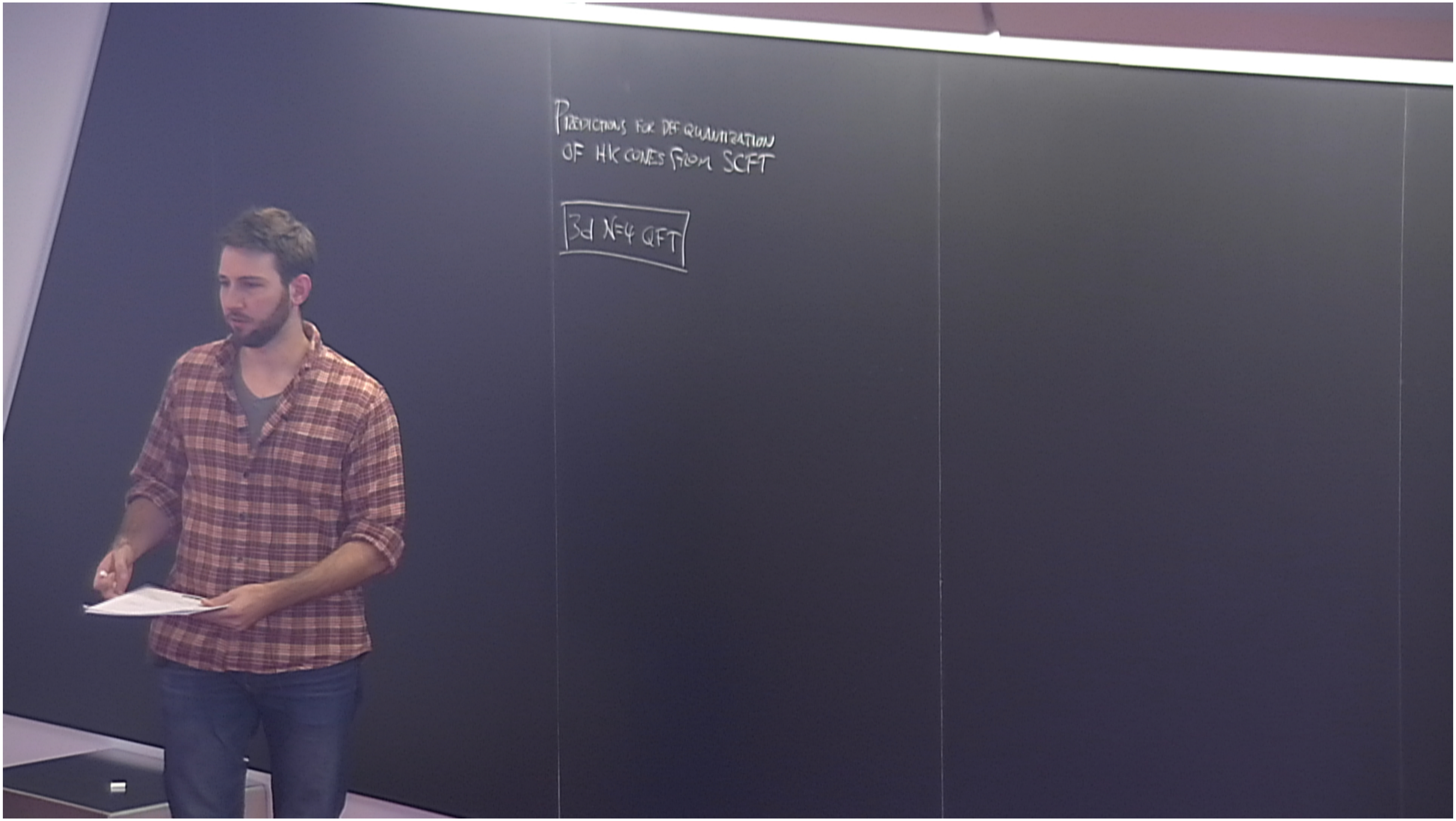
Title: Half-BPS boundary conditions in 3d N=4 theories

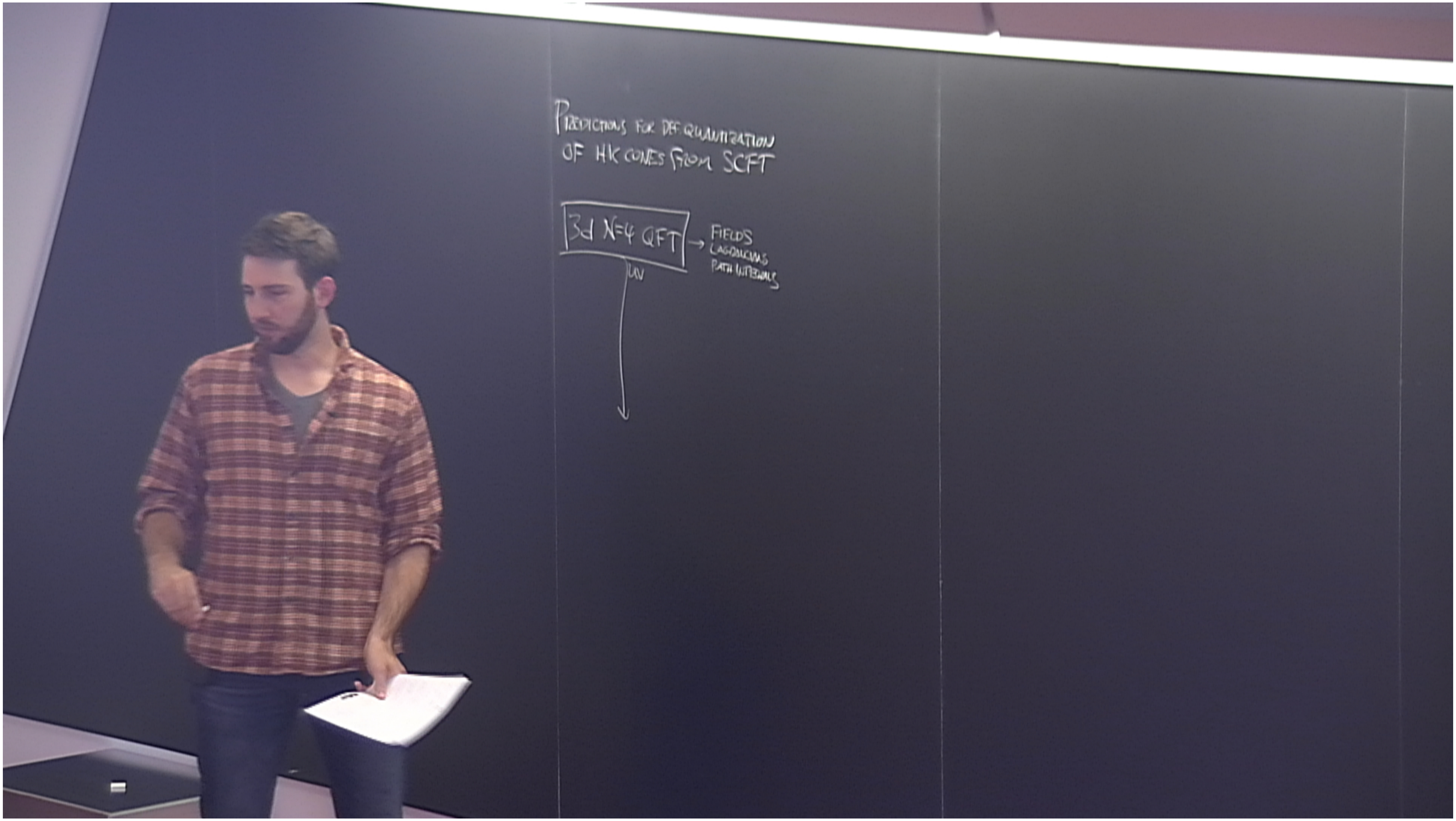
Date: Oct 08, 2015 01:30 PM

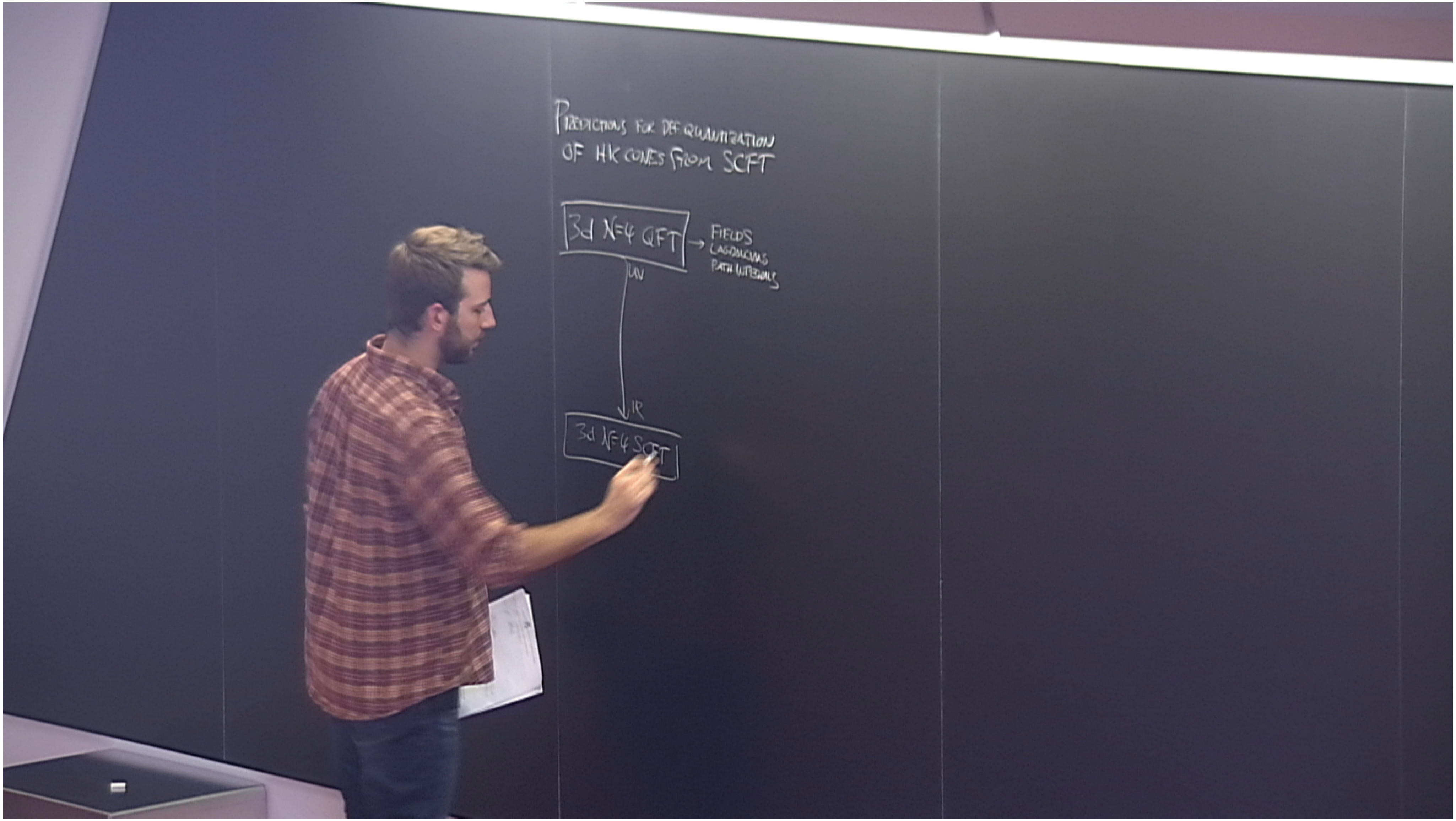
URL: http://pirsa.org/15100071

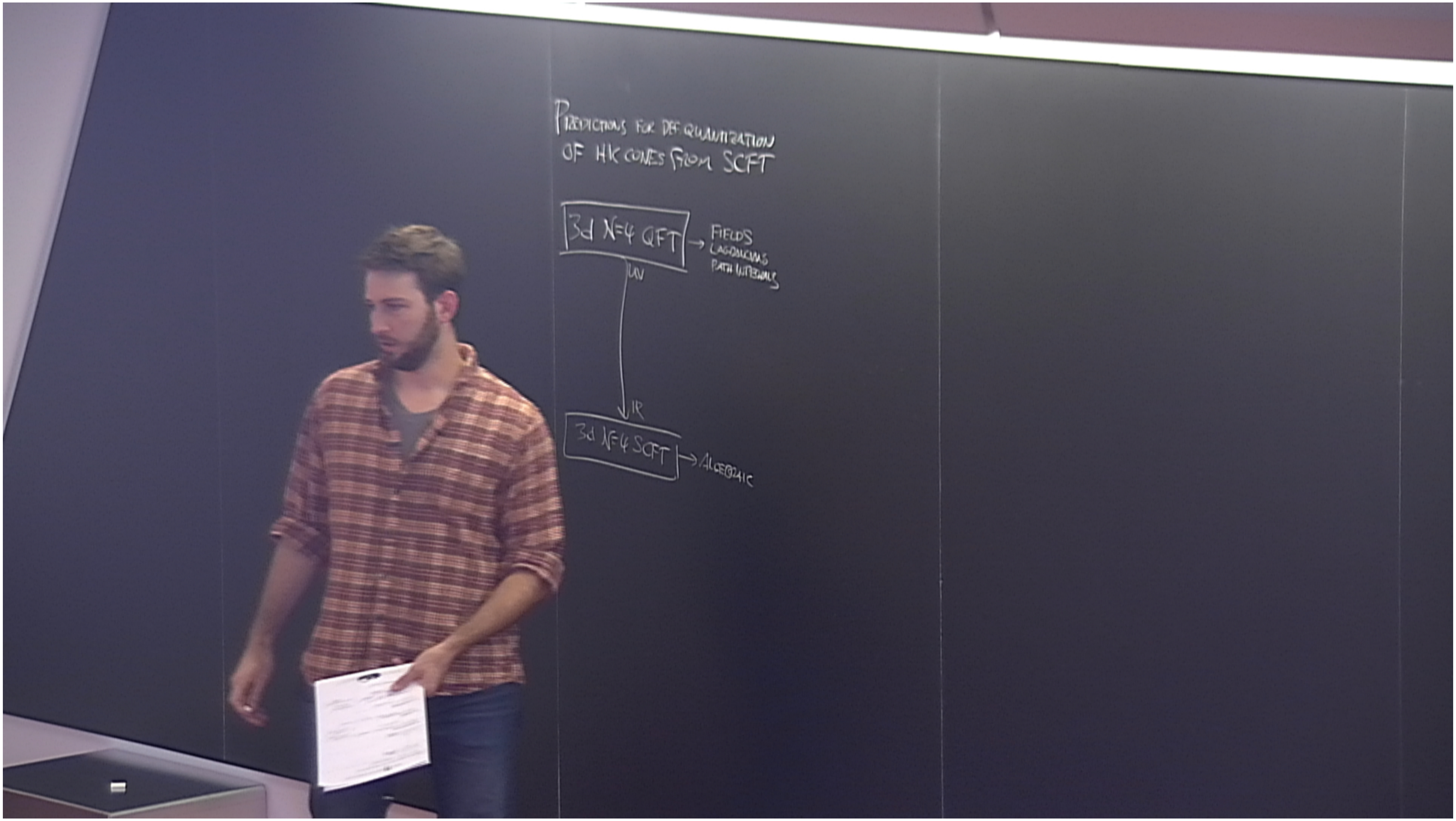
Abstract:

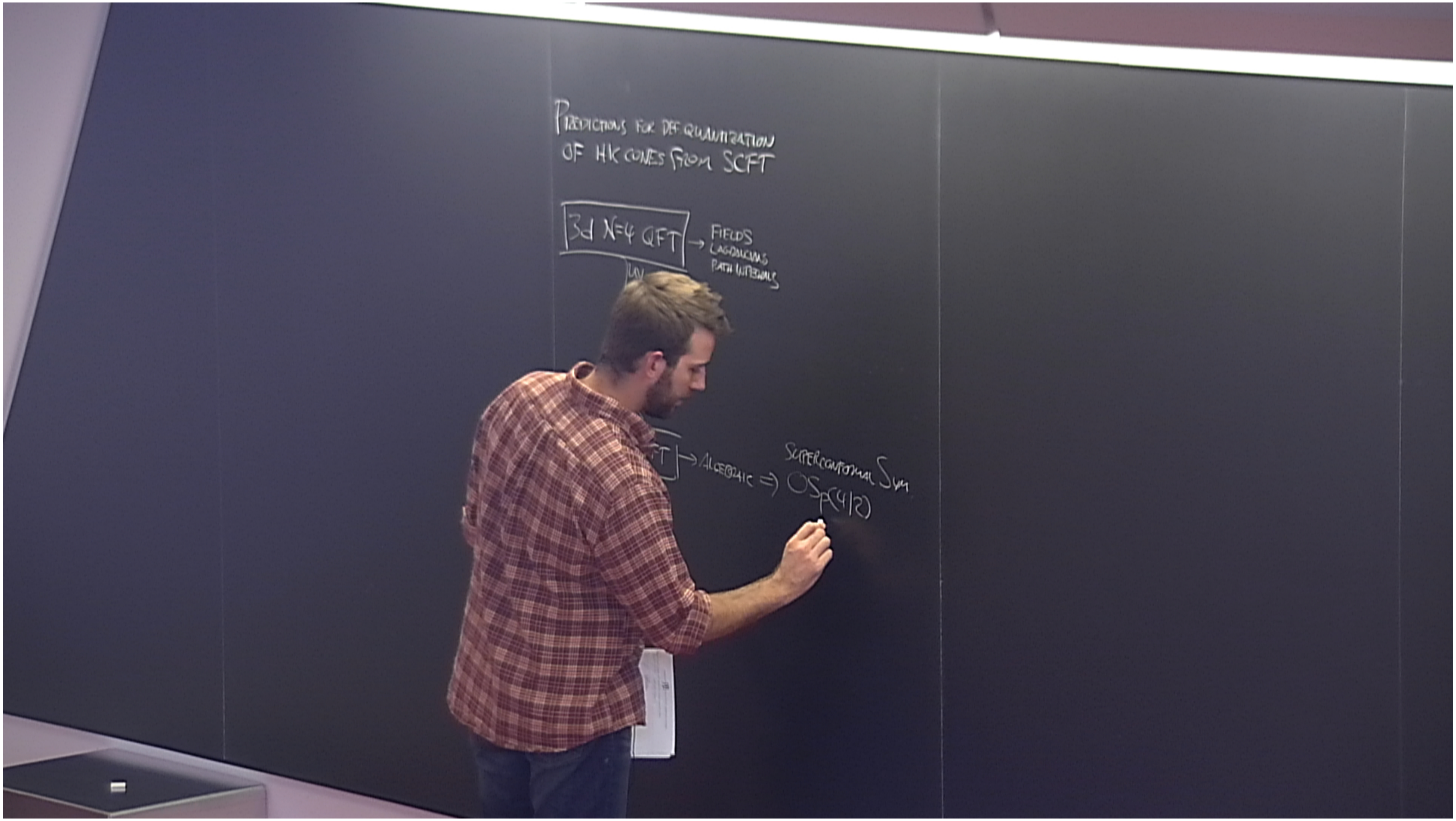

PREDICTIONS FOR DEF QUANTIZATION
OF HK CONES FROM SCFT

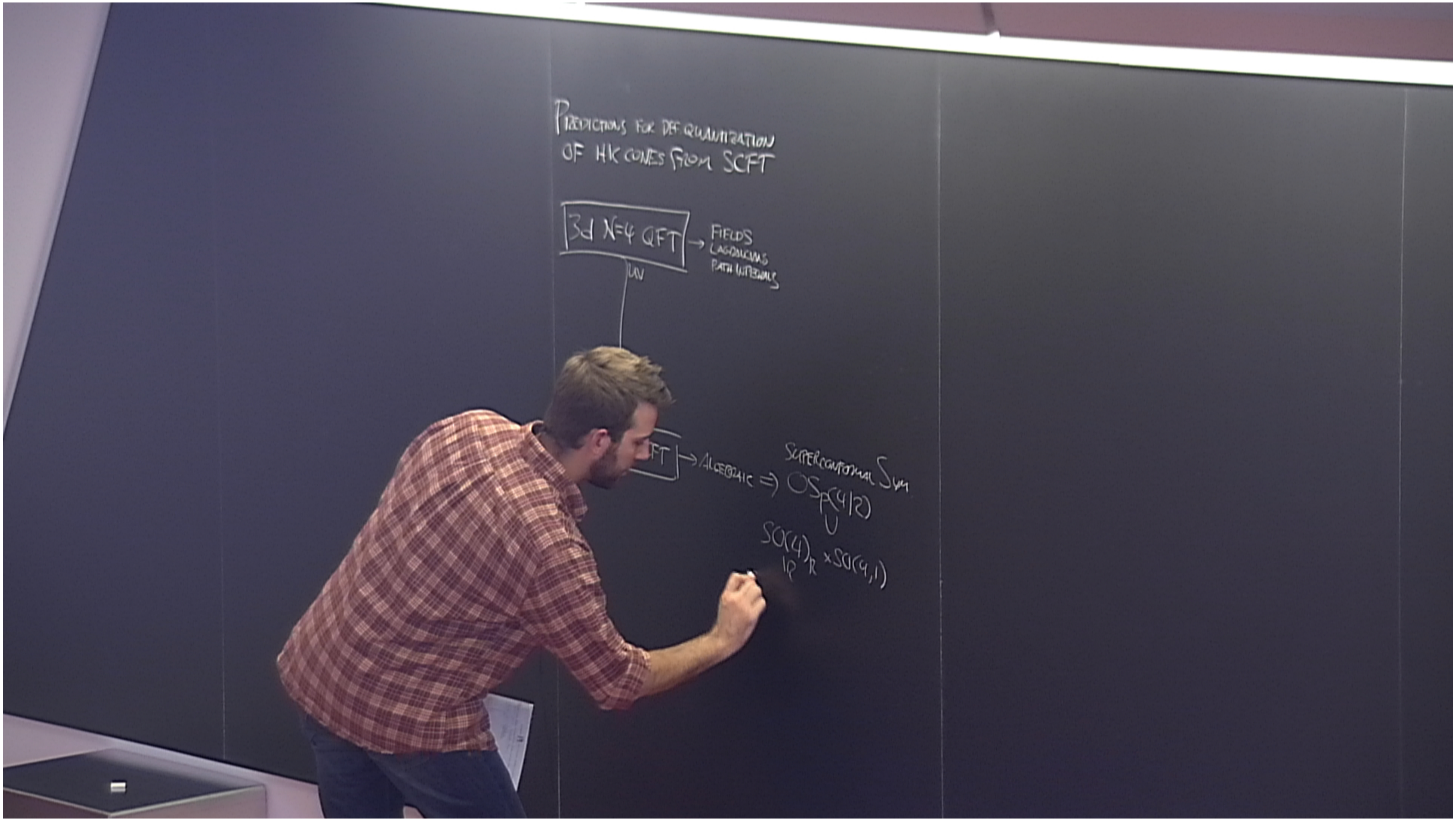

PREDICTIONS FOR DEF QUANTIZATION
OF HK CONES FROM SCFT
3d N=4 QFT


PREDICTIONS FOR DEF. QUANTIZATION
OF HK CONES FROM SCFT
3d N=4 QFT
FIELDS
LAGRANGIANS
PATH INTEGRALS
UV


PREDICTIONS FOR DEF QUANTIZATION
OF HK CONES FROM SCFT
3d N=4 QFT
FIELDS
LAGRANGIANS
PATH INTEGRALS
UV
IR
3d N=4 SCFT


PREDICTIONS FOR DEF QUANTIZATION
OF HK CONES FROM SCFT
3d N=4 QFT
FIELDS
LAGRANGIANS
PATH INTEGRALS
UV
IR
3d N=4 SCFT
ALGEBRAIC


PREDICTIONS FOR DEF QUANTIZATION
OF HK CONES FROM SCFT
3d N=4 QFT
FIELDS
LAGRANGIANS
PATH INTEGRALS
UV
ALGEBRAIC ⇒ OSp(4|2)
SUPERCONFORMAL SYM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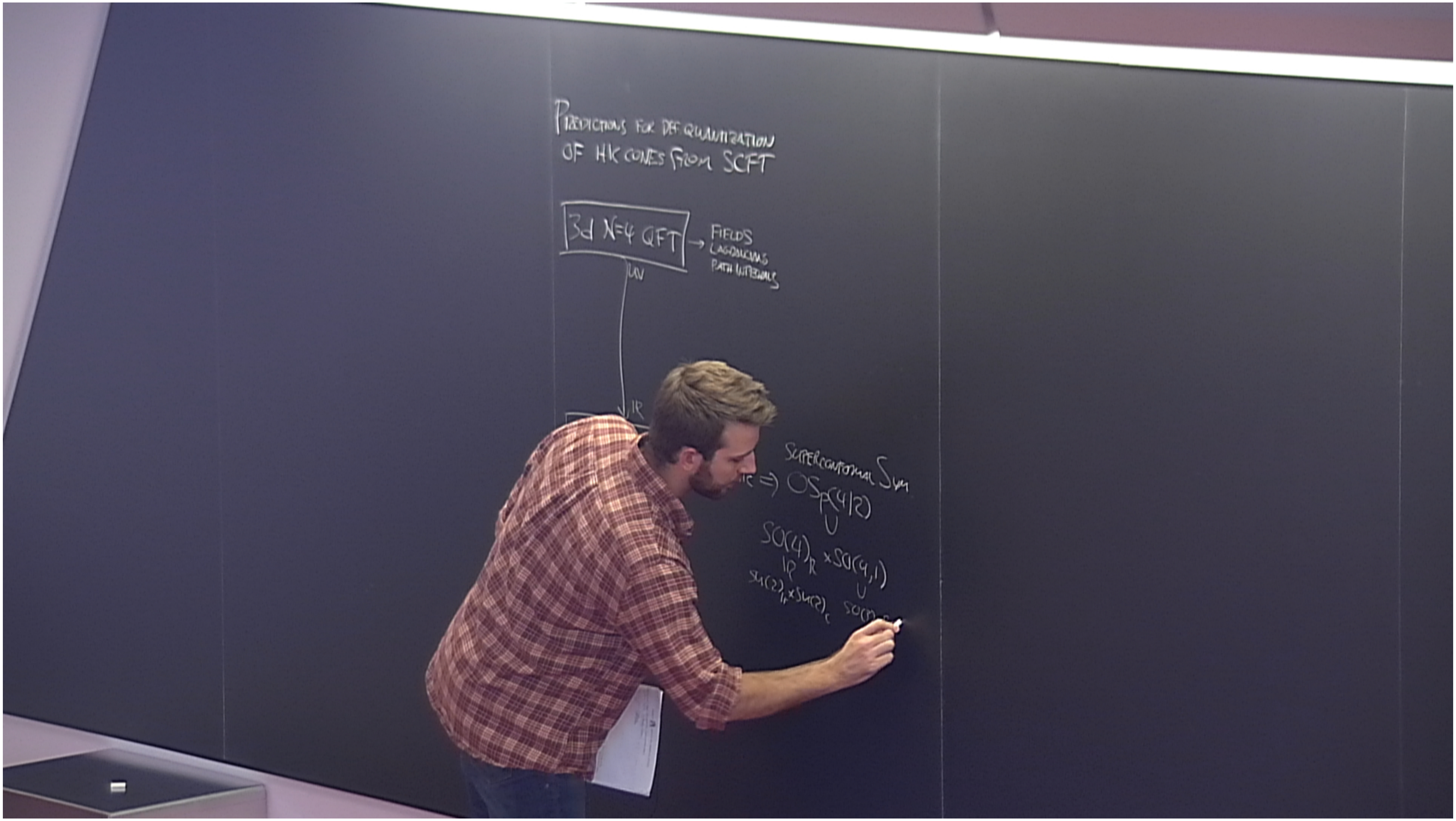
OF HK CONES FROM SCFT
3d N=4 QFT
FIELDS
LAGRANGIANS
PATH INTEGRALS
UV
FT
ALGEBRAIC
SUPERCONFORMAL SYM
OSp(4|2)
SO(4)_R × SO(4,1)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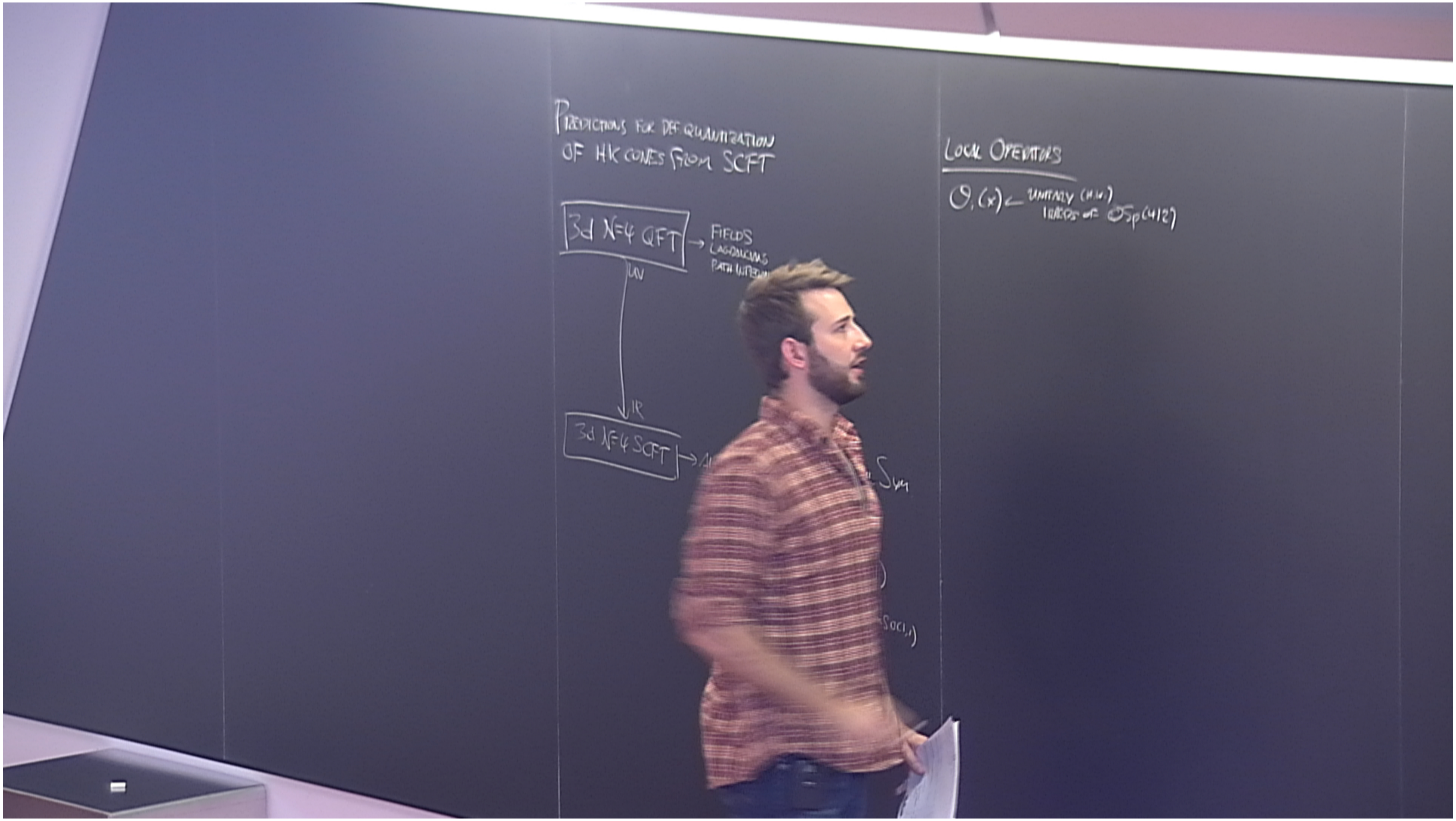
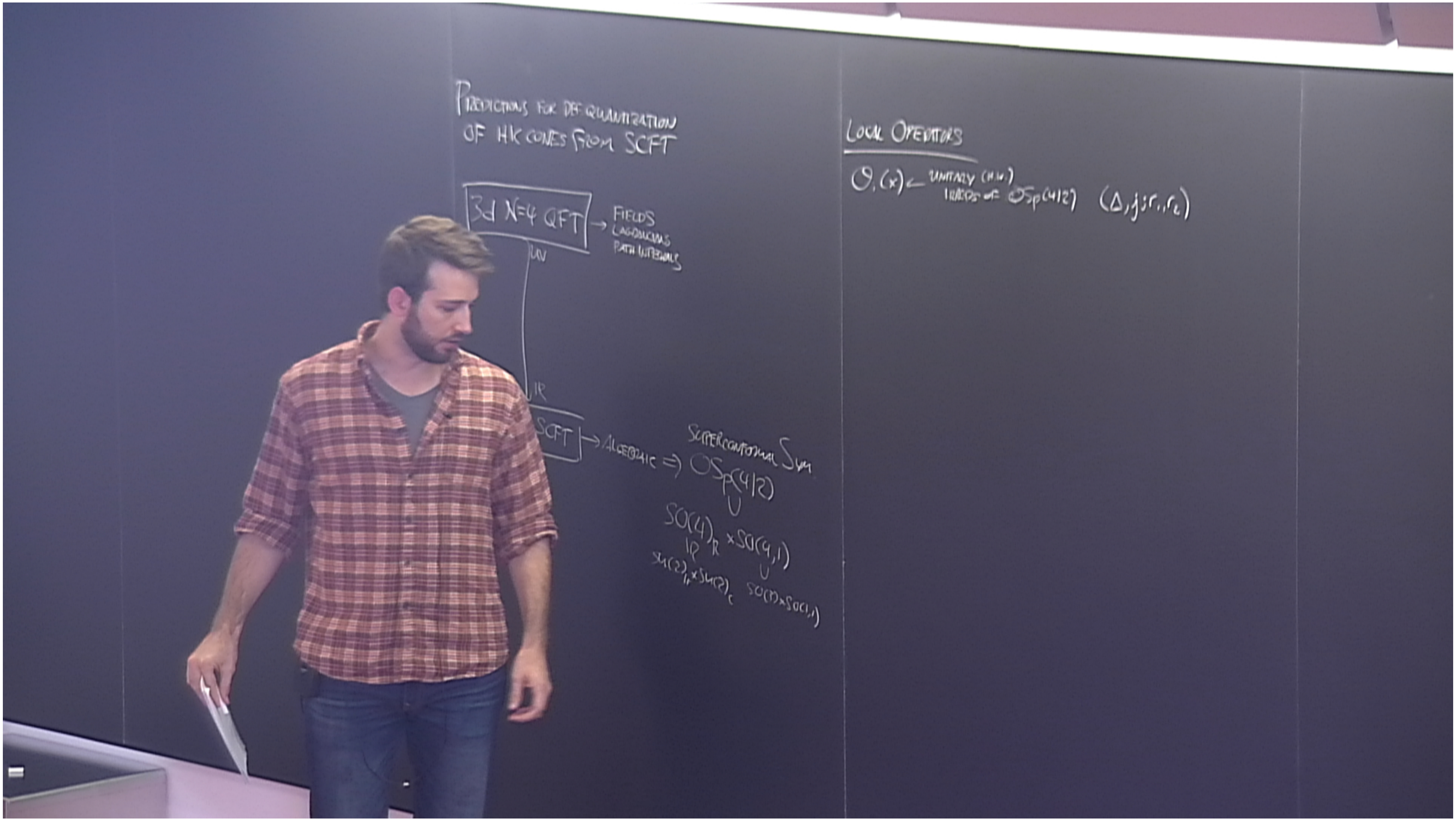
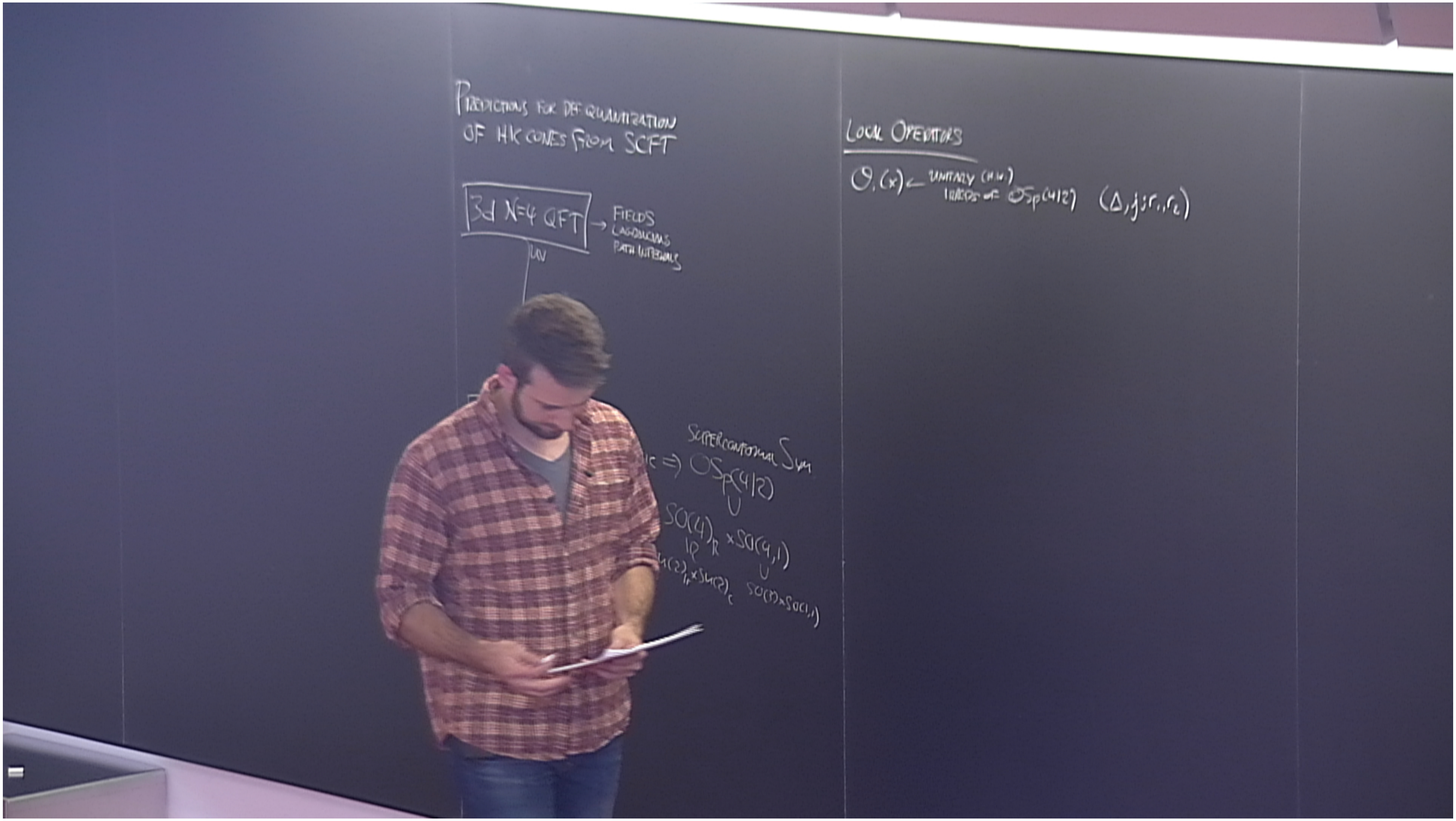
OF HK CONES FROM SCFT
3d N=4 QFT
FIELDS
LAGRANGIANS
PATH INTEGRALS
UV
IR
SUPERCONFORMAL SYM
OSp(4|2)
SO(4)R × SO(4,1)
SU(2)H × SU(2)C


PREDICTIONS FOR DEF QUANTIZATION
OF HK CONES FROM SCFT
3d N=4 QFT
FIELDS
LAGRANGIANS
UV
IR
3d N=4 SCFT
LOCAL OPERATORS
O(x)
UNITARY (H.W.)
IRREPS OF OSp(4|2)


PREDICTIONS FOR DEF QUANTIZATION
OF HK CONES FROM SCFT
3d N=4 QFT → FIELDS
LAGRANGIANS
PATH INTEGRALS
UV
IR
SCFT → ALGEBRAIC ⇒ OSp(4|2)
SUPERCONFORMAL SYM
SO(4)_R × SO(4,1)
SU(2)_H × SU(2)_C
SO(3) × SO(1,1)
LOCAL OPERATORS
O_i(x) ← UNITARY (H.W.) IRREPS OF OSp(4|2)
(Δ, j; r_1, r_2)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3d N=4 QFT
FIELDS
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SUPERCONFORMAL SYM
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SO(4)R × SO(4,1)
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UNITARY (H.W.)
IRREPS OF OSp(4|2)
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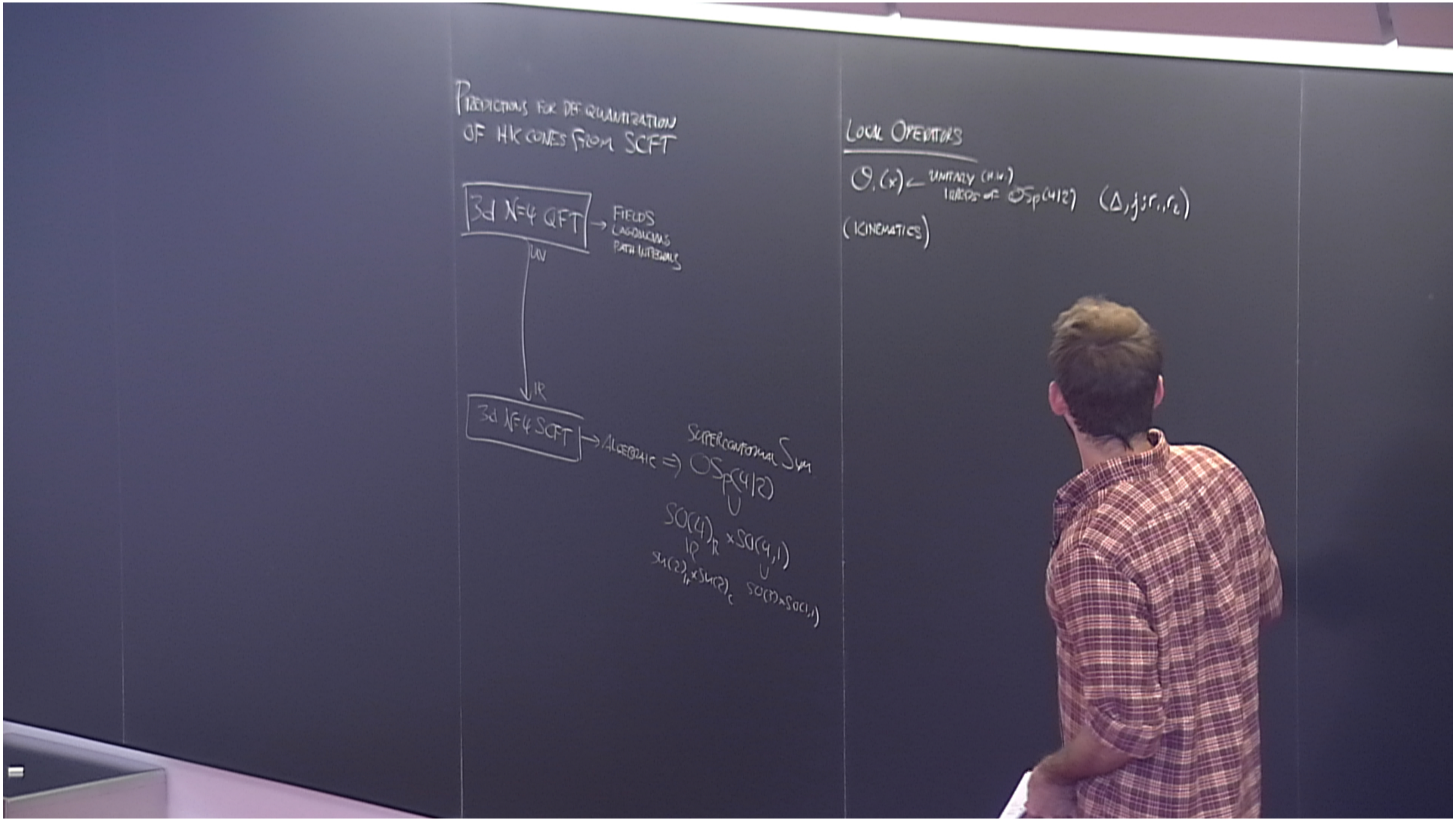
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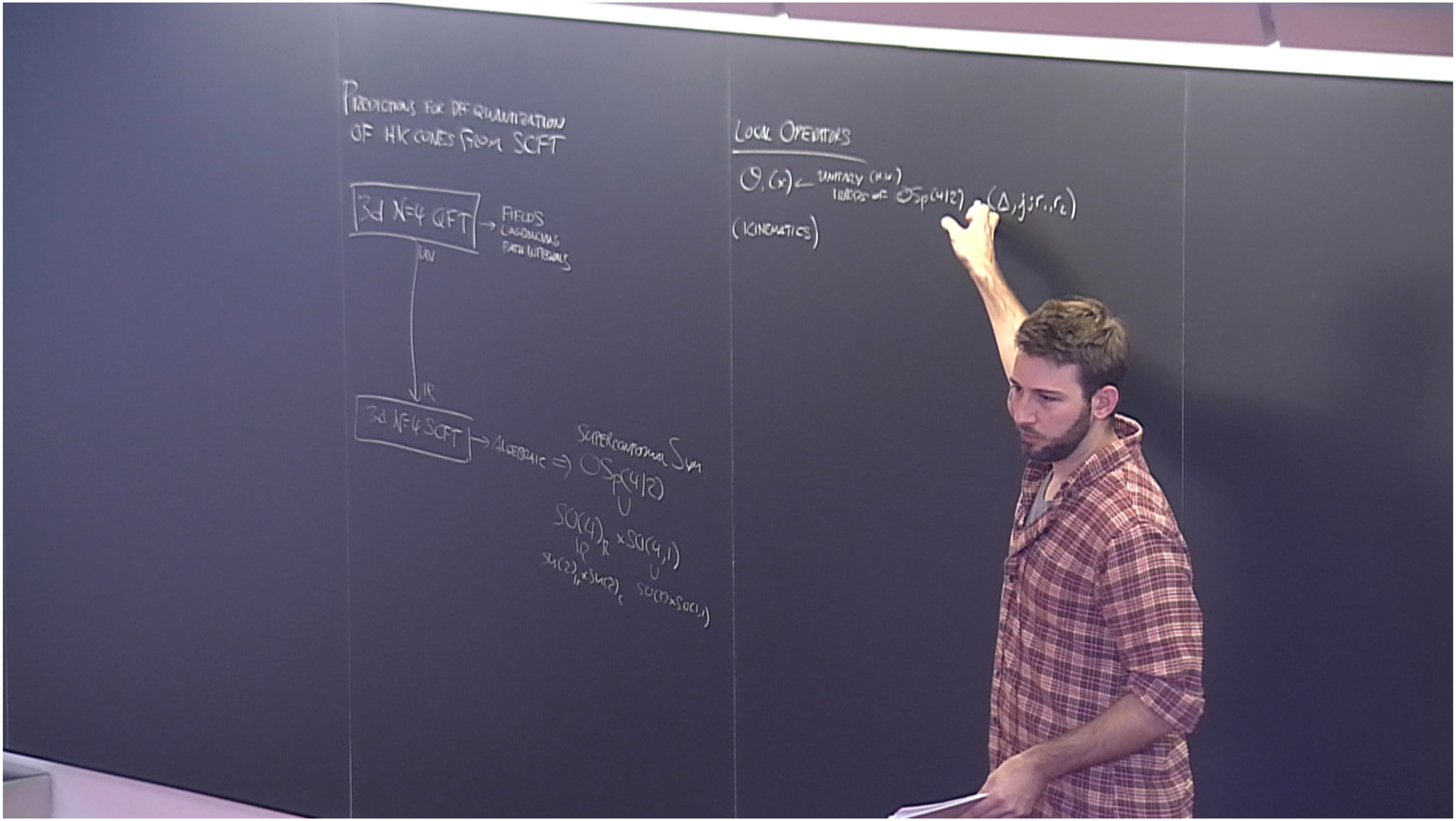
LOCAL OPERATORS
O(x)
UNITARY (H.W.)
IRREPS OF OSp(4|2)
(Δ, j; r1, r2)
(KINEMATICS)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OF HK CONES FROM SCFT
3d N=4 QFT
FIELDS
LAGRANGIANS
PATH INTEGRALS
UV
IR
3d N=4 SCFT
ALGEBRAIC ⇒ OSp(4|2)
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SO(4)_R × SO(4,1)
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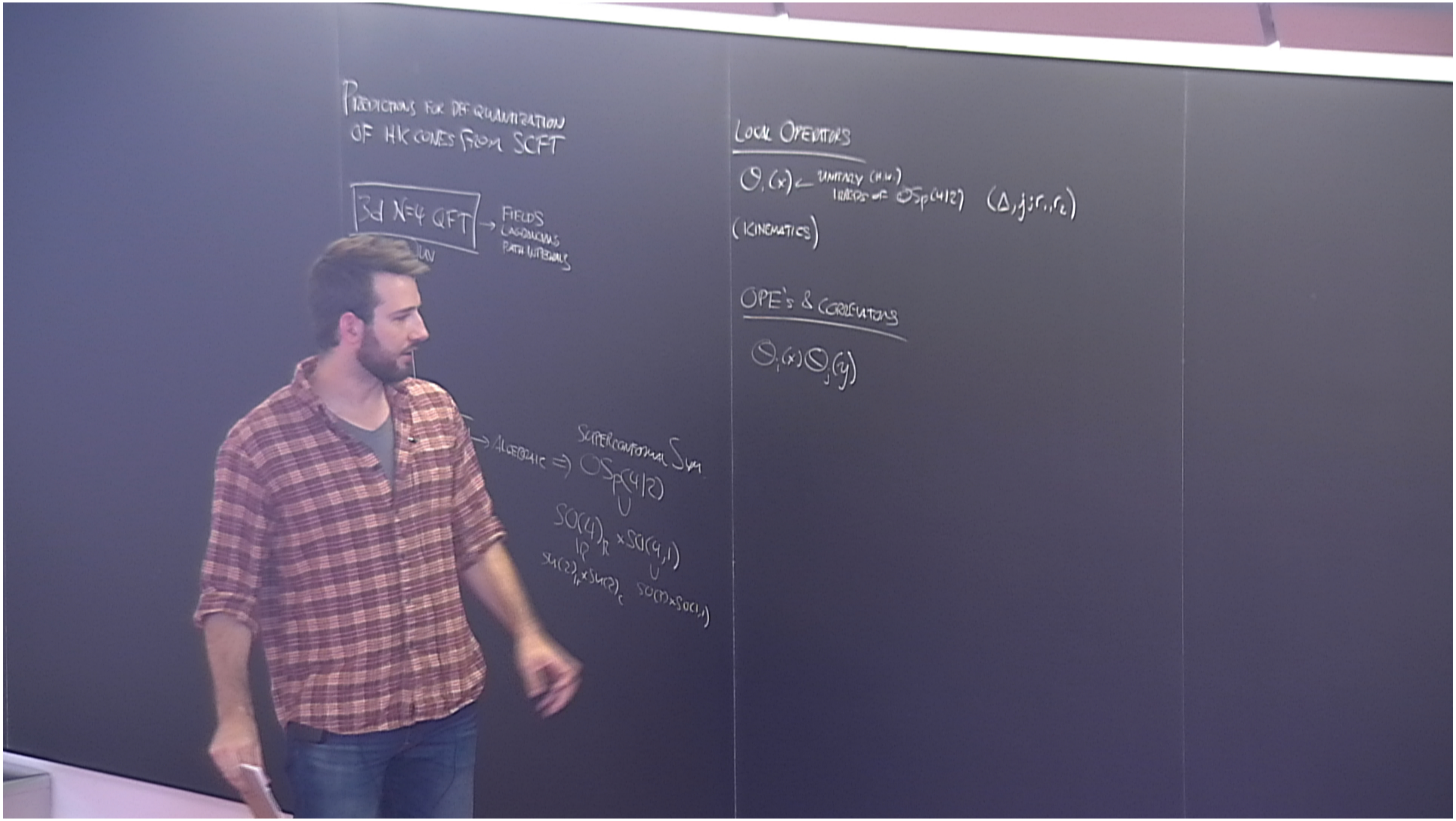
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FIELDS
LAGRANGIANS
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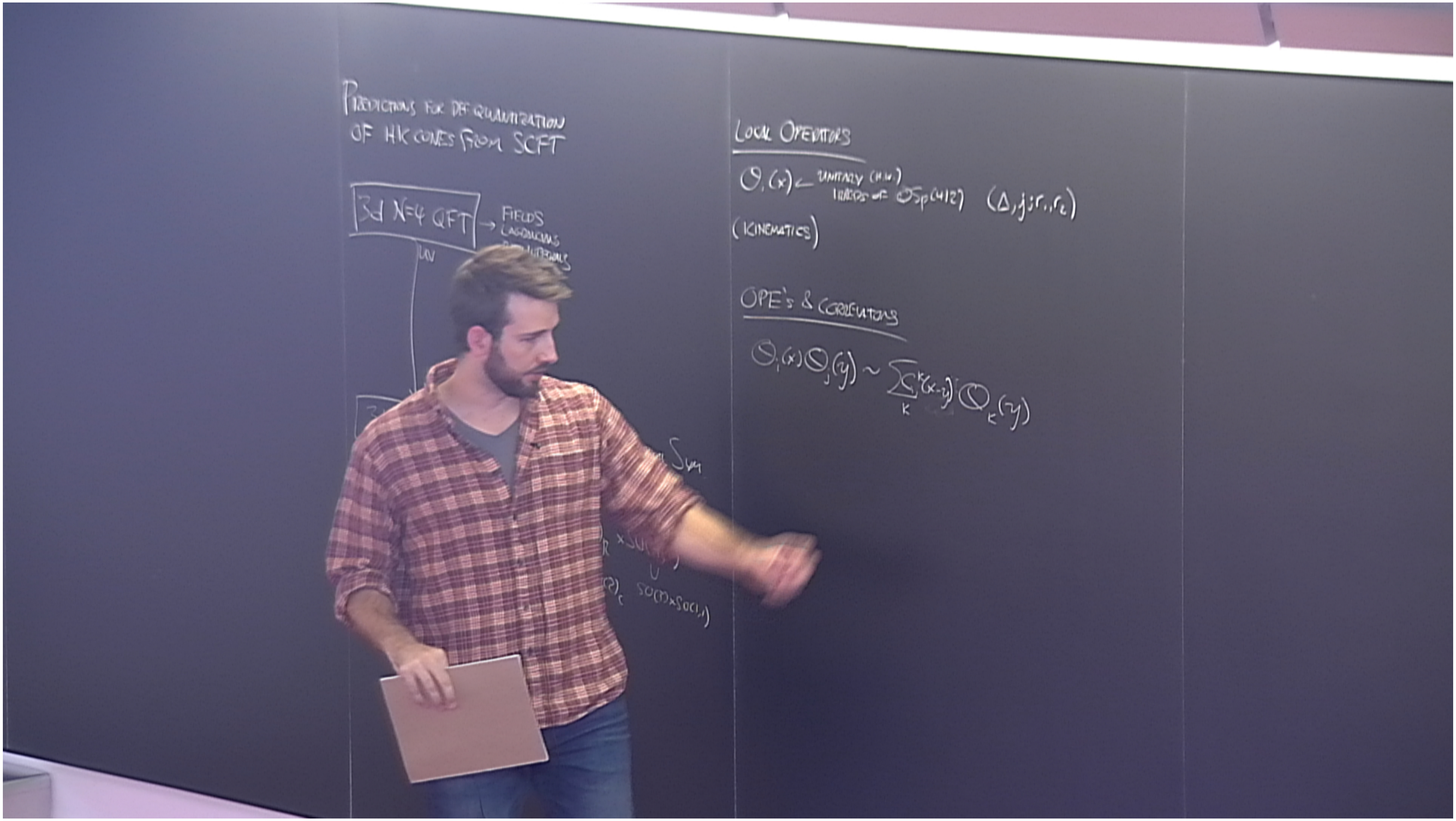
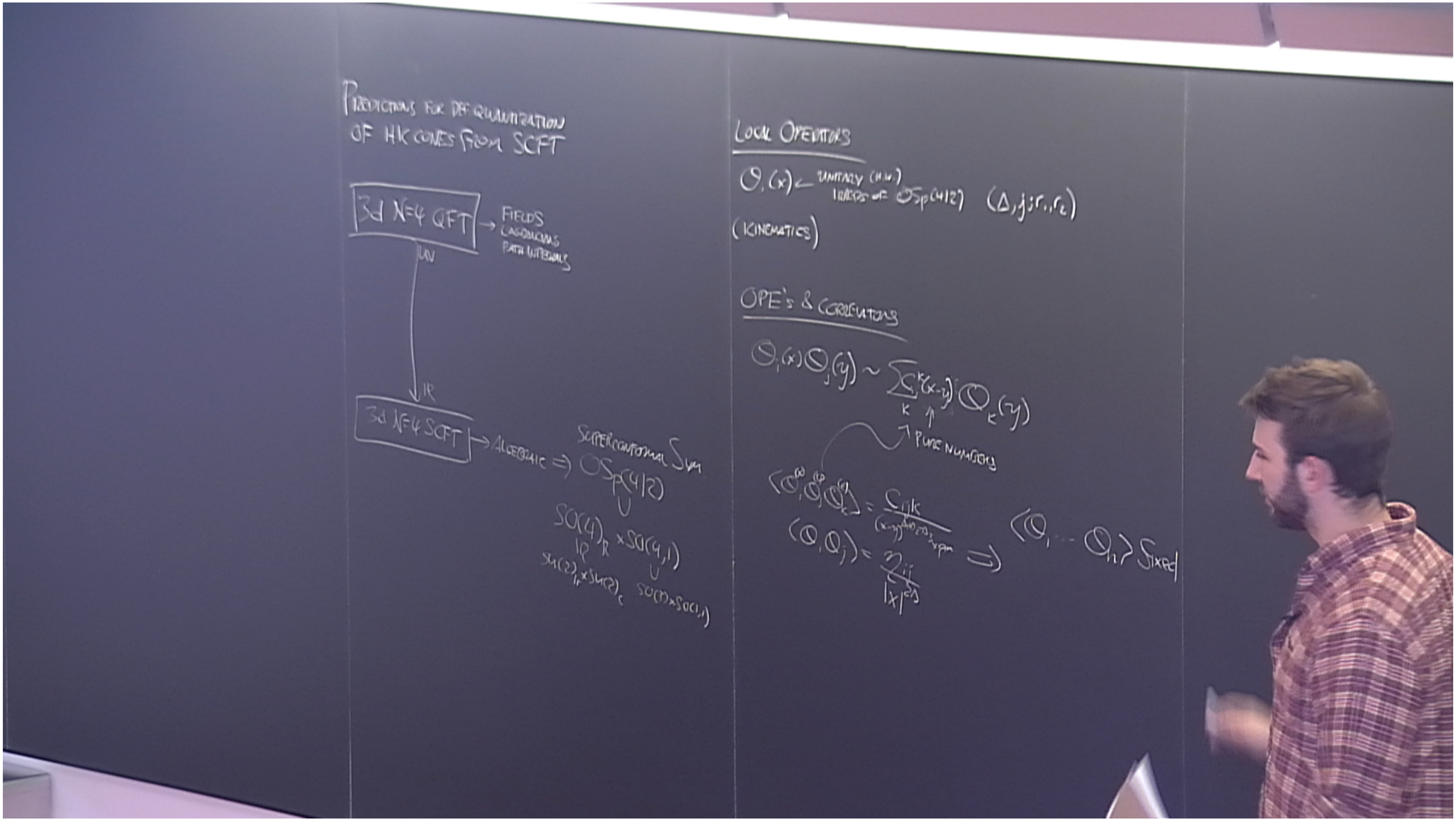
(KINEMATICS)
OPE's & CORRELATORS
O_i(x) O_j(y)


PREDICTIONS FOR DEF QUANTIZATION
OF HK CONES FROM SCFT
3d N=4 QFT
→ FIELDS
LAGRANGIANS
UV
LOCAL OPERATORS
UNITARY (H.W.)
IRREPS OF OSp(4|2)
(Δ, j; r1, r2)
(KINEMATICS)
OPE's & CORRELATORS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3d N=4 QFT
FIELDS
LAGRANGIANS
PATH INTEGRALS
UV
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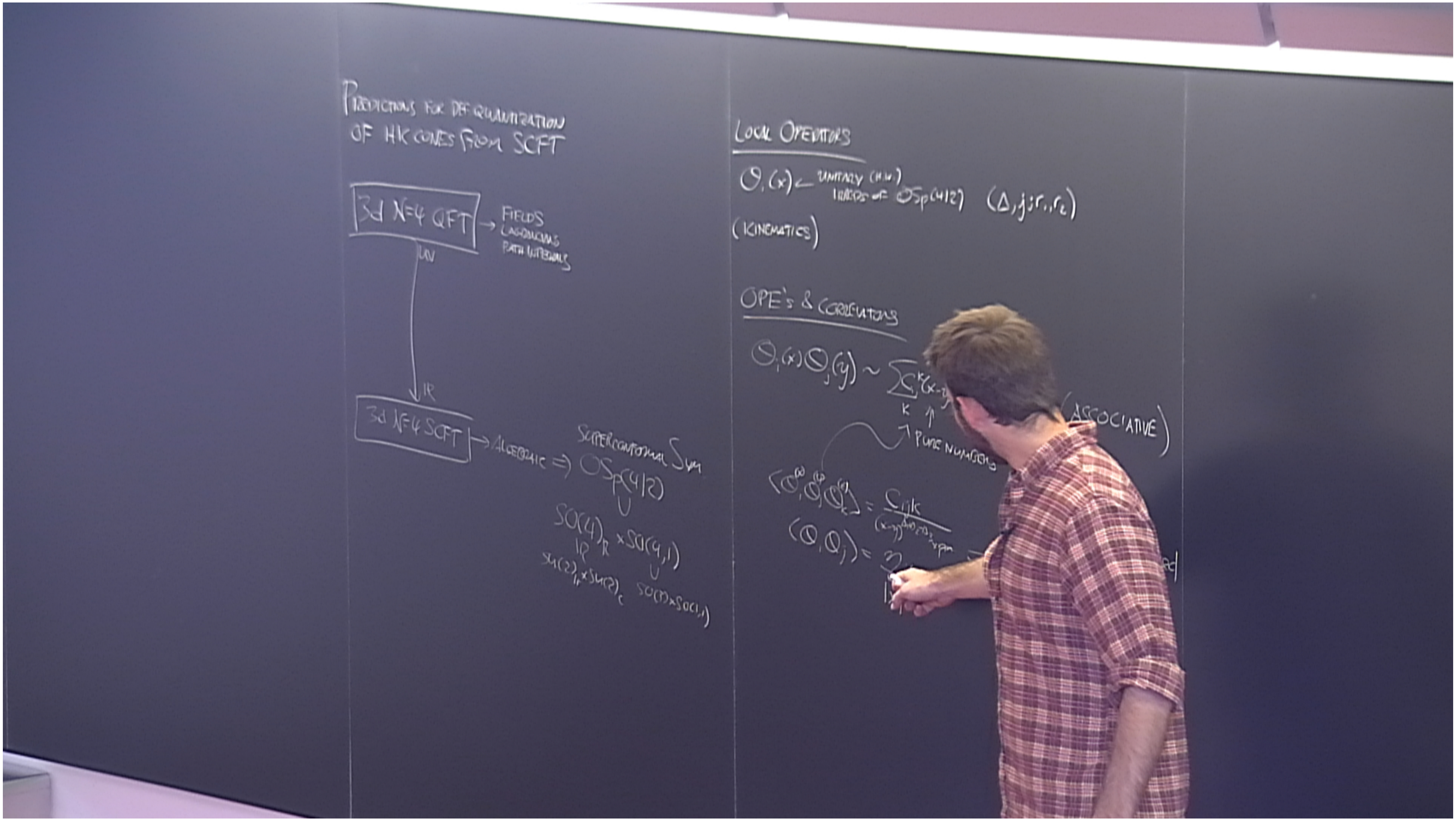
3d N=4 SCFT
ALGEBRAIC
SUPERCONFORMAL SYM
OSp(4|2)
SO(4)R × SO(4,1)
SU(2)H × SU(2)C
SO(3) × SO(1,1)
LOCAL OPERATORS
UNITARY (H.W.)
IRREPS OF OSp(4|2)
(Δ, j; r1, r2)
(KINEMATICS)
OPE's & CORRELATORS
PURE NUMBERS
fixed


PREDICTIONS FOR DEF QUANTIZATION
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3d N=4 QFT
FIELDS
LAGRANGIANS
PATH INTEGRALS
UV
IR
3d N=4 SCFT
ALGEBRAIC
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SU(2)H × SU(2)C
SO(3) × SO(1,1)
LOCAL OPERATORS
UNITARY (H.W.)
IRREPS OF OSp(4|2)
(Δ, j; r1, r2)
(KINEMATICS)
OPE's & CORRELATORS
K
PURE NUMBERS
(ASSOCIATIVE)

PREDICTIONS FOR DEF. QUANTIZATION OF HK CONES FROM SCFT

$\boxed{\text{3d } \mathcal{N}=4 \text{ QFT}}$ → FIELDS, LAGRANGIANS, PATH INTEGRALS

$\downarrow$ UV / IR

$\boxed{\text{3d } \mathcal{N}=4 \text{ SCFT}}$ → ALGEBRAIC ⇒ SUPERCONFORMAL SYM

$$OSp(4|2) \supset SO(4)_R \times SO(4,1)$$

$$SO(4)_R \cong SU(2)_H \times SU(2)_C \qquad SO(4,1) \supset SO(3) \times SO(1,1)$$

LOCAL OPERATORS

$\mathcal{O}_i(x) \leftarrow$ UNITARY (H.W.) IRREPS OF $OSp(4|2)$ $\quad (\Delta, j; r_1, r_2)$

(KINEMATICS)

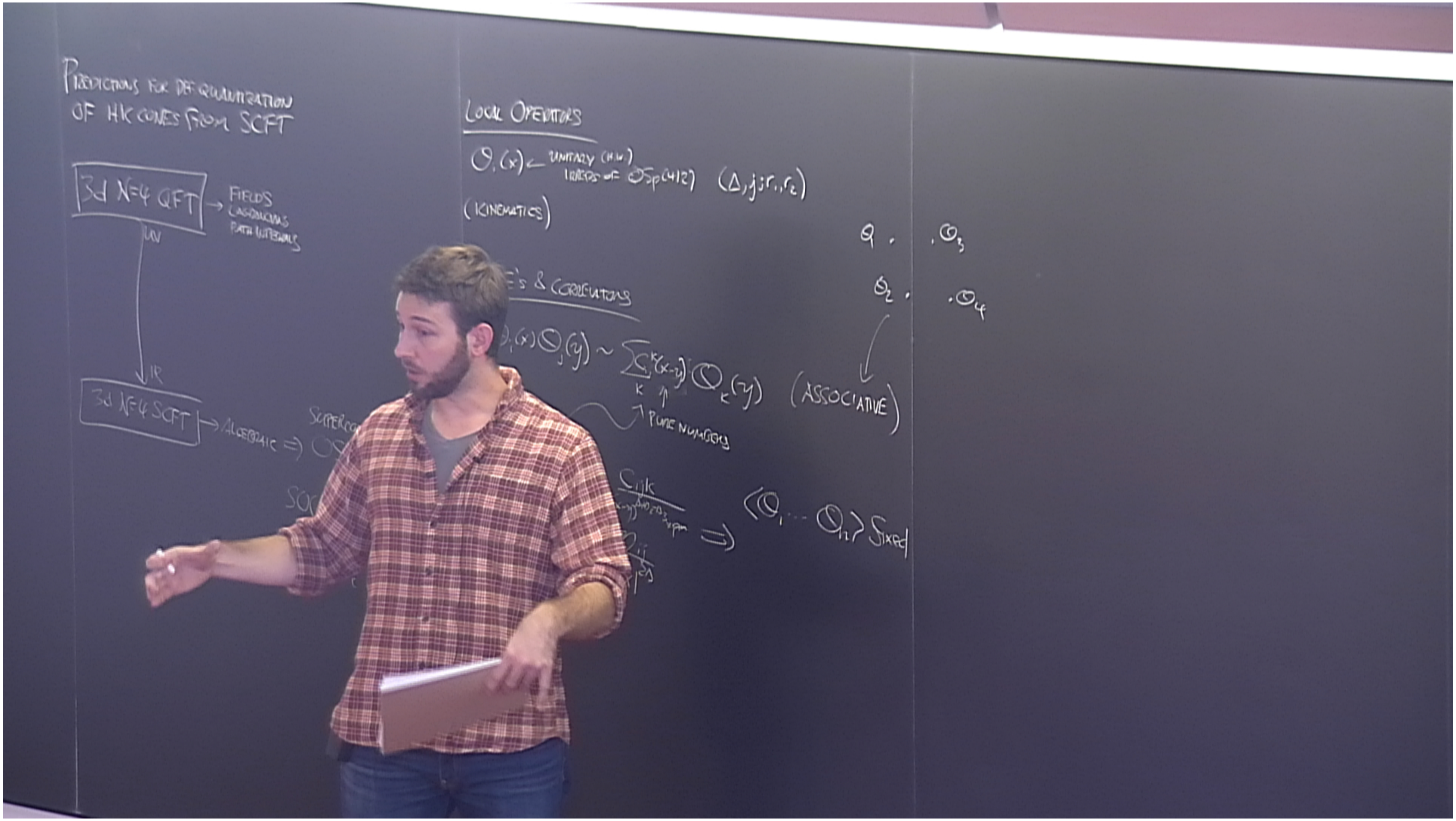
OPE's & CORRELATORS

$$\mathcal{O}_i(x)\mathcal{O}_j(y) \sim \sum_k C_{ij}^k(x-y)\,\mathcal{O}_k(y) \quad \text{(ASSOCIATIVE)}$$

↑ PURE NUMBERS

$$\langle \mathcal{O}_i^{(x)} \mathcal{O}_j^{(y)} \mathcal{O}_k^{(z)} \rangle = \frac{C_{ijk}}{(x-y)^{\Delta_1+\Delta_2-\Delta_3} \cdots}$$

$$\langle \mathcal{O}_i \mathcal{O}_j \rangle = \frac{\eta_{ij}}{|x|^{2\Delta}} \Rightarrow \langle \mathcal{O}_1 \cdots \mathcal{O}_n \rangle \text{ fixed}$$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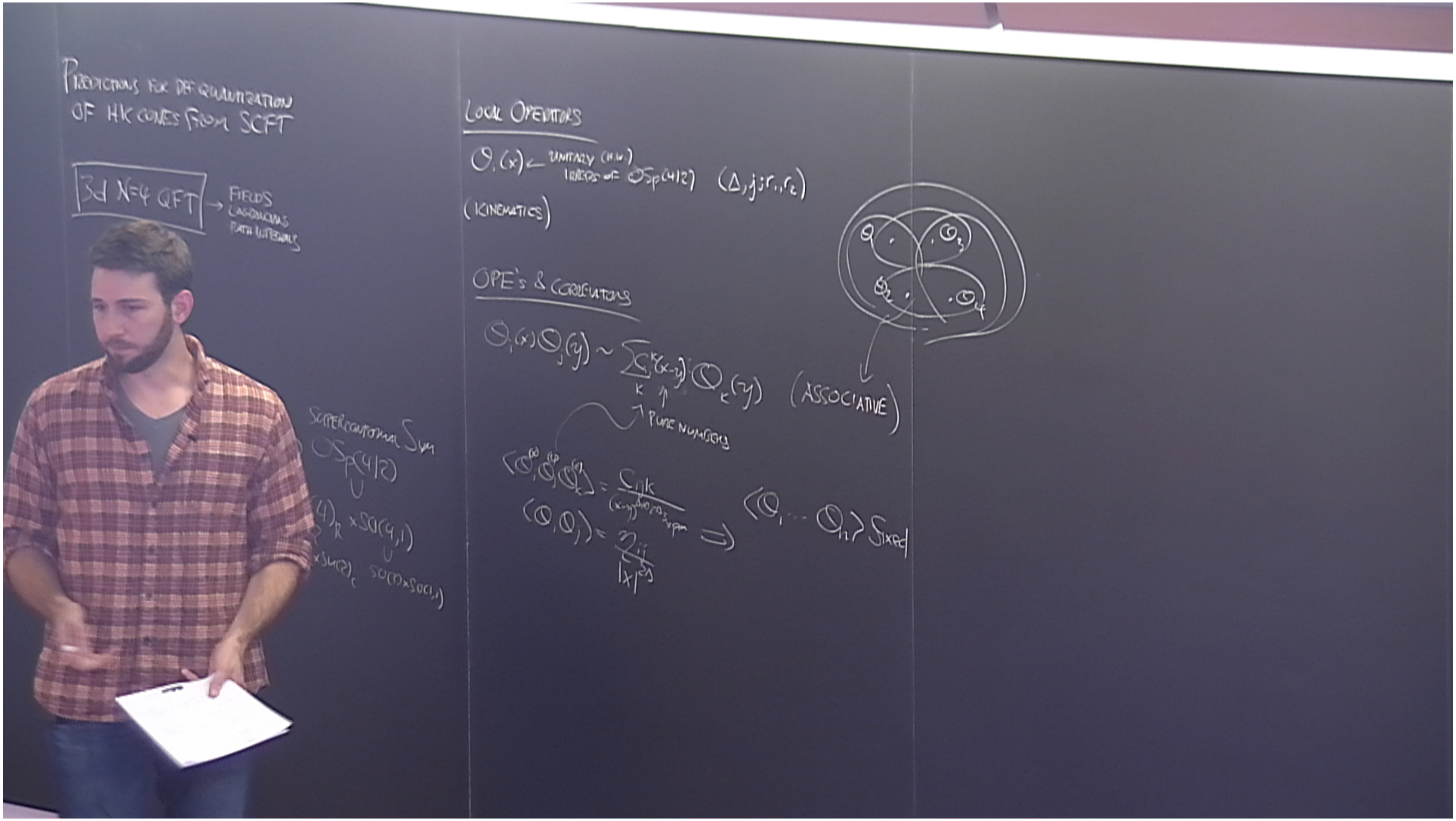
OF HK CONES FROM SCFT
3d N=4 QFT
FIELDS
LAGRANGIANS
PATH INTEGRALS
UV
IR
3d N=4 SCFT
ALGEBRAIC
LOCAL OPERATORS
UNITARY (H.W.)
IRREPS OF OSp(4|2)
(Δ, j; r₁, r₂)
(KINEMATICS)
E's & CORRELATORS
(ASSOCIATIVE)
PURE NUMBERS
Sixed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OSp(4|2)
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IRREPS OF OSp(4|2)
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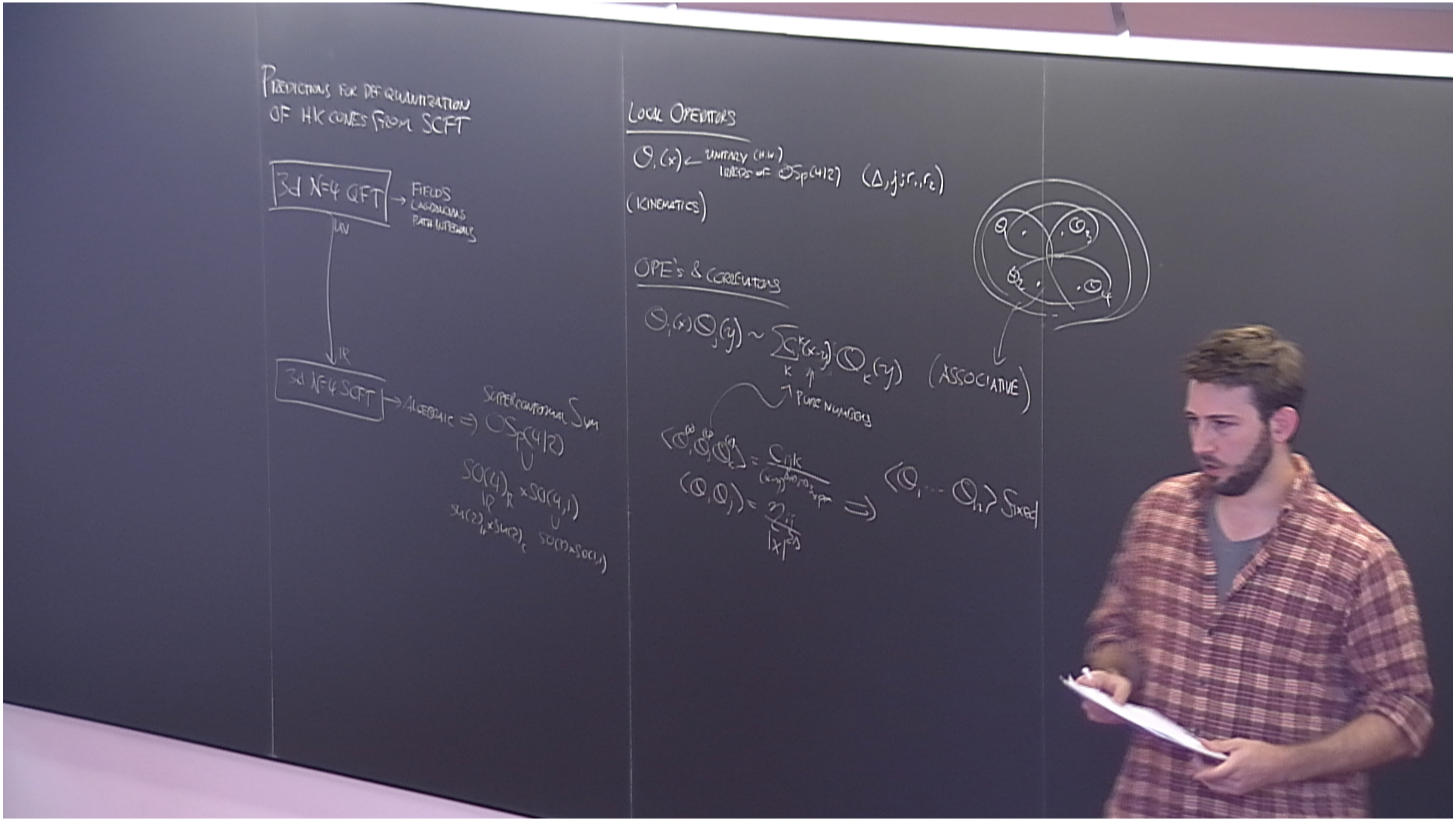
(KINEMATICS)
OPE's & CORRELATORS
PURE NUMBERS
(ASSOCIATIVE)
fixed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FIELDS
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OSp(4|2)
SO(4)_R × SO(4,1)
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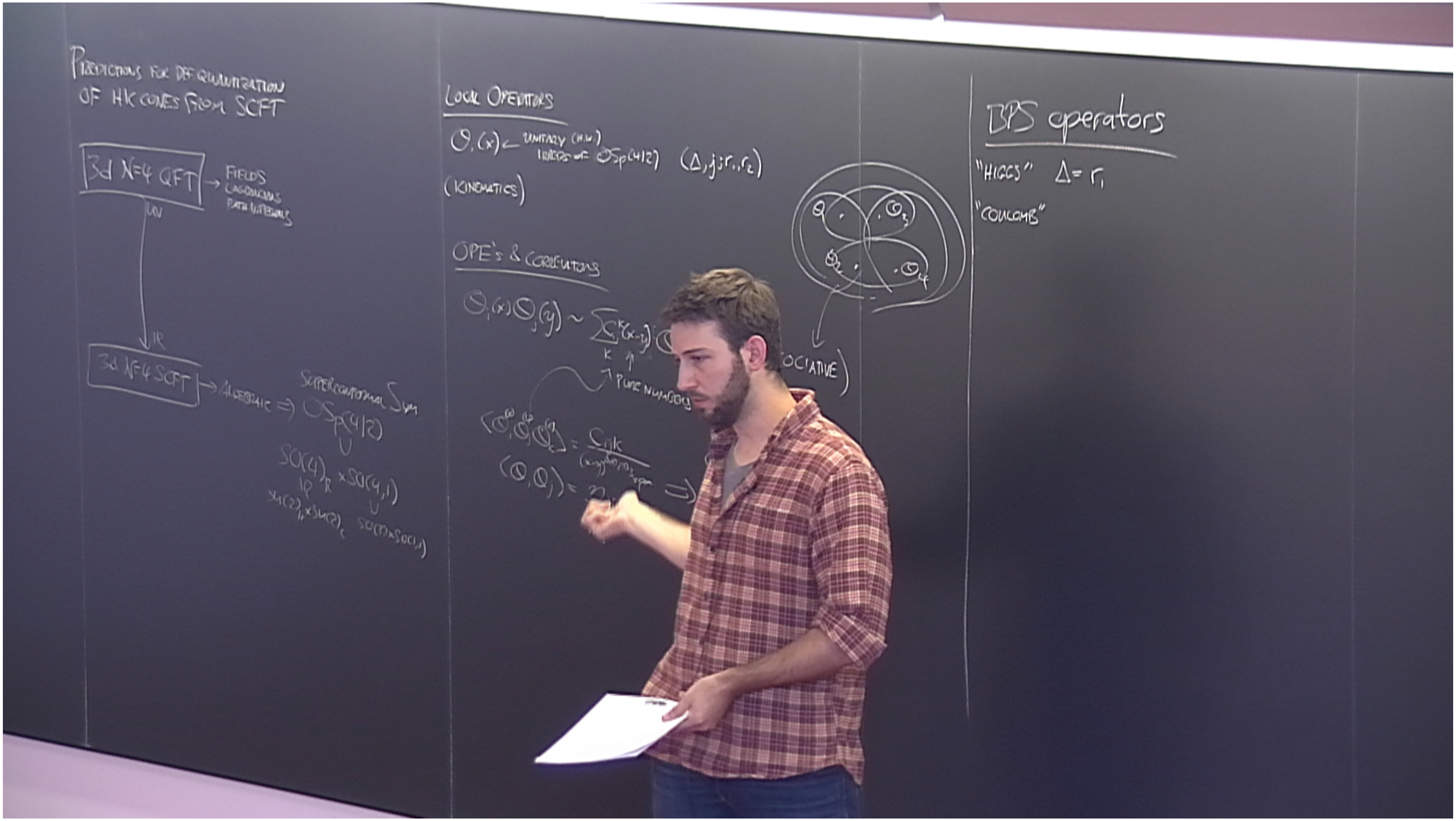
(Δ, j; r_1, r_2)
(KINEMATICS)
OPE's & CORRELATORS
(ASSOCIATIVE)
PURE NUMBERS
⟨O_1 ... O_n⟩ fixed



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3d N=4 QFT
FIELDS
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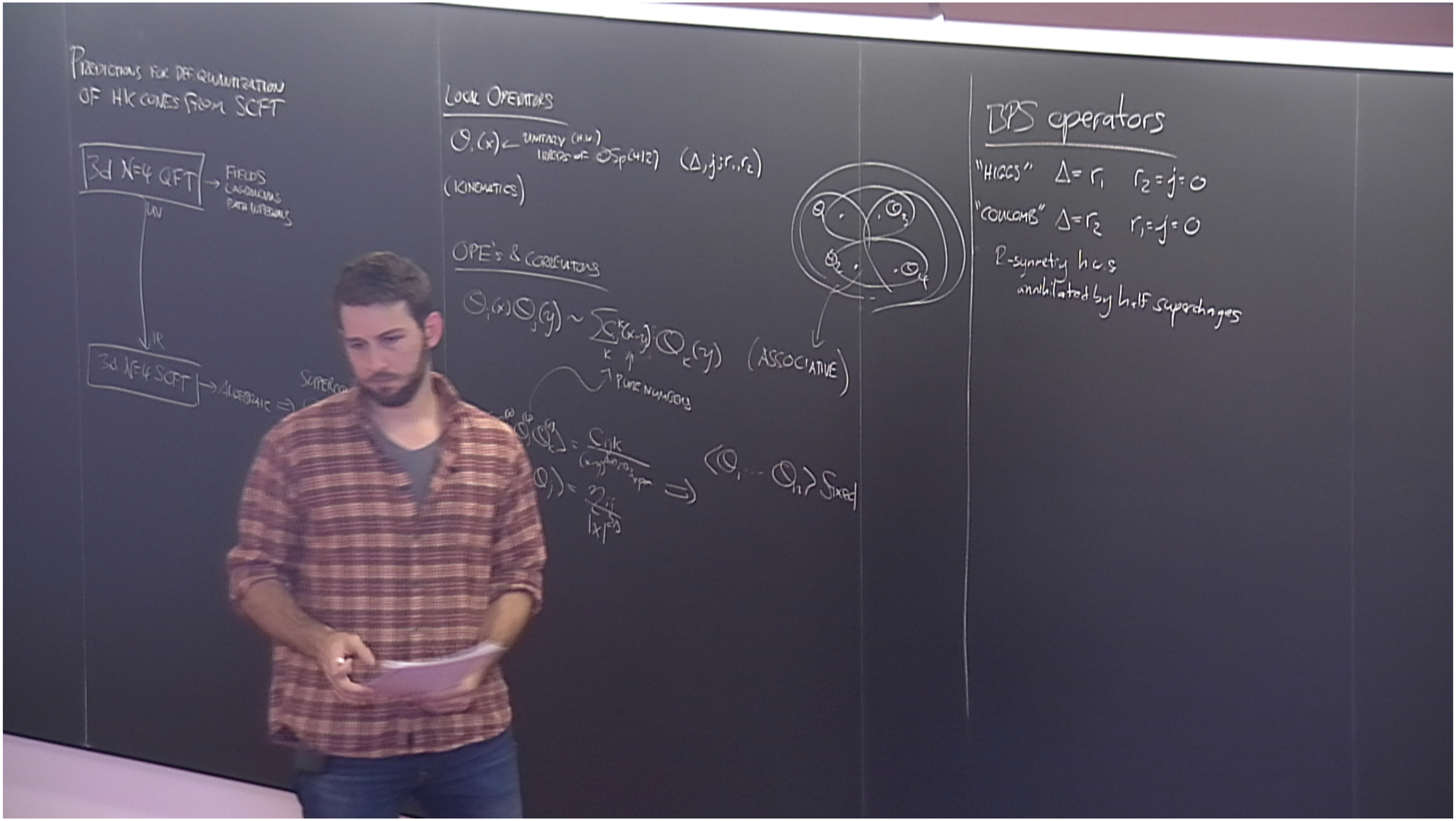
3d N=4 SCFT
ALGEBRAIC
SUPERCONFORMAL SYM
OSp(4|2)
LOCAL OPERATORS
UNITARY (H.W.) IRREPS OF OSp(4|2)
(KINEMATICS)
OPE's & CORRELATORS
PURE NUMBERS
OCIATIVE
BPS operators
"HIGGS" Δ= r1
"COULOMB"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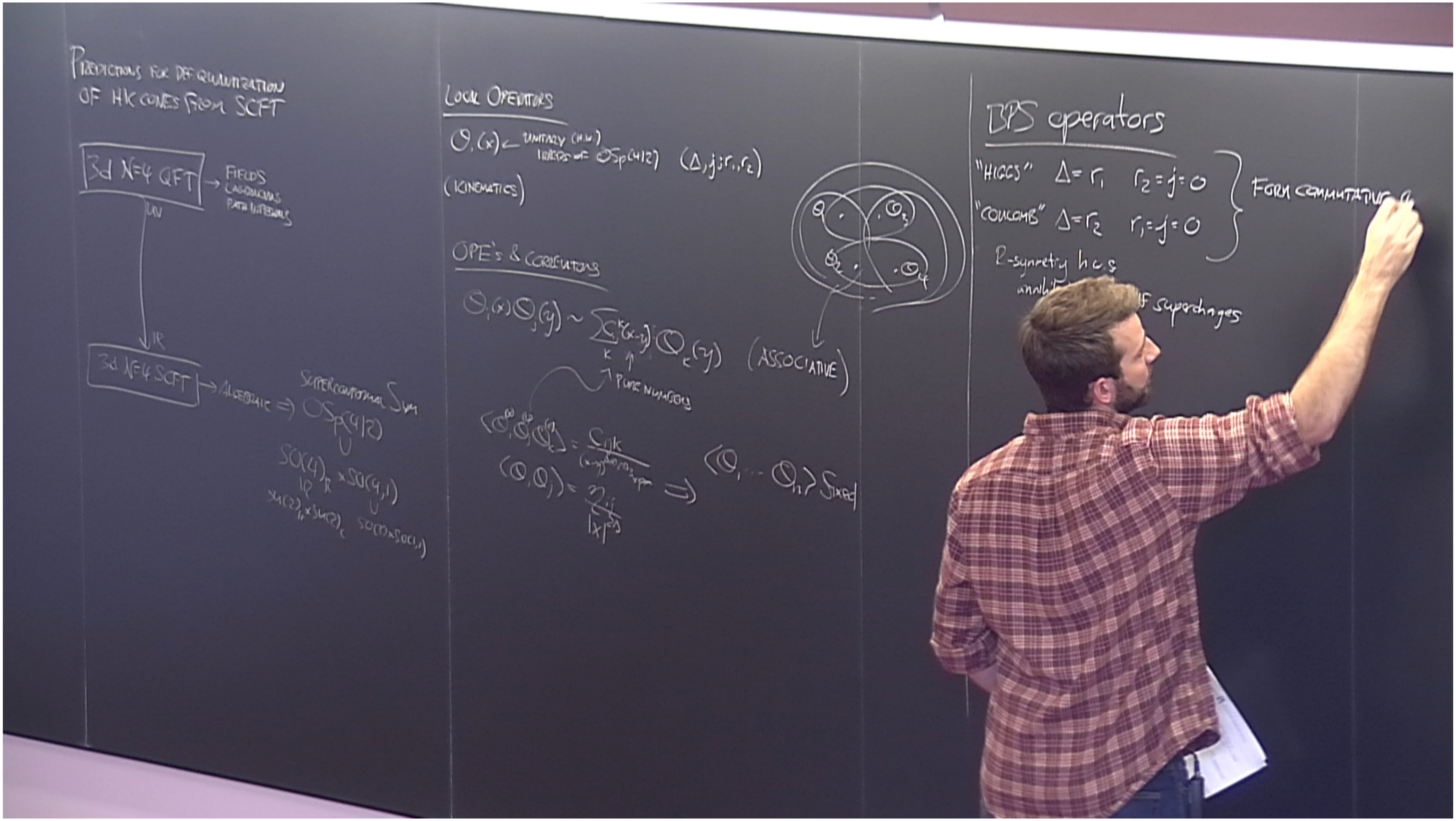
UNITARY (H.W.) IRREPS OF OSp(4|2)
(Δ, j; r₁, r₂)
(KINEMATICS)
OPE's & CORRELATORS
PURE NUMBERS
(ASSOCIATIVE)
BPS operators
"HIGGS" Δ = r₁ r₂ = j = 0
"COULOMB" Δ = r₂ r₁ = j = 0
R-symmetry h.w.s
annihilated by half supercharges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3d N=4 QFT
FIELDS
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UV
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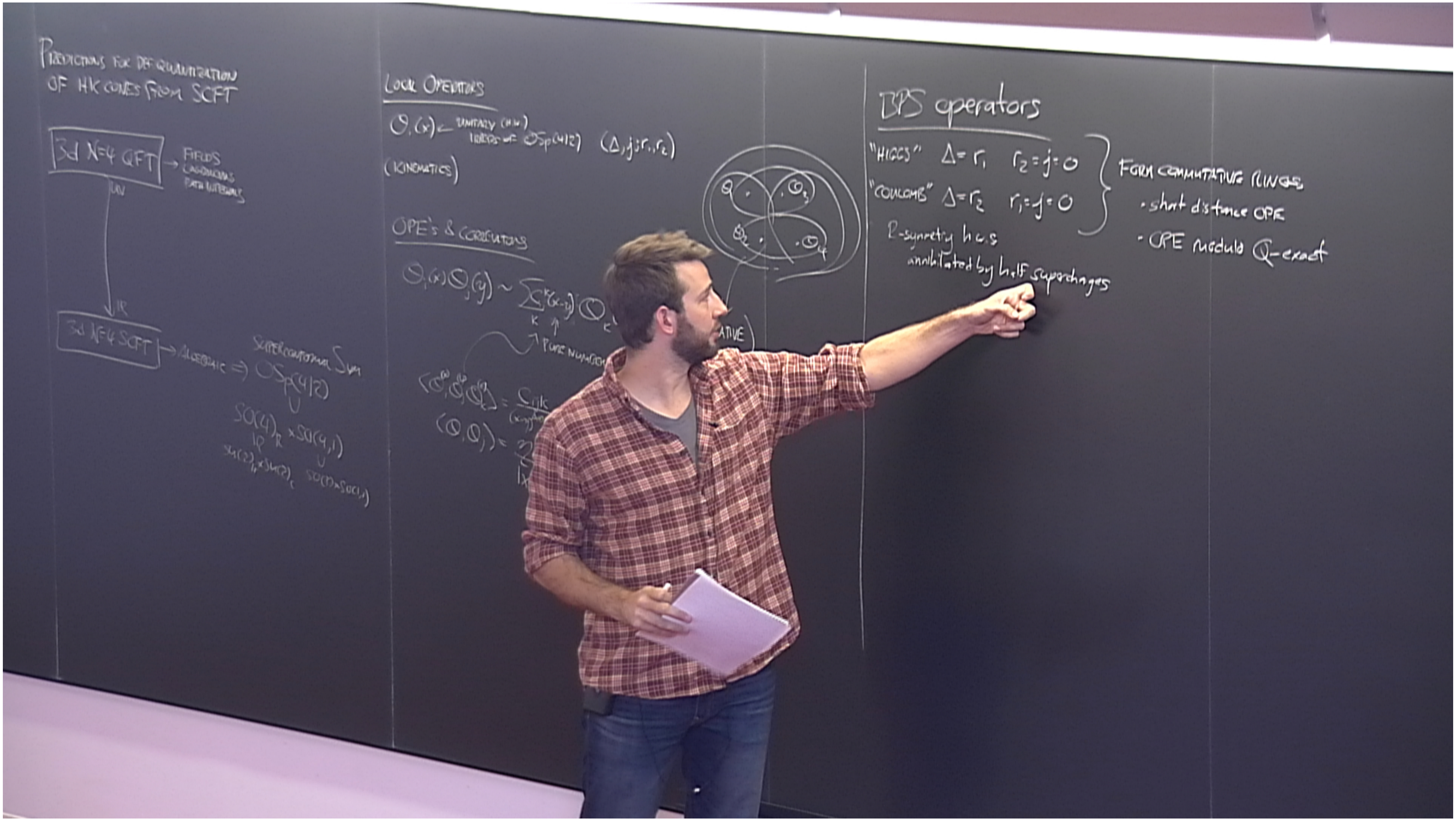
3d N=4 SCFT
ALGEBRAIC
SUPERCONFORMAL SYM
OSp(4|2)
LOCAL OPERATORS
UNITARY (H.W.) IRREPS OF OSp(4|2)
(KINEMATICS)
OPE's & CORRELATORS
PURE NUMBERS
(ASSOCIATIVE)
Fixed
BPS operators
"HIGGS"
"COULOMB"
FORM COMMUTATIVE
R-symmetry h.w.s
supercharges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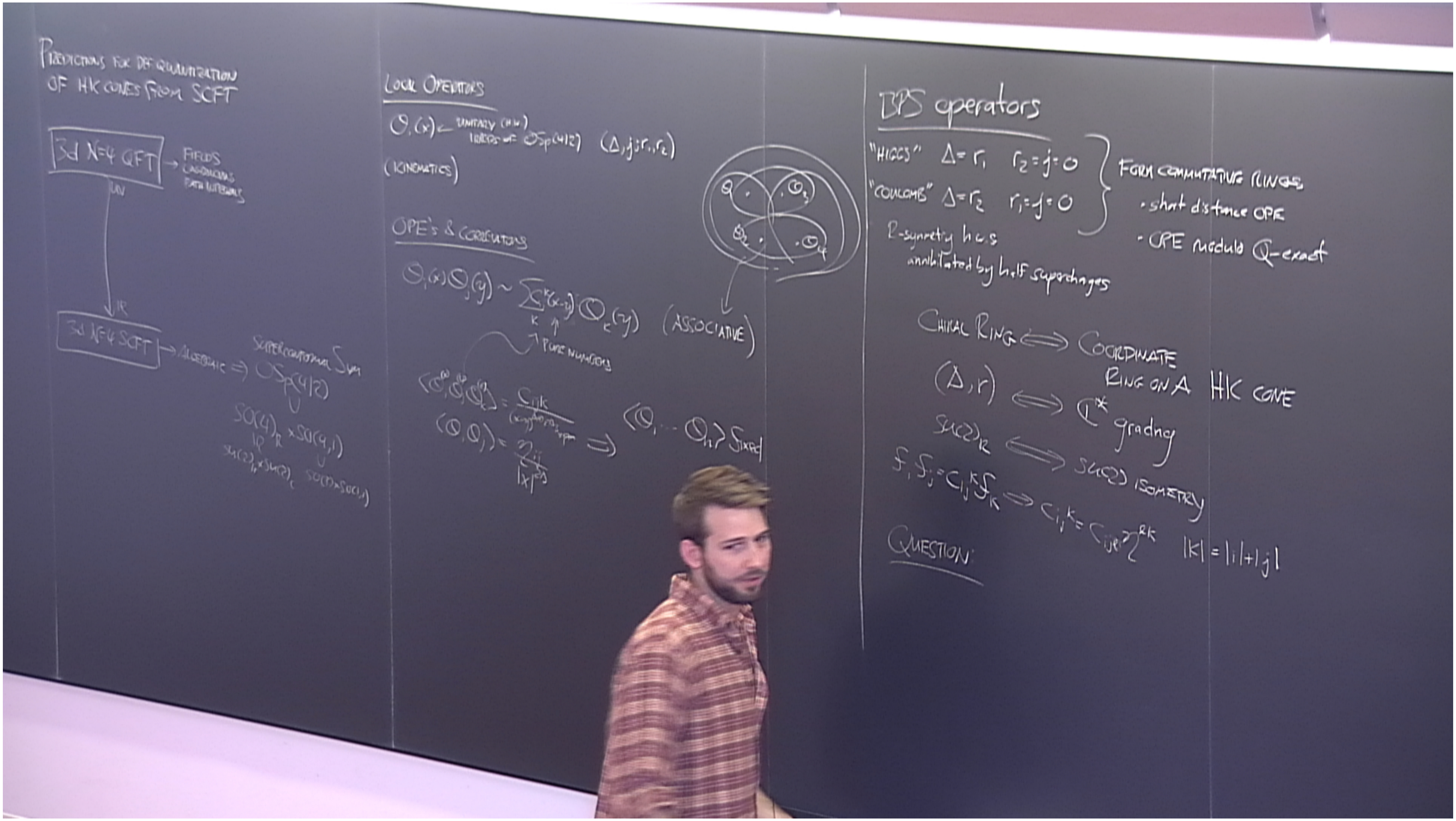
R-symmetry h.w.s
annihilated by half supercharges
FORM COMMUTATIVE RINGS
· short distance OPE
· OPE modulo Q-exact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FIELDS
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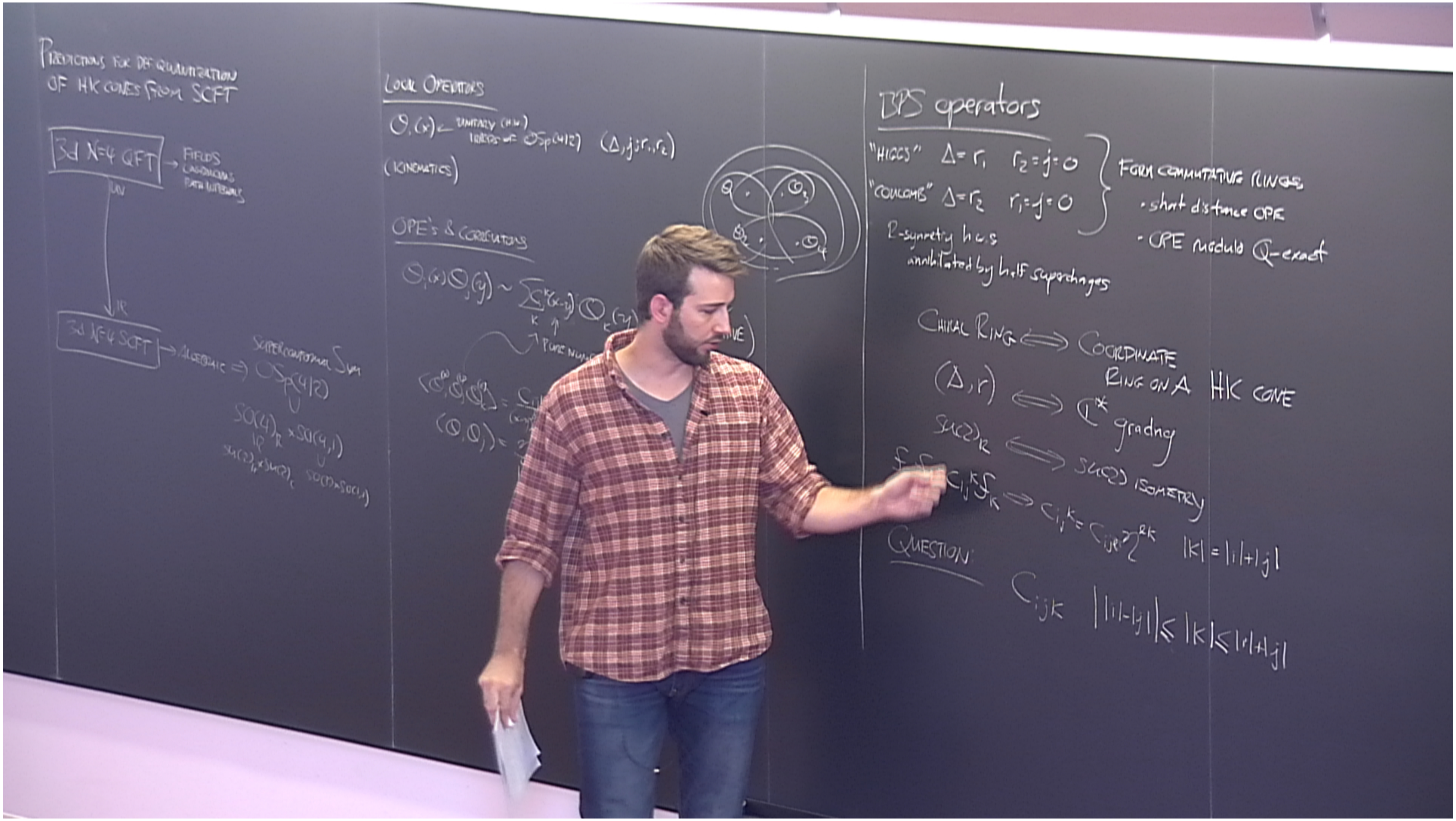
(ASSOCIATIVE)
PURE NUMBERS
BPS operators
"HIGGS"
"COULOMB"
R-symmetry h.w.s
annihilated by half supercharges
FORM COMMUTATIVE RINGS
· short distance OPE
· OPE modulo Q-exact
CHIRAL RING
COORDINATE RING ON A HK CONE
grading
ISOMETRY
QUESTION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3d N=4 QFT
FIELDS
UV
IR
3d N=4 SCFT
ALGEBRAIC
SUPERCONFORMAL SYM
OSp(4|2)
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(KINEMATICS)
OPE's & CORRELATORS
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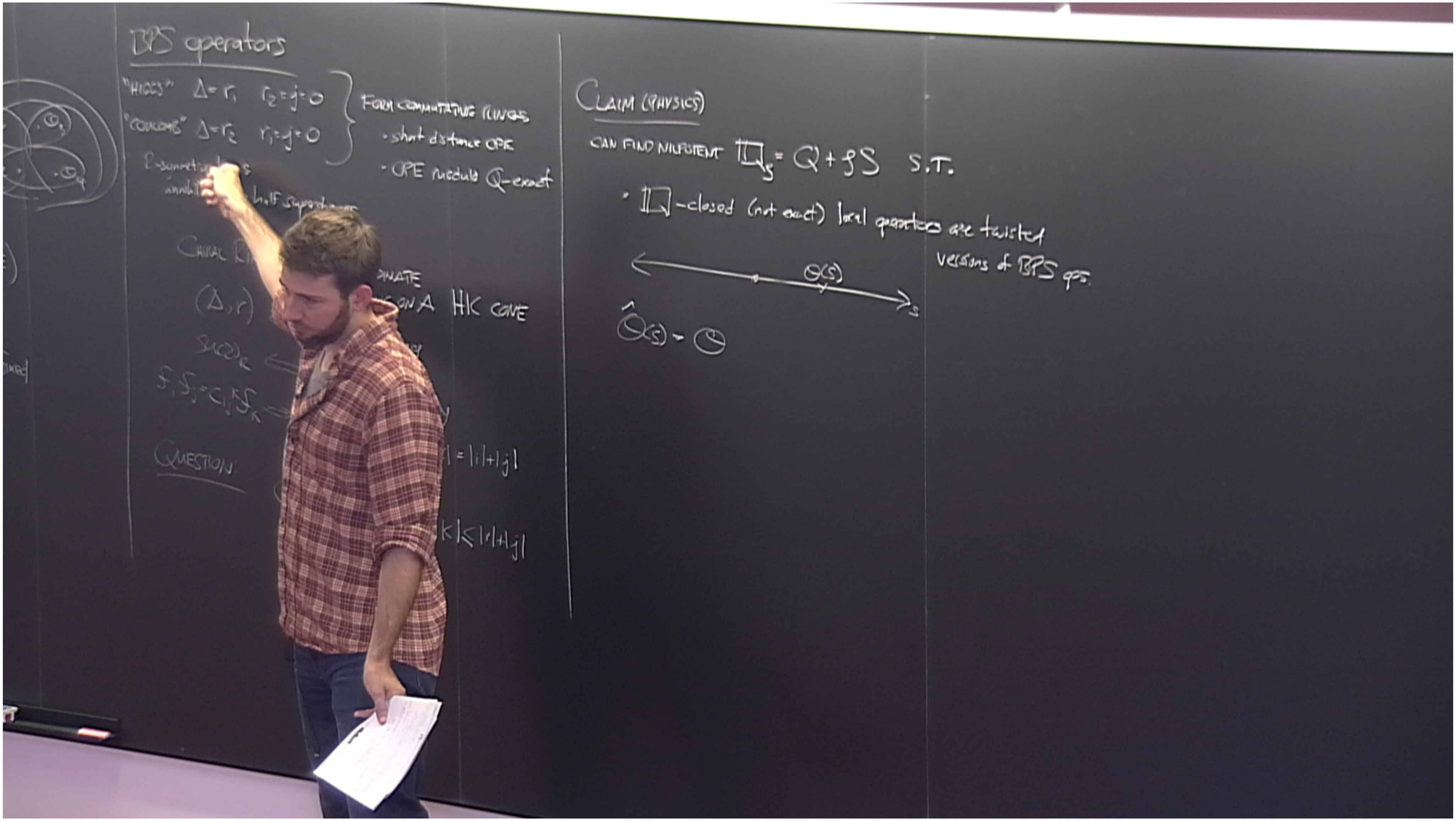
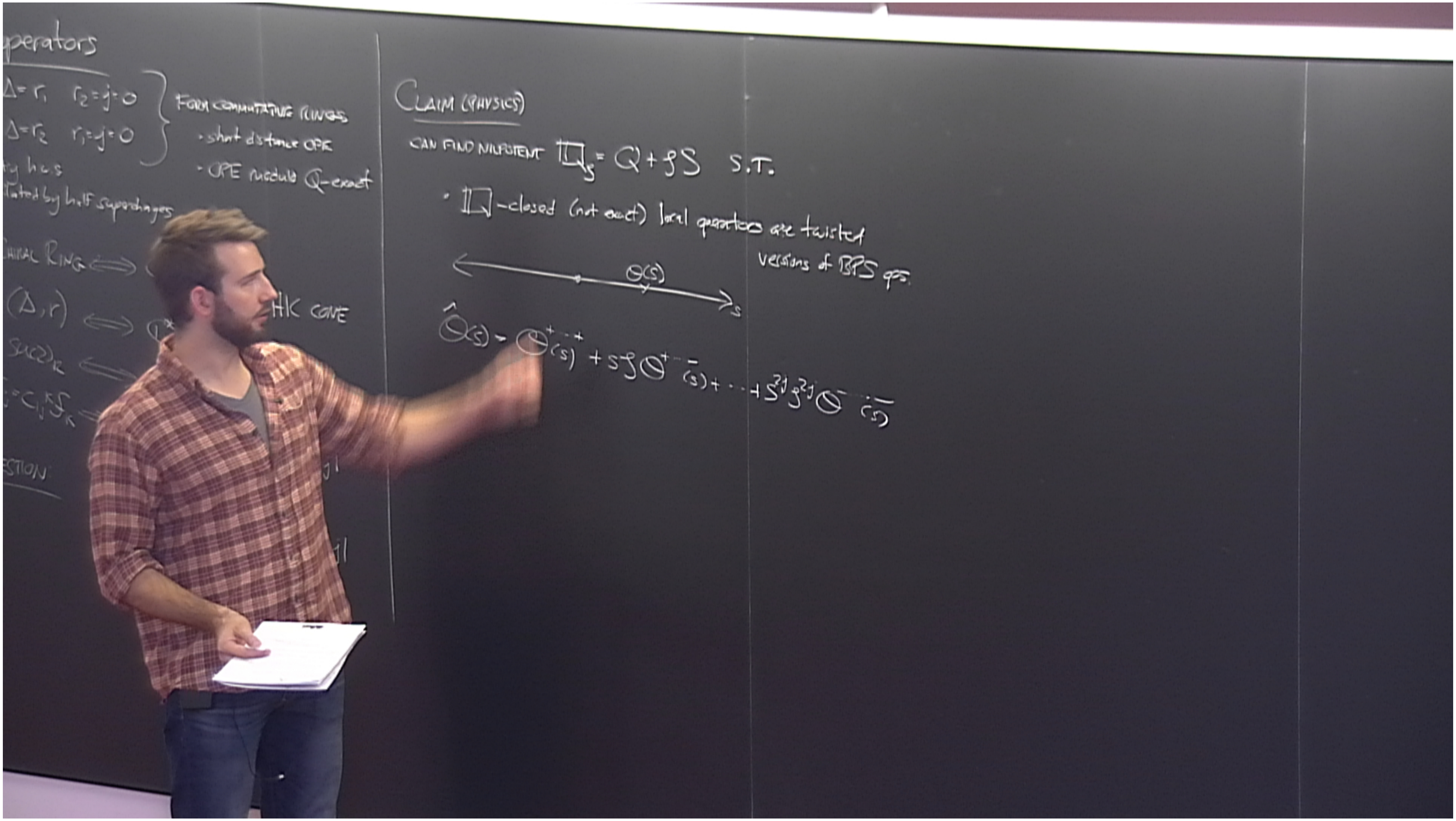
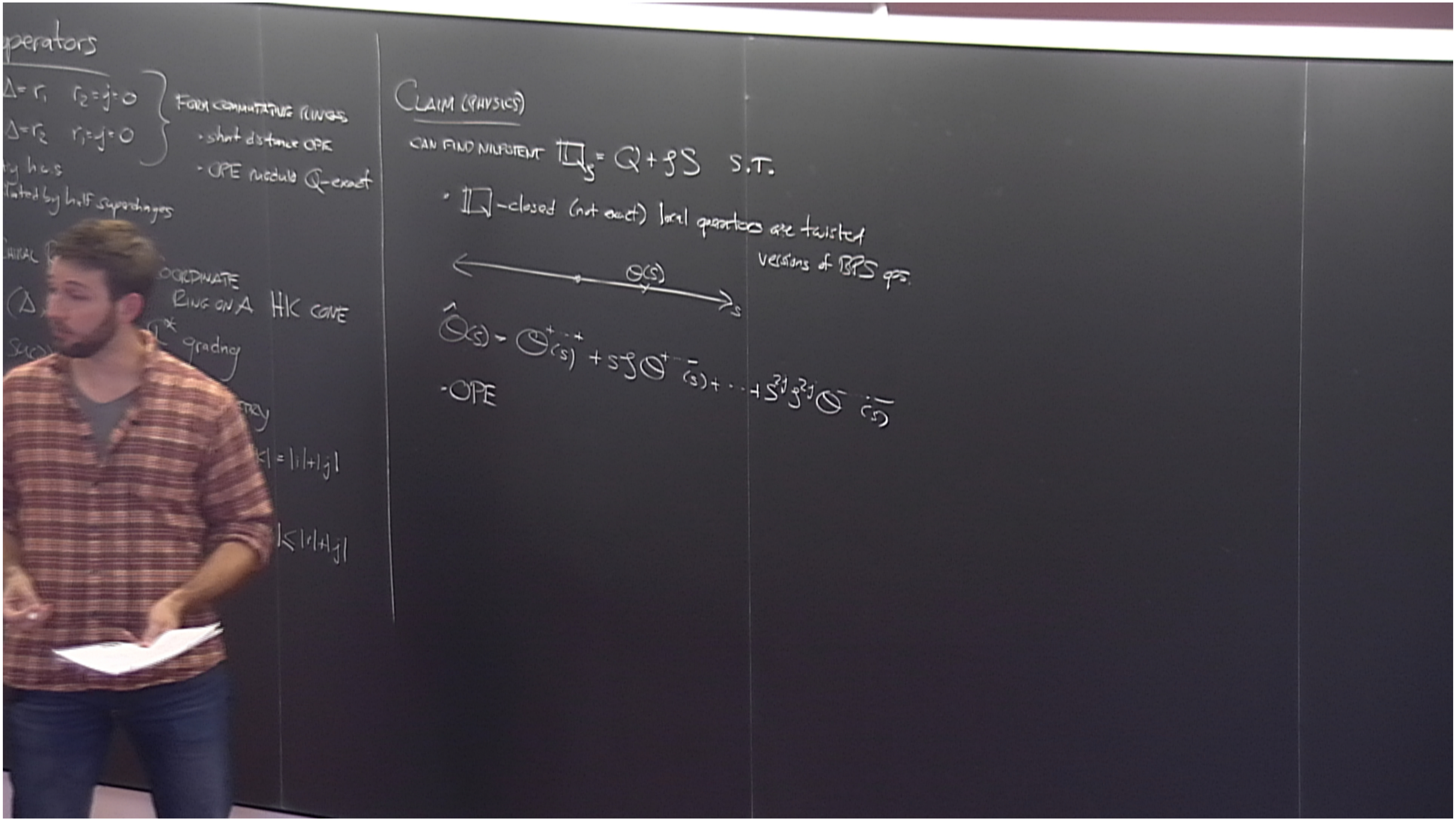
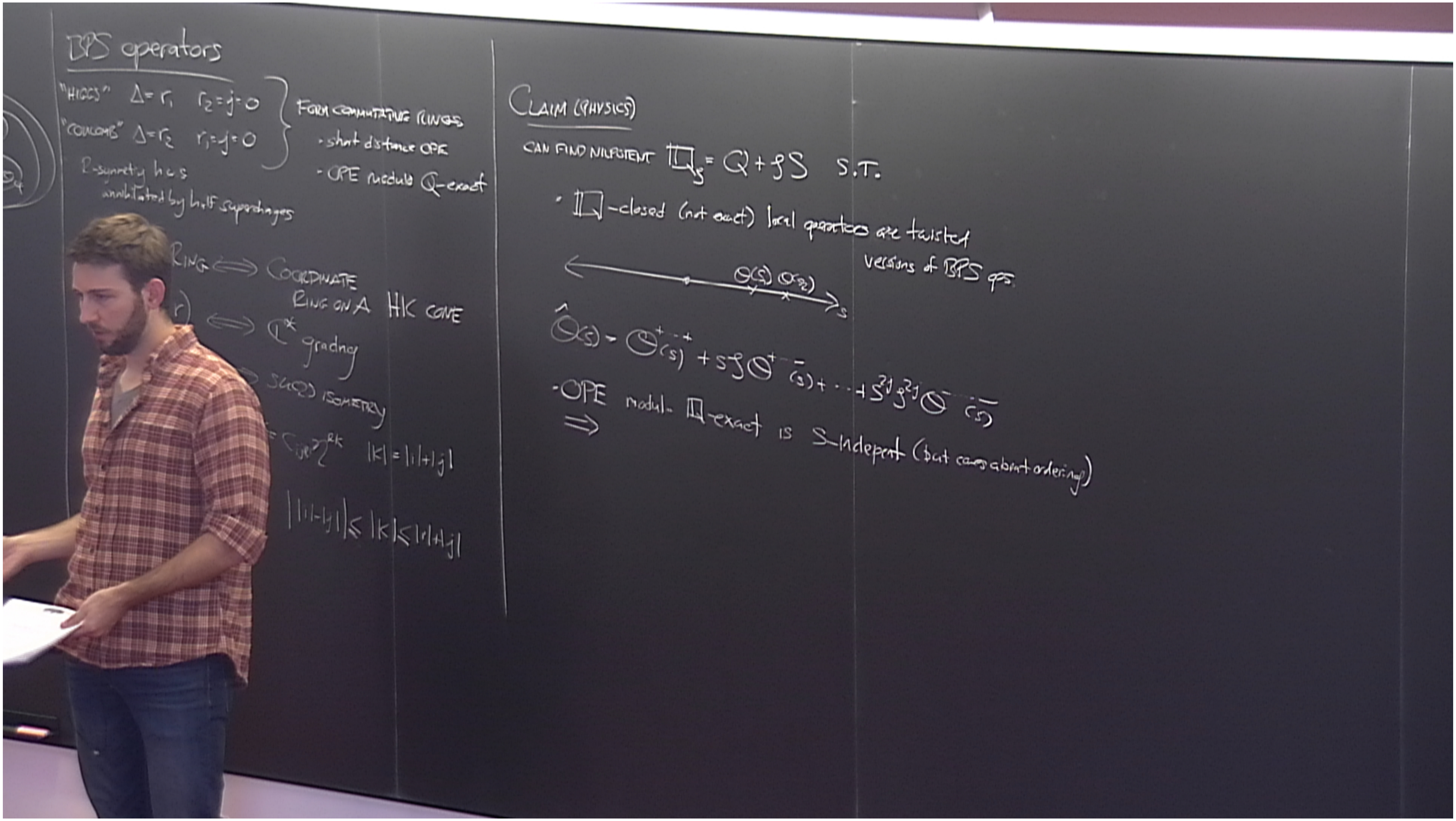
FORM COMMUTATIVE RINGS
· short distance OPE
· OPE modulo Q-exact
CHIRAL RING ⟺ COORDINATE RING ON A HK CONE
(Δ, r) ⟺ ℂ* grading
SU(2)_R ⟺ SU(2) ISOMETRY
QUESTION
|k| = |i| + |j|
C_ijk ||i| - |j|| ≤ |k| ≤ |i| + |j|


BPS operators
"HIGGS" Δ = r1 r2 = j = 0
"COULOMB" Δ = r2 r1 = j = 0
FORM COMMUTING RINGS
- short distance OPE
- OPE modulo Q-exact
half superchar
CHIRAL RI
HK CONE
QUESTION:
CLAIM (PHYSICS)
CAN FIND NILPOTENT Q_S = Q + ρS S.T.
- Q-closed (not exact) local operators are twisted versions of BPS ops.
O(s)


perators
FORM COMMUTATIVE RINGS
· short distance OPE
· OPE modulo Q-exact
CLAIM (PHYSICS)
CAN FIND NILPOTENT $\mathbb{Q}_s = Q + \rho S$ S.T.
· $\mathbb{Q}$-closed (not exact) local operators are twisted versions of BPS ops.
$\mathcal{O}(s)$
$\hat{\mathcal{O}}(s) = \mathcal{O}^{+\cdots+}(s) + s\rho\,\mathcal{O}^{+\cdots-}(s) + \cdots + s^{2j}\rho^{2j}\mathcal{O}^{-\cdots-}(s)$



operators
FORM COMMUTATIVE RINGS
· short distance OPE
· OPE modulo Q-exact
CLAIM (PHYSICS)
CAN FIND NILPOTENT $\mathbb{Q}_{\varsigma} = Q + \varsigma S$ S.T.
· $\mathbb{Q}$-closed (not exact) local operators are twisted versions of BPS ops.
· OPE
COORDINATE RING ON A HK CONE
grading


BPS operators
"HIGGS" Δ = r1 r2 = j = 0
"COULOMB" Δ = r2 r1 = j = 0
FORM COMMUTATIVE RINGS
- short distance OPE
- OPE modulo Q-exact
R-symmetry h.w.s
annihilated by half supercharges
RING ⟺ COORDINATE
RING ON A HK CONE
C* grading
SU(2) ISOMETRY
|K| = |l| + |j|
CLAIM (PHYSICS)
CAN FIND NILPOTENT
= Q + ρS S.T.
-closed (not exact) local operators are twisted
versions of BPS ops
-OPE modulo
-exact is
S-independent (but cares about ordering)

BPS operators

"HIGGS" $\Delta = r_1 \quad r_2 = j = 0$

"COULOMB" $\Delta = r_2 \quad r_1 = j = 0$

} FORM COMMUTATIVE RINGS
- short distance OPE
- OPE modulo Q-exact

R-symmetry h.w.s annihilated by half supercharges

CHIRAL RING $\Longleftrightarrow$ COORDINATE RING ON A HK CONE

$(\Delta, r) \Longleftrightarrow \mathbb{C}^*$ grading

$SU(2)_R \Longleftrightarrow SU(2)$ ISOMETRY

$\mathcal{O}_i \mathcal{O}_j = c_{ij}{}^k \mathcal{O}_k \Rightarrow c_{ij}{}^k = C_{ij\ell}\, g^{\ell k} \quad |k| = |i| + |j|$

QUESTION

$C_{ijk} \quad \big||i|-|j|\big| \leq |k| \leq |i|+|j|$

CLAIM (PHYSICS)

CAN FIND NILPOTENT $\mathbb{Q}_\zeta = Q + \zeta S$ S.T.

- $\mathbb{Q}$-closed (not exact) local operators are twisted versions of BPS ops

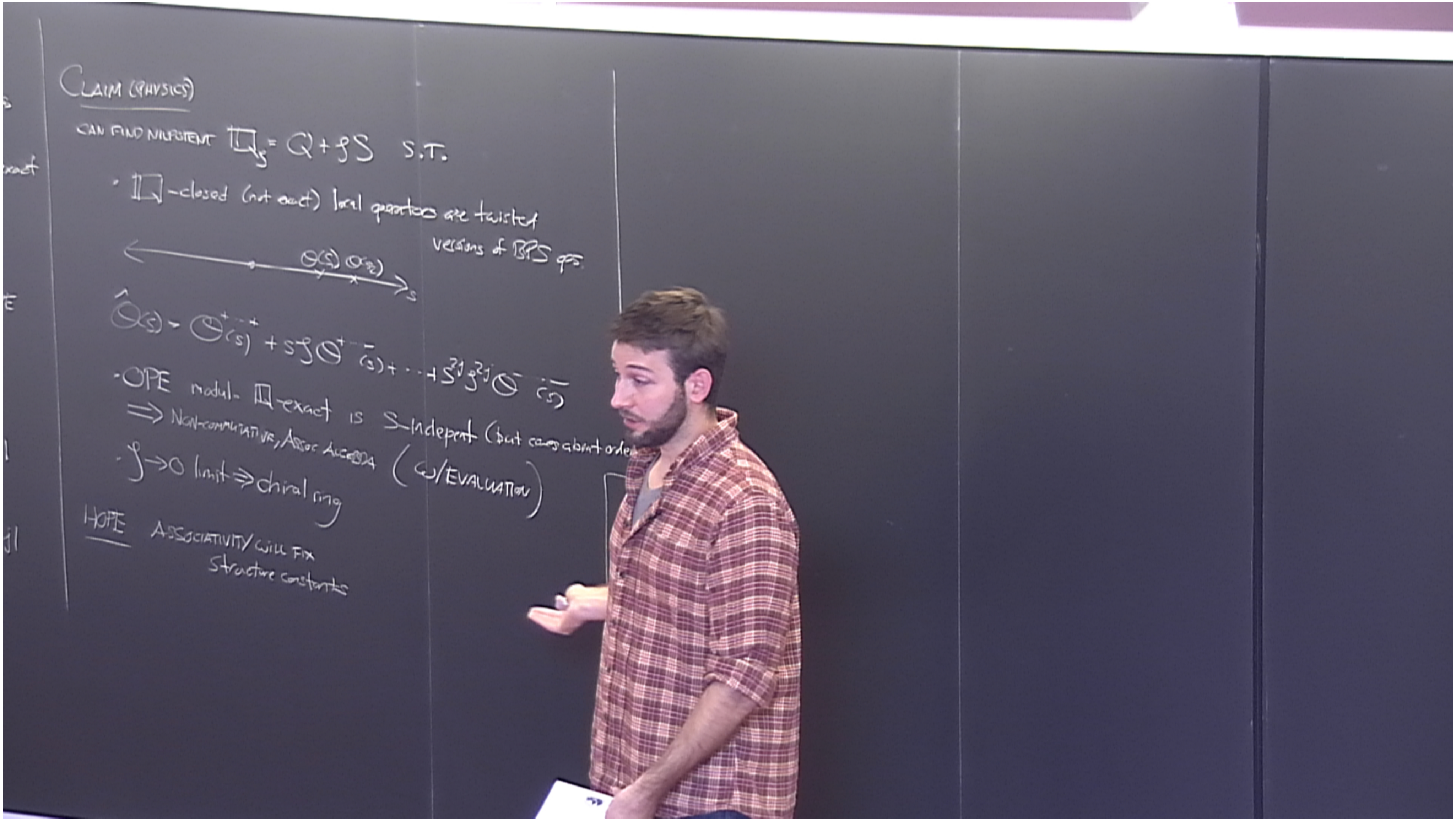
$\mathcal{O}(s_1) \quad \mathcal{O}(s_2) \quad s$

$$\hat{\mathcal{O}}(s) = \mathcal{O}^{+\cdots+}(s) + s\zeta\, \mathcal{O}^{+\cdots-}(s) + \cdots + s^{2j}\zeta^{2j}\, \mathcal{O}^{-\cdots-}(s)$$

- OPE modulo $\mathbb{Q}$-exact is s-independent (but cares about ordering)

$\Longrightarrow$ NON-COMMUTATIVE, ASSOC. ALGEBRA (W/ EVALUATION)

- $\zeta \to 0$ limit $\Rightarrow$ chiral ring



CLAIM (PHYSICS)
CAN FIND NILPOTENT $\mathbb{Q}_\varsigma = Q + \varsigma S$ S.T.
· $\mathbb{Q}$-closed (not exact) local operators are twisted versions of BPS ops.
$\mathcal{O}(s_1)\ \mathcal{O}(s_2)$
s
$\hat{\mathcal{O}}(s) = \mathcal{O}^{+\cdots+}(s) + s\varsigma\,\mathcal{O}^{+\cdots-}(s) + \cdots + s^{2j}\varsigma^{2j}\,\mathcal{O}^{-\cdots-}(s)$
· OPE modulo $\mathbb{Q}$-exact is s-independent (but cares about order)
$\Rightarrow$ NON-COMMUTATIVE, ASSOC ALGEBRA (W/EVALUATION)
· $\varsigma \to 0$ limit $\Rightarrow$ chiral ring
HOPE ASSOCIATIVITY WILL FIX structure constants

CLAIM (PHYSICS)

CAN FIND NILPOTENT $\mathbb{Q}_S = Q + \varrho S$ S.T.

- $\mathbb{Q}$-closed (not exact) local operators are twisted versions of BPS ops.

$\mathcal{O}(s)\ \mathcal{O}(s_2)$

$\hat{\mathcal{O}}(s) = \mathcal{O}^{+\cdots+}(s) + s\varrho\,\mathcal{O}^{+\cdots-}(s) + \cdots + s^{2j}\varrho^{2j}\mathcal{O}^{-\cdots-}(s)$

- OPE modulo $\mathbb{Q}$-exact is S-independent (but cares about ordering)

$\Rightarrow$ NON-COMMUTATIVE, ASSOC ALGEBRA (W/EVALUATION)

- $\varrho \to 0$ limit $\Rightarrow$ chiral ring

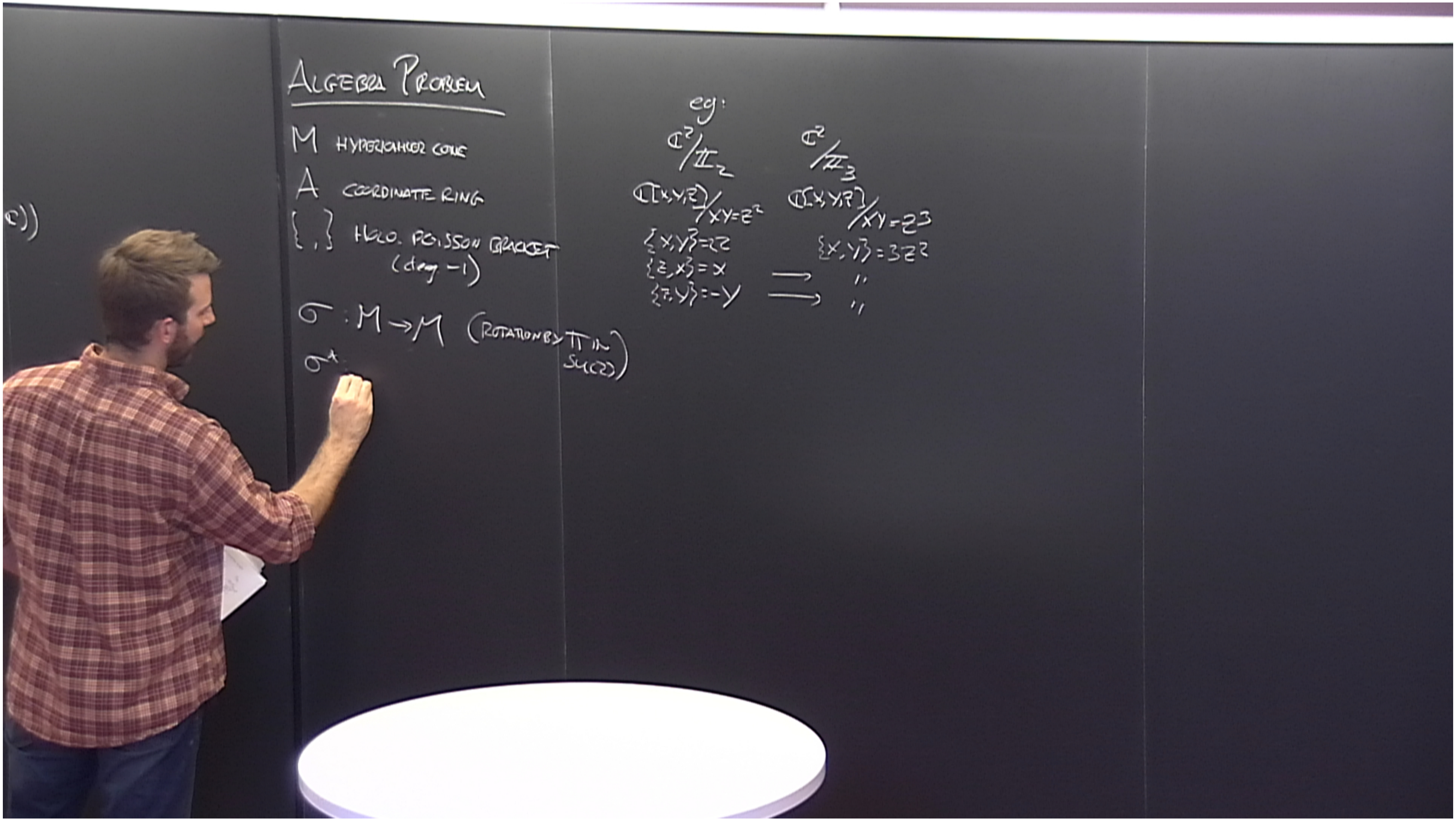
HOPE: ASSOCIATIVITY WILL FIX structure constants

Assoc Alg problem

DEF QUANTIZATION OF HK CONE

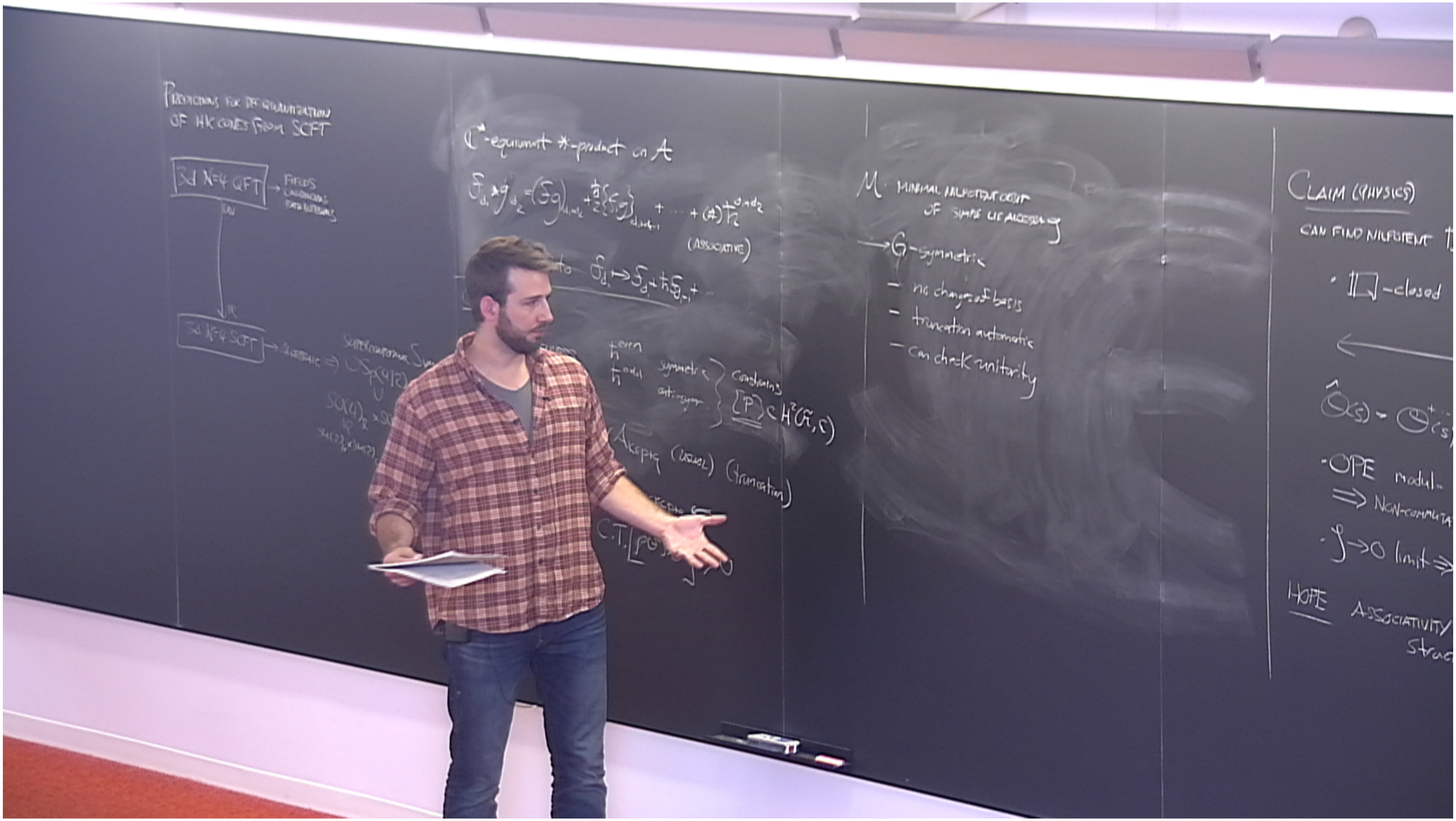
GOOD: CLASSIFICATION OF DEFS $(H^2(\tilde{\mathcal{M}};\mathbb{C}))$

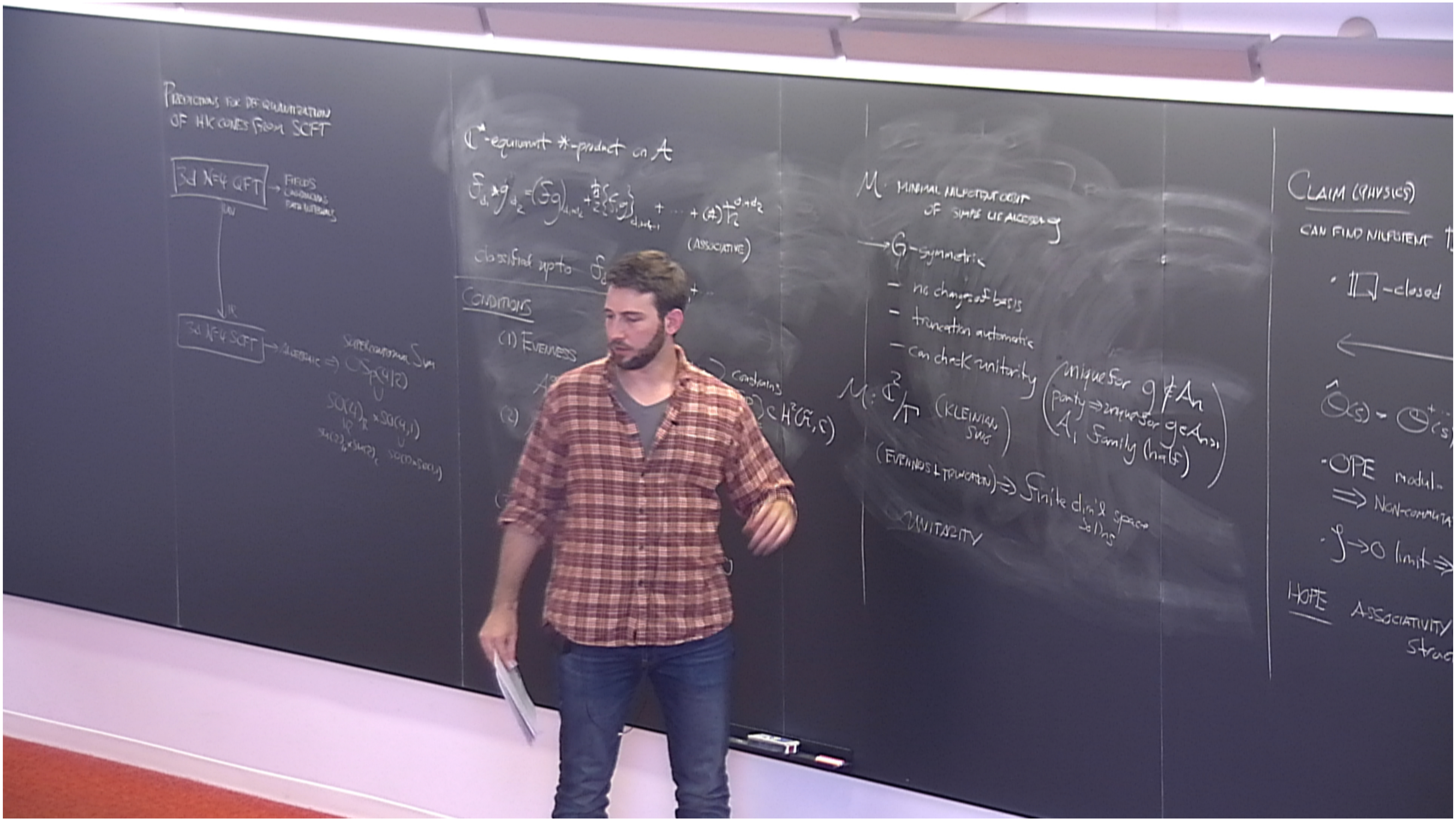
BAD: WRONG CLASSIFICATION

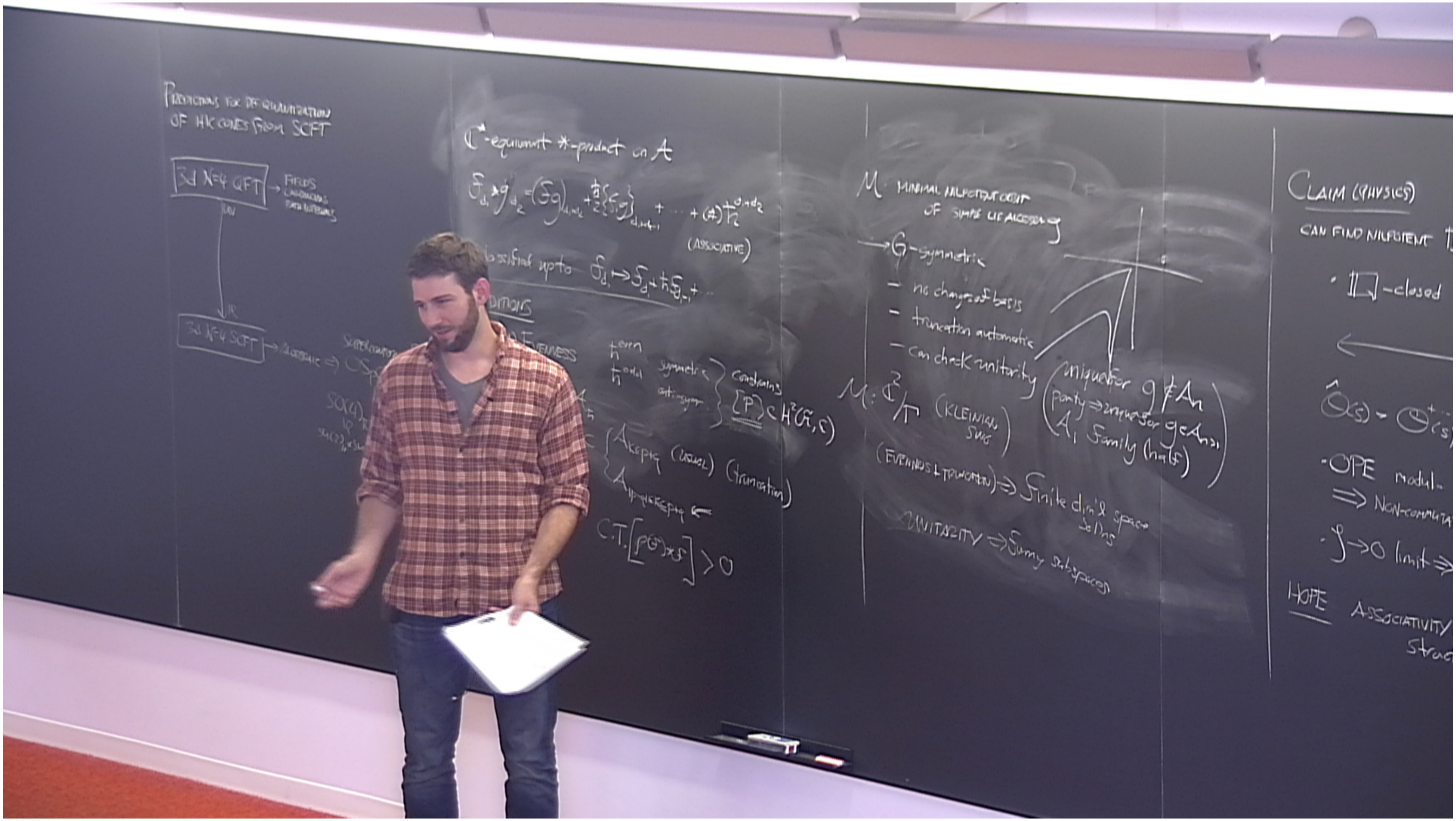

ALGEBRA PROBLEM
M HYPERKAHLER CONE
A COORDINATE RING
{ , } HOLO. POISSON BRACKET (deg -1)
σ : M → M (ROTATION BY π IN SU(2))
σ*
eg:
ℂ²/ℤ₂
ℂ[x,y,z]/xy=z²
{x,y}=2z
{z,x}=x
{z,y}=-y
ℂ²/ℤ₃
ℂ[x,y,z]/xy=z³
{x,y}=3z²
"
"

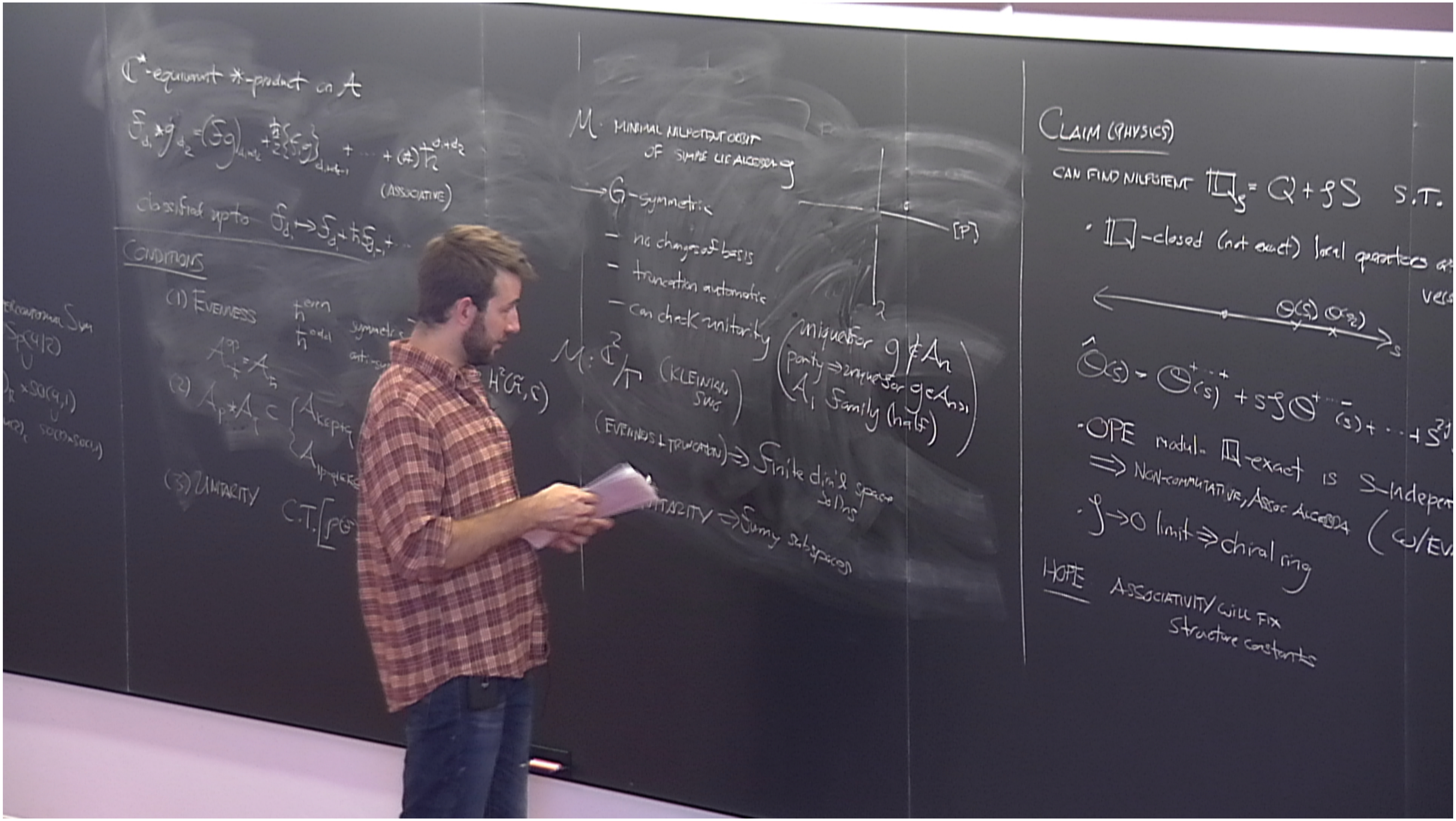

PREDICTIONS FOR DEF QUANTIZATION
OF HK CONES FROM SCFT
3d N=4 QFT
FIELDS
UV
IR
3d N=4 SCFT
C*-equivariant *-product on A
(ASSOCIATIVE)
classified up to
CONDITIONS
BPS operators
"HIGGS" Δ = r1 r2 = j = 0
"COULOMB" Δ = r2 r1 = j = 0
FORM COMMUTATIVE
· short distance
· OPE modulo
R-symmetry h.w.s
annihilated by half supercharges
CHIRAL RING ⟺ COORDINATE
RING ON A
HK
(Δ, r) ⟺ C* grading
SU(2)R ⟺ SU(2) ISOMETRY
QUESTION


OF HK CONES FROM SCFT
3d N=4 QFT
FIELDS
LAGRANGIANS
PATH INTEGRALS
UV
IR
3d N=4 SCFT
ALGEBRAIC
C*-equivariant *-product on A
(ASSOCIATIVE)
classified up to
CONDITIONS
(1) EVENNESS
symmetric
anti-symm.
BPS operators
"HIGGS" Δ = r1 r2 = j = 0
"COULOMB" Δ = r2 r1 = j = 0
FORM COMMUTATIVE
· short distance OPE
· OPE modulo
R-symmetry h.w.s
annihilated by half supercharges
CHIRAL RING ⟺ COORDINATE RING ON A
HK
(Δ, r) ⟺ C* grading
SU(2)R ⟺ SU(2) ISOMETRY
QUESTION

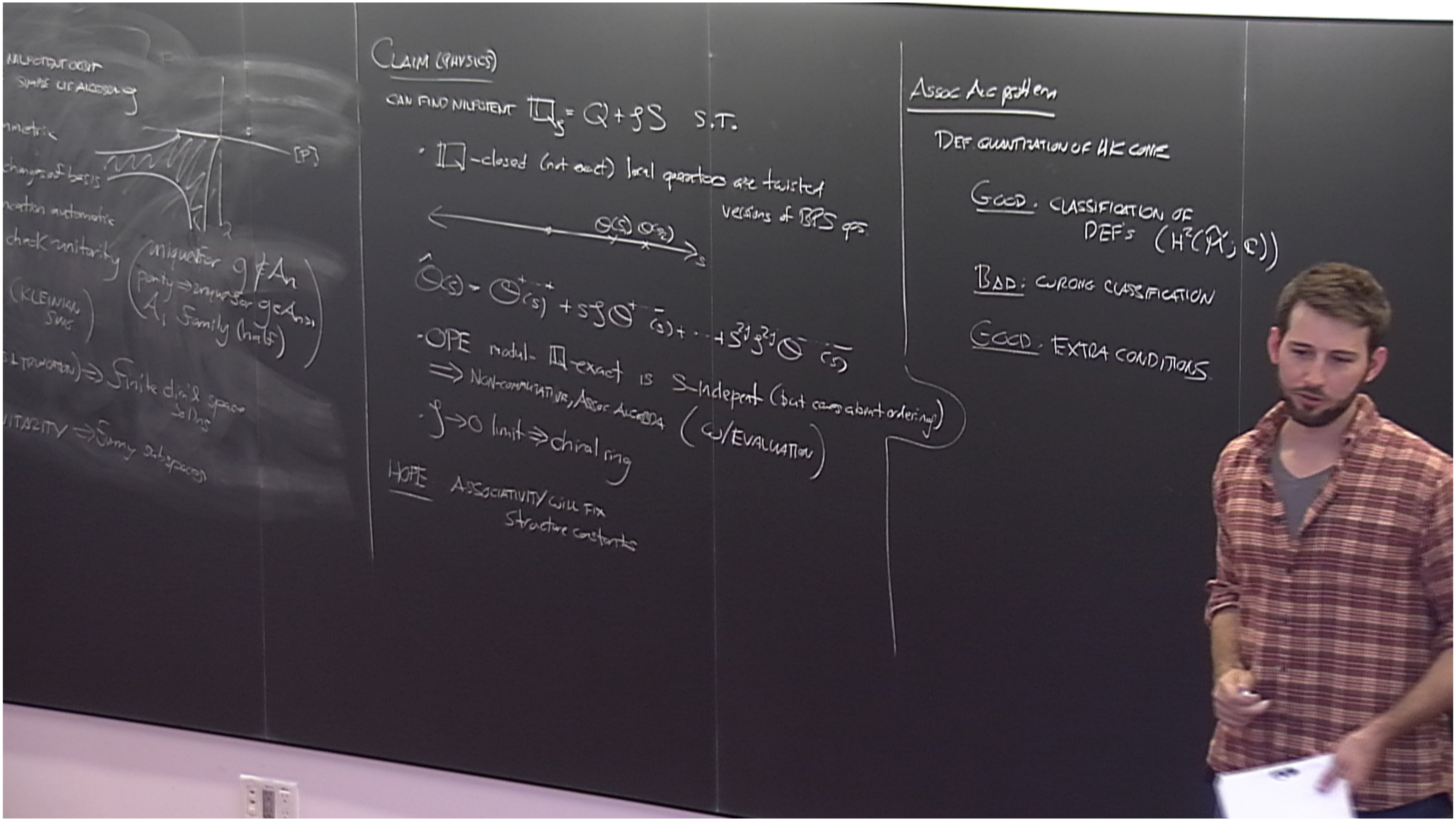

OF HK CONES FROM SCFT
3d N=4 QFT
3d N=4 SCFT
C*-equivariant *-product on A
(ASSOCIATIVE)
M · MINIMAL NILPOTENT ORBIT
OF SIMPLE LIE ALGEBRA g
→ G-symmetric
– no change of basis
– truncation automatic
– can check unitarity
CLAIM (PHYSICS)
CAN FIND NILPOTENT
-OPE modul.
⇒ NON-COMMUTA
HOPE ASSOCIATIVITY


PREDICTIONS FOR DEFORMATION QUANTIZATION
OF HK CONES FROM SCFT
3d N=4 QFT
FIELDS
3d N=4 SCFT
CONDITIONS
(1) EVENNESS
(ASSOCIATIVE)
M: MINIMAL NILPOTENT ORBIT OF SIMPLE LIE ALGEBRA
G-symmetric
- no changes of basis
- truncation automatic
- can check unitarity
(KLEINIAN SING)
(EVENNESS + TRUNCATION) ⇒ finite dim'l space sol'ns
UNITARITY
CLAIM (PHYSICS)
CAN FIND NILPOTENT
-OPE
HOPE ASSOCIATIVITY


PREDICTIONS FOR DEFORMATION QUANTIZATION
OF HK CONES FROM SCFT
3d N=4 QFT
3d N=4 SCFT
ℂ-equivariant *-product on A
(ASSOCIATIVE)
M: MINIMAL NILPOTENT ORBIT
OF SIMPLE LIE ALGEBRA g
→ G-symmetric
– no change of basis
– truncation automatic
– can check unitarity
(KLEINIAN SING)
A1 family (half)
(EVENNESS + TRUNCATION) ⇒ finite dim'l space of sol'ns
UNITARITY ⇒ Sunny subspaces
CLAIM (PHYSICS)
CAN FIND NILPOTENT
-OPE modul.
⇒ NON-COMMUTA
HOPE ASSOCIATIVITY



C*-equivariant *-product on A
(ASSOCIATIVE)
classified up to
CONDITIONS
(1) EVENNESS
(2)
(3) UNITARITY
M. MINIMAL NILPOTENT ORBIT OF SIMPLE LIE ALGEBRA g
G-symmetric
— no change of basis
— truncation automatic
— can check unitarity
(KLEINIAN SING)
unique for g ∉ A_n
A_1 family (half)
(EVENNESS & TRUNCATION) ⇒ finite dim'l space sol'ns
UNITARITY ⇒ Sunny subspaces
CLAIM (PHYSICS)
CAN FIND NILPOTENT
S.T.
-closed (not exact) local operators
-OPE modulo -exact IS S-independent
⇒ NON-COMMUTATIVE, ASSOC ALGEBRA
limit ⇒ chiral ring
HOPE ASSOCIATIVITY WILL FIX Structure constants


CLAIM (PHYSICS)
CAN FIND NILPOTENT Q_S = Q + gS S.T.
-closed (not exact) local operators are twisted
versions of BPS ops
OPE modulo -exact is S-independent
⇒ NON-COMMUTATIVE, ASSOC ALGEBRA (W/EVALUATION)
g → 0 limit ⇒ chiral ring
HOPE ASSOCIATIVITY WILL FIX
Structure constants
Assoc Alg problem
DEF QUANTIZATION OF HK CONE
GOOD. CLASSIFICATION OF
DEF'S
BAD: WRONG CLASSIFICATION
GOOD. EXTRA CONDITIONS
check unitarity
Finite dim'l space