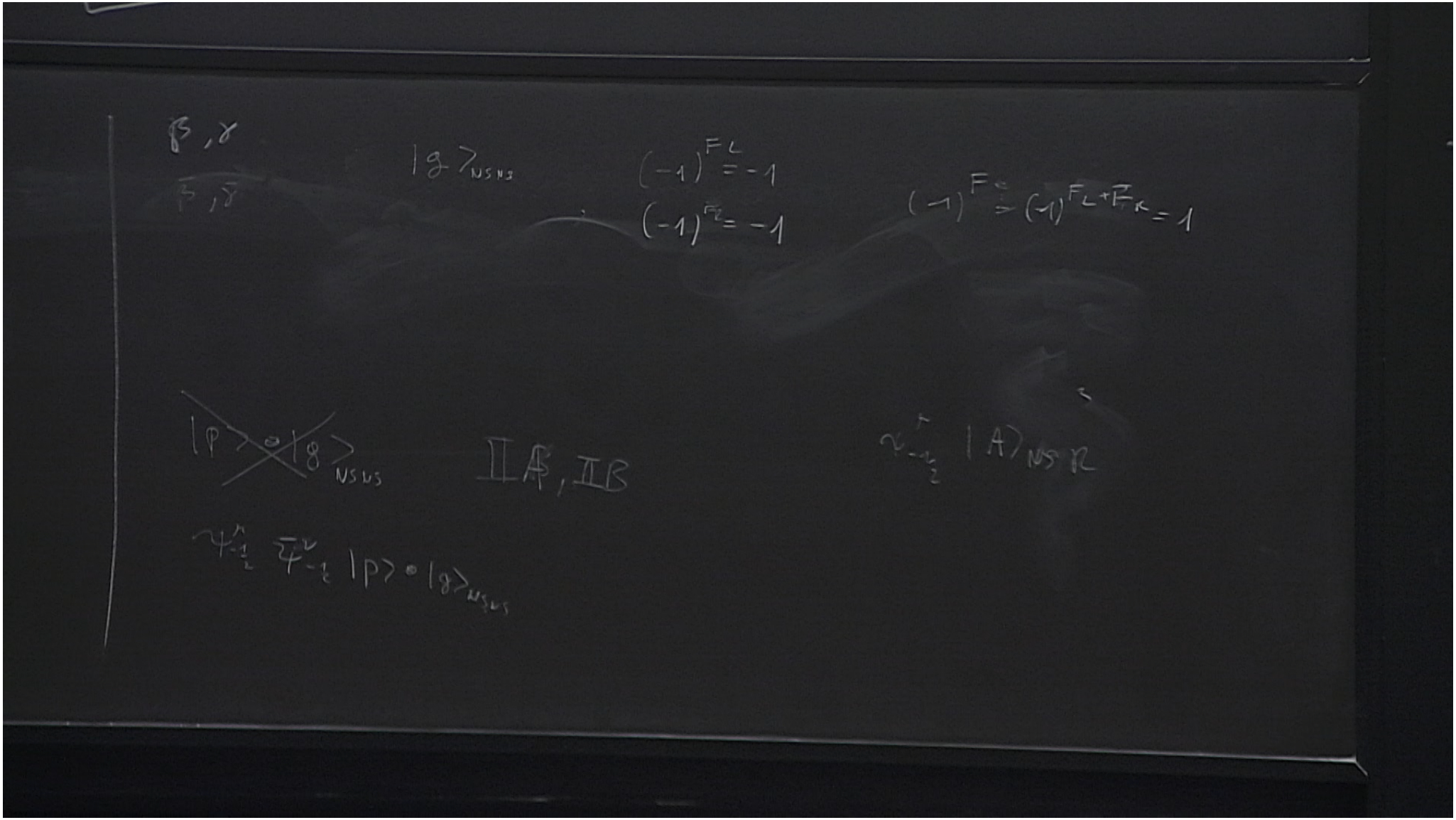

SPINOR OF SO(9,1)
ψ_0^μ
$|\alpha\rangle_R$
$\{\psi_0^\mu, \psi_0^\nu\} = \eta^{\mu\nu}$

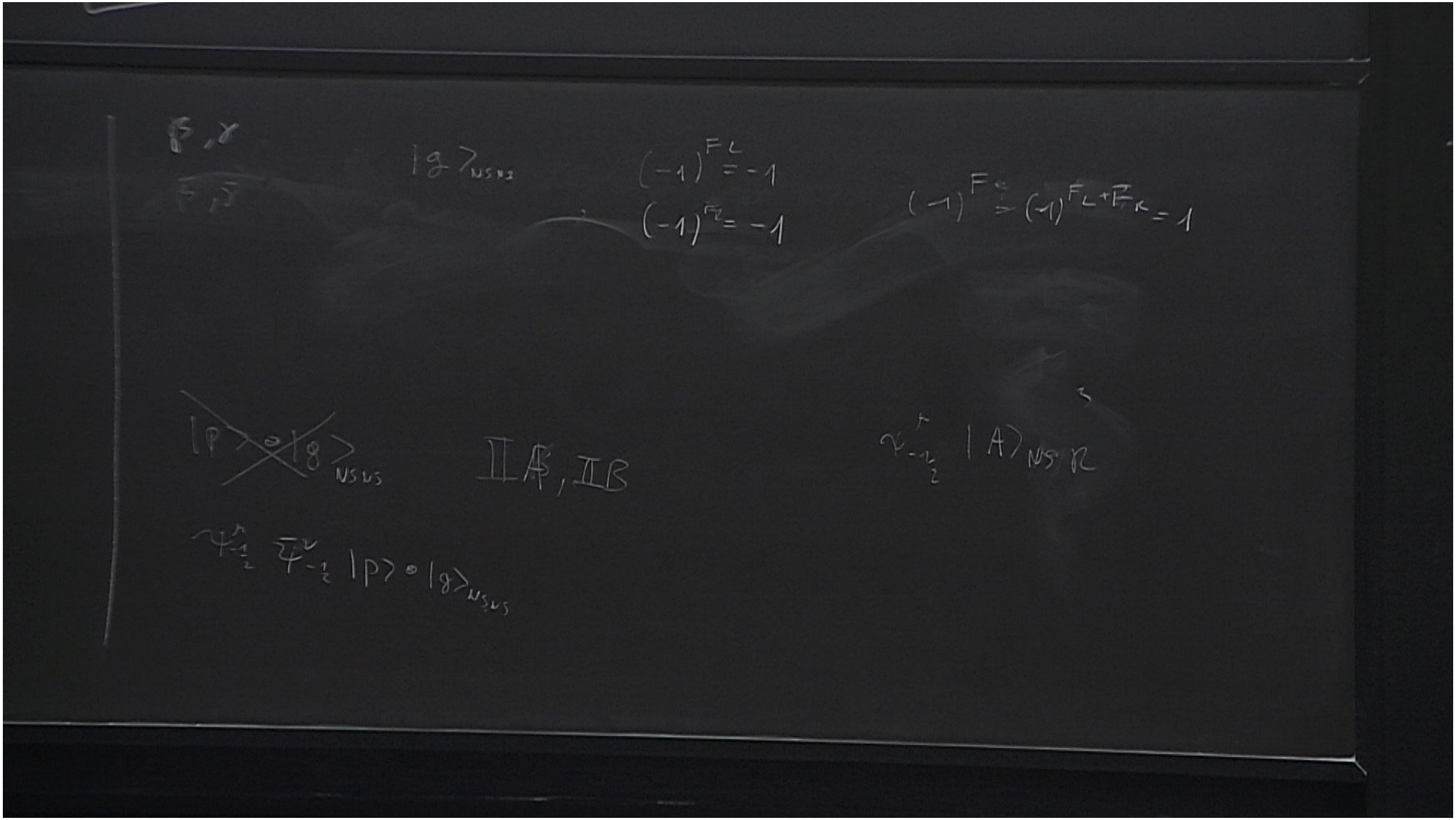

SPINOR OF SO(9,1)
ψ_0^μ
$|\alpha\rangle_R$
$\{\psi_0^\mu, \psi_0^\nu\} = \eta^{\mu\nu}$


HET
HET
HAVE TACHYONS
SPINOR OF SO(9,1)
A
MAJORANA - WEYL
+
Å
-
ψ_0^μ
$|\Lambda\rangle_R$
$|\dot{\Lambda}\rangle_R$
$\{\psi_0^\mu, \psi_0^\nu\} = \eta^{\mu\nu}$


β, γ
β̄, δ̄
$|g\rangle_{NS\,NS}$
$(-1)^F = -1$
$(-1)^{\bar{F}} = -1$
$|p\rangle \otimes |g\rangle$


β, γ
$|q\rangle_{NSNS}$
$(-1)^{F_L} = -1$
$(-1)^{F_R} = -1$
$(-1)^{F} = (-1)^{F_L + F_R} = 1$
$|p\rangle \otimes |q\rangle_{NSNS}$
IIA, IIB
$\psi^{\mu}_{-\frac{1}{2}} \tilde{\psi}^{\nu}_{-\frac{1}{2}} |p\rangle \otimes |q\rangle_{NSNS}$


β, γ
$|g\rangle_{NSNS}$
$(-1)^{F_L} = -1$
$(-1)^{F_R} = -1$
$(-1)^{F} = (-1)^{F_L + F_R} = 1$
$|p\rangle \otimes |g\rangle_{NSNS}$
IIA, IIB
$\psi_{-\frac{1}{2}} |A\rangle_{NSR}$
$\psi_{-\frac{1}{2}} \bar{\psi}_{-\frac{1}{2}} |p\rangle \otimes |g\rangle_{NSNS}$


ψ, χ
ϕ, ζ
|g⟩NSNS
(−1)^FL = −1
(−1)^FR = −1
(−1)^F = (−1)^FL+FR = 1
|p⟩ ⊗ |g⟩NSNS
IIA, IIB
ψ^μ_−1/2 |A⟩NS R
ψ^μ_−1/2 ψ̃^ν_−1/2 |p⟩ ⊗ |g⟩NSNS