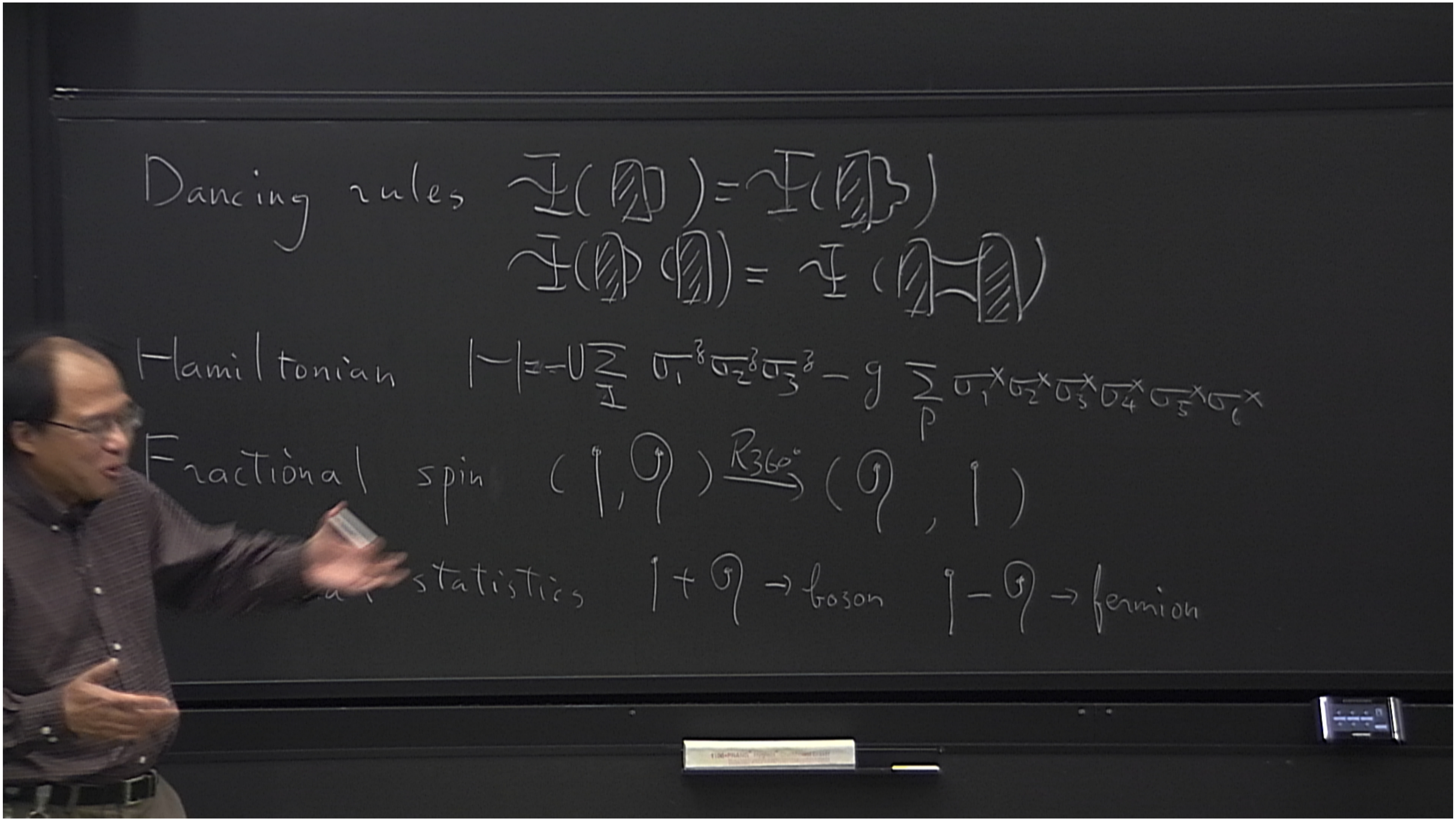
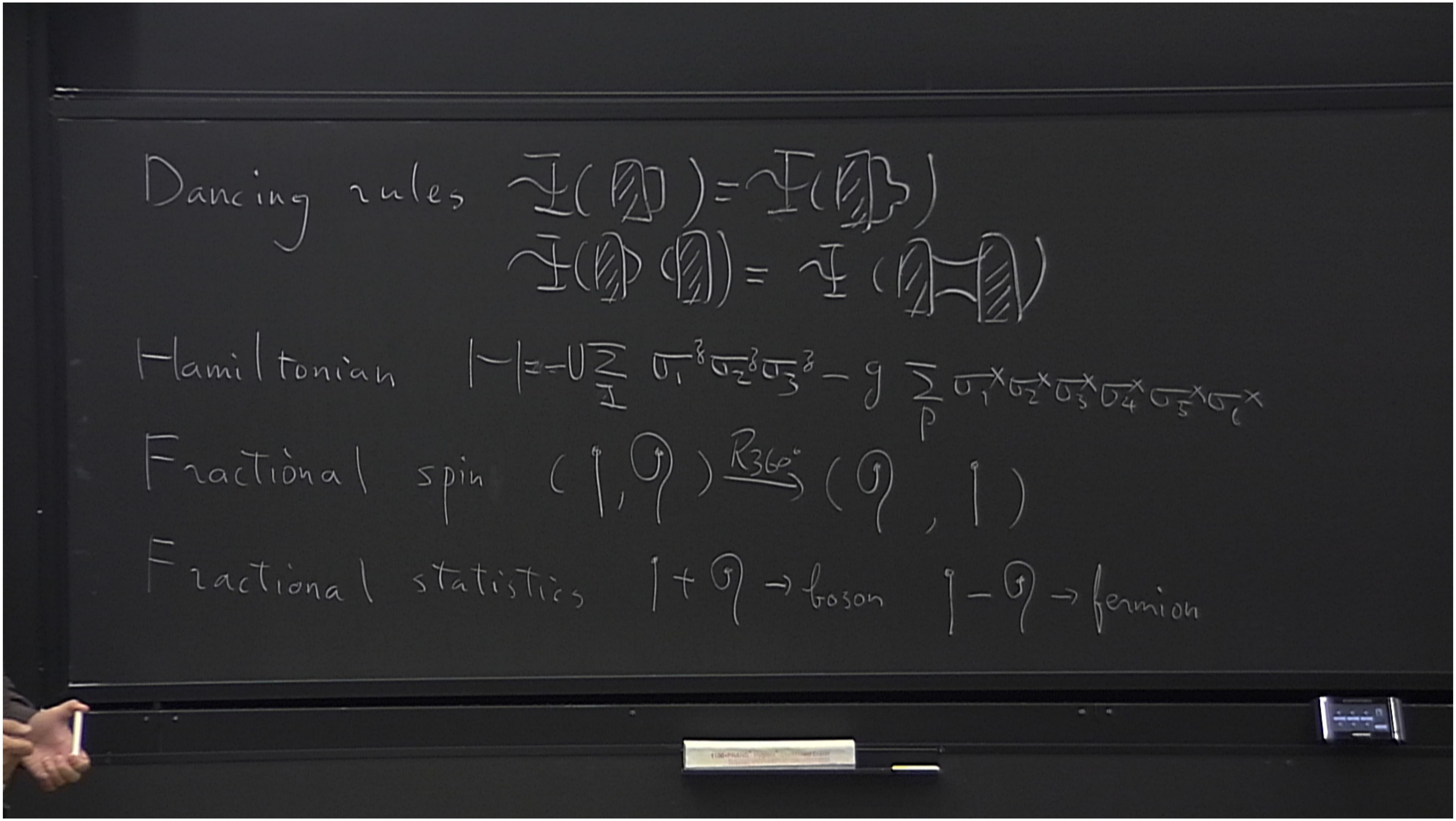
Title: 12/13 PSI - Explorations in Condensed Matter Lecture 14

Date: Apr 25, 2013 09:00 AM

URL: http://pirsa.org/13040060

Abstract:


Dancing rules
Hamiltonian $H = -U \sum_I \sigma_1^z \sigma_2^z \sigma_3^z - g \sum_p \sigma_1^x \sigma_2^x \sigma_3^x \sigma_4^x \sigma_5^x \sigma_6^x$
Fractional spin
$R_{360°}$
statistics
boson
fermion


Dancing rules
Hamiltonian $H = -U\sum_I \sigma_1^z\sigma_2^z\sigma_3^z - g\sum_p \sigma_1^x\sigma_2^x\sigma_3^x\sigma_4^x\sigma_5^x\sigma_6^x$
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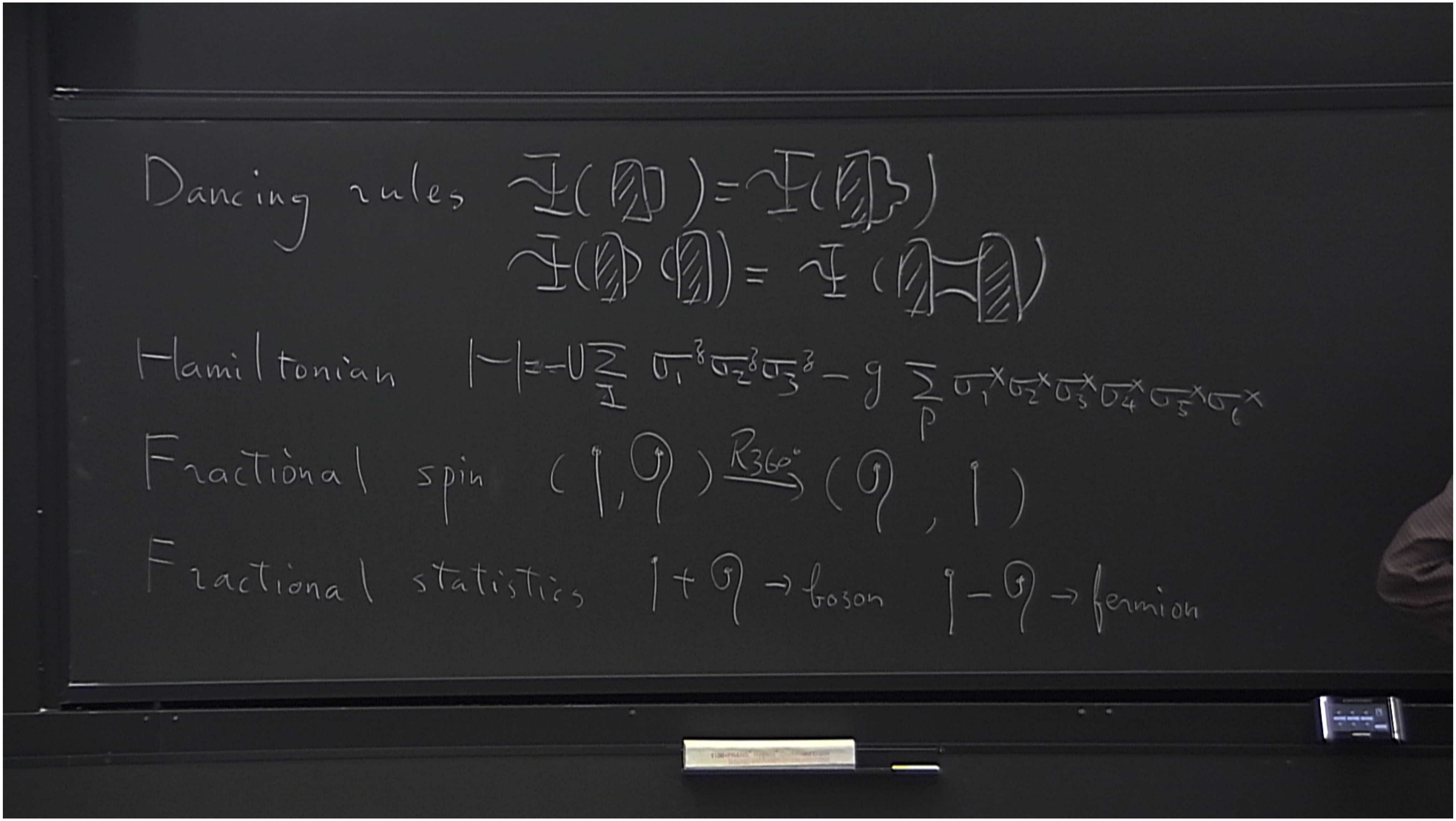
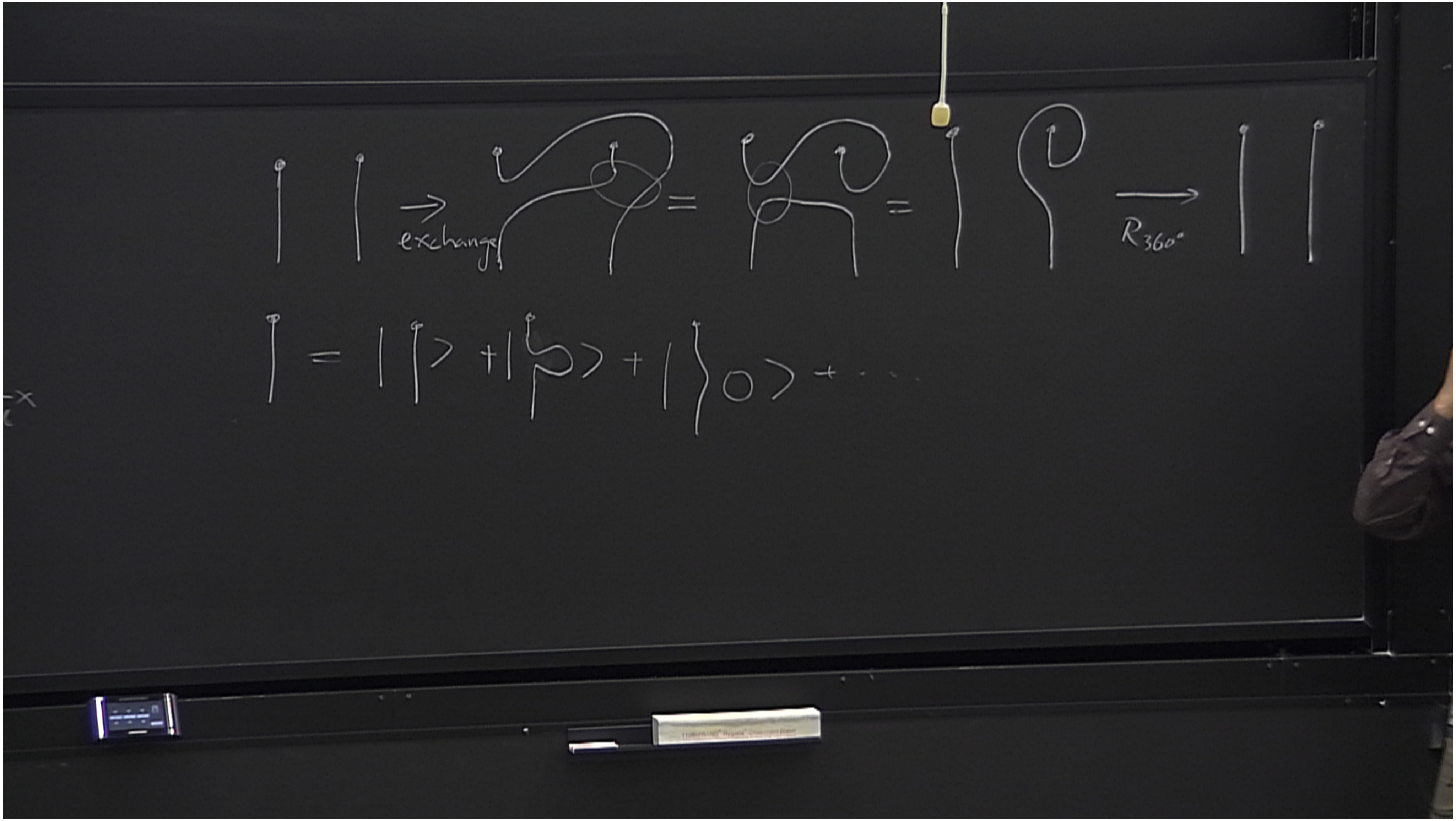
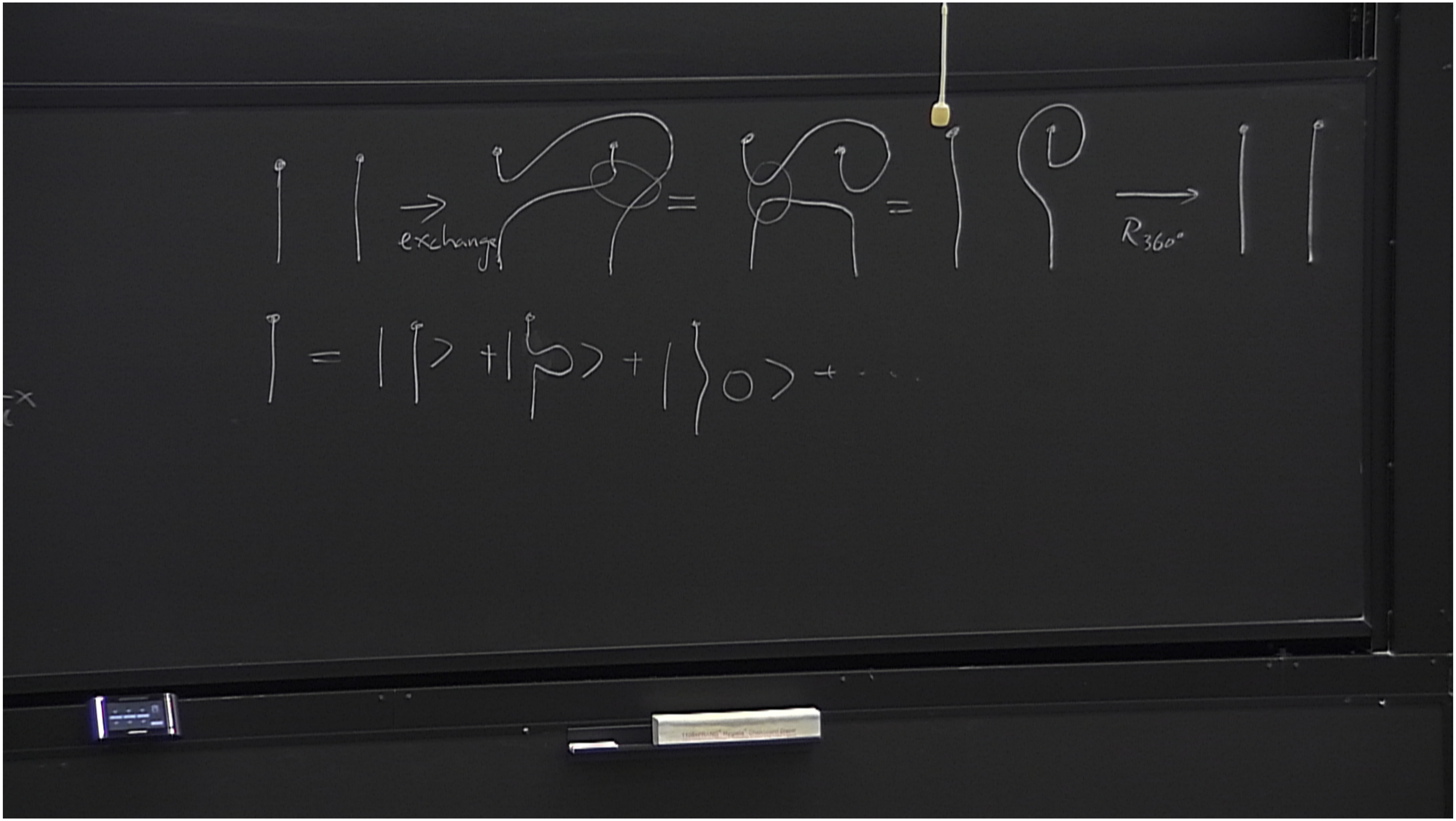
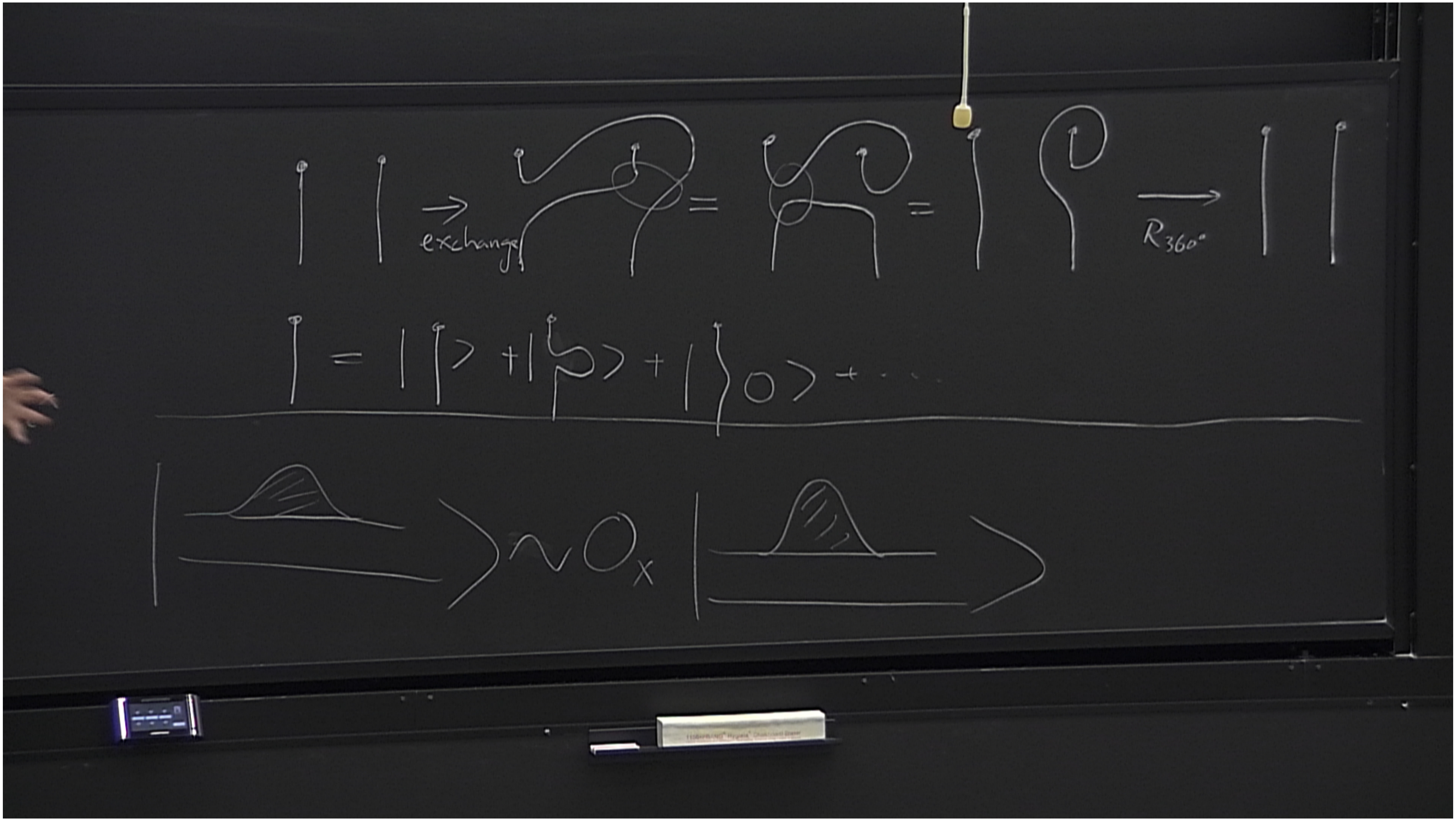
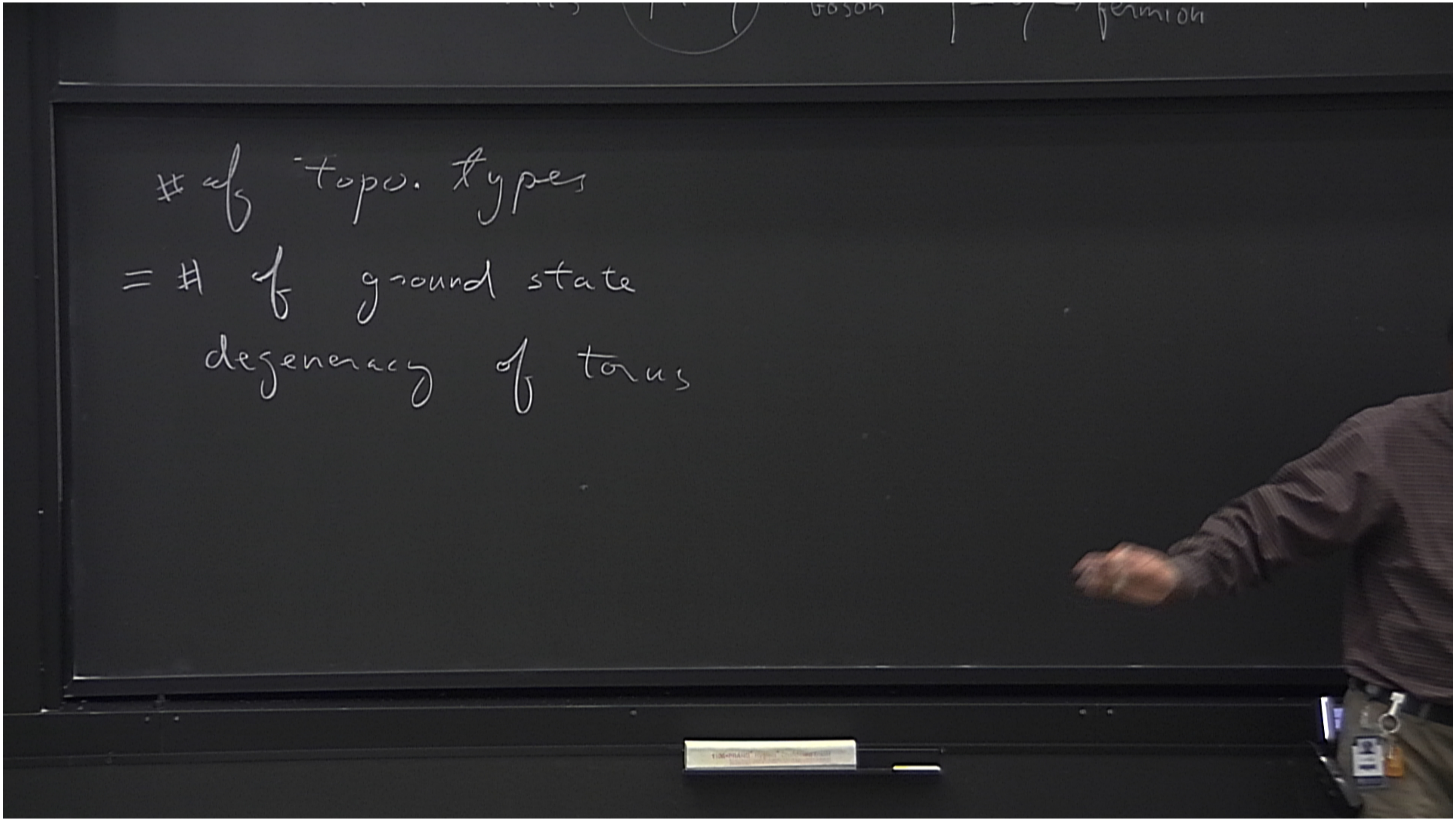
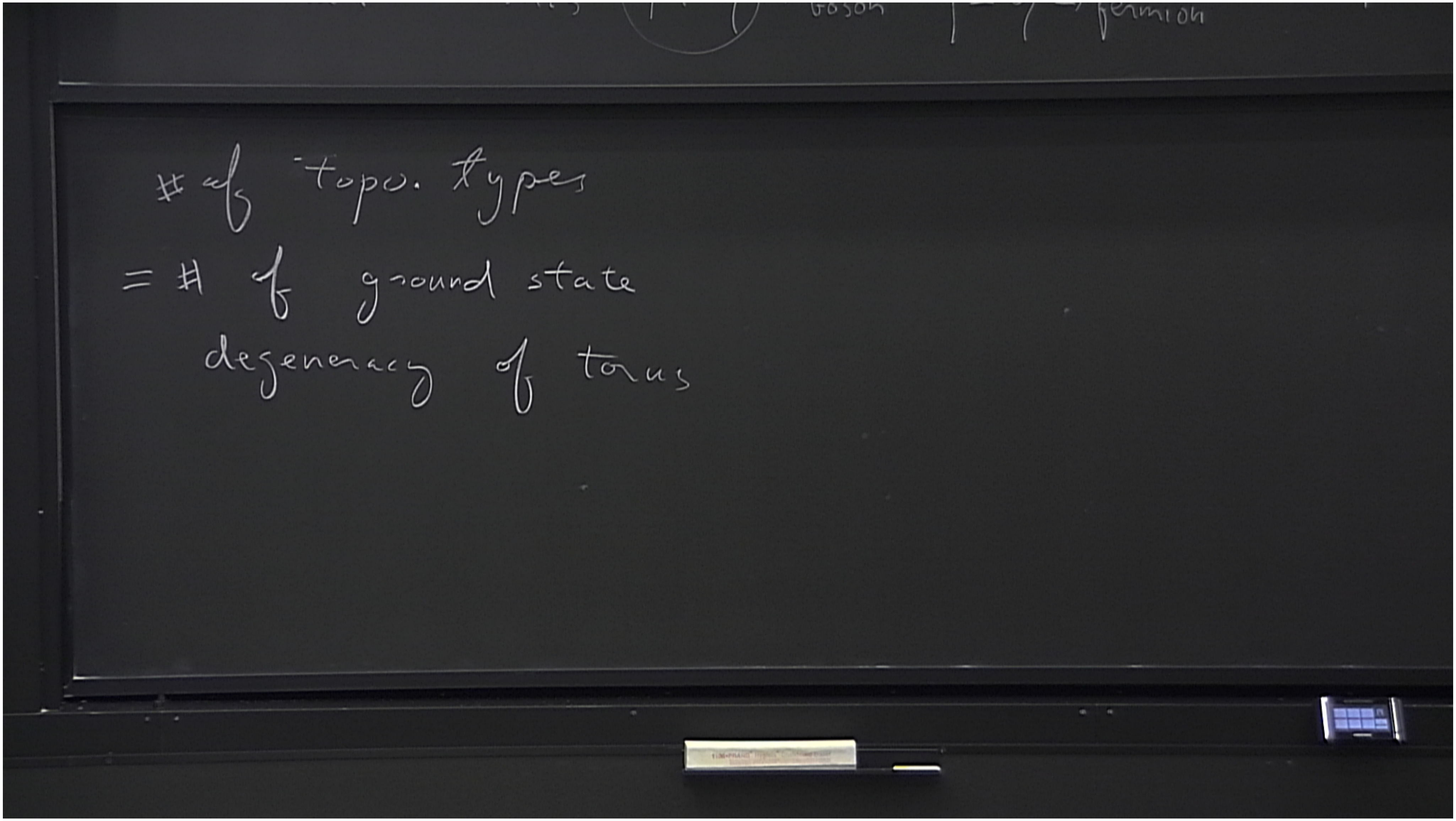

Dancing rules
Hamiltonian $H = -U \sum_{I} \sigma_1^z \sigma_2^z \sigma_3^z - g \sum_{p} \sigma_1^x \sigma_2^x \sigma_3^x \sigma_4^x \sigma_5^x \sigma_6^x$
Fractional spin
R360°
Fractional statistics
→ boson
→ fermion

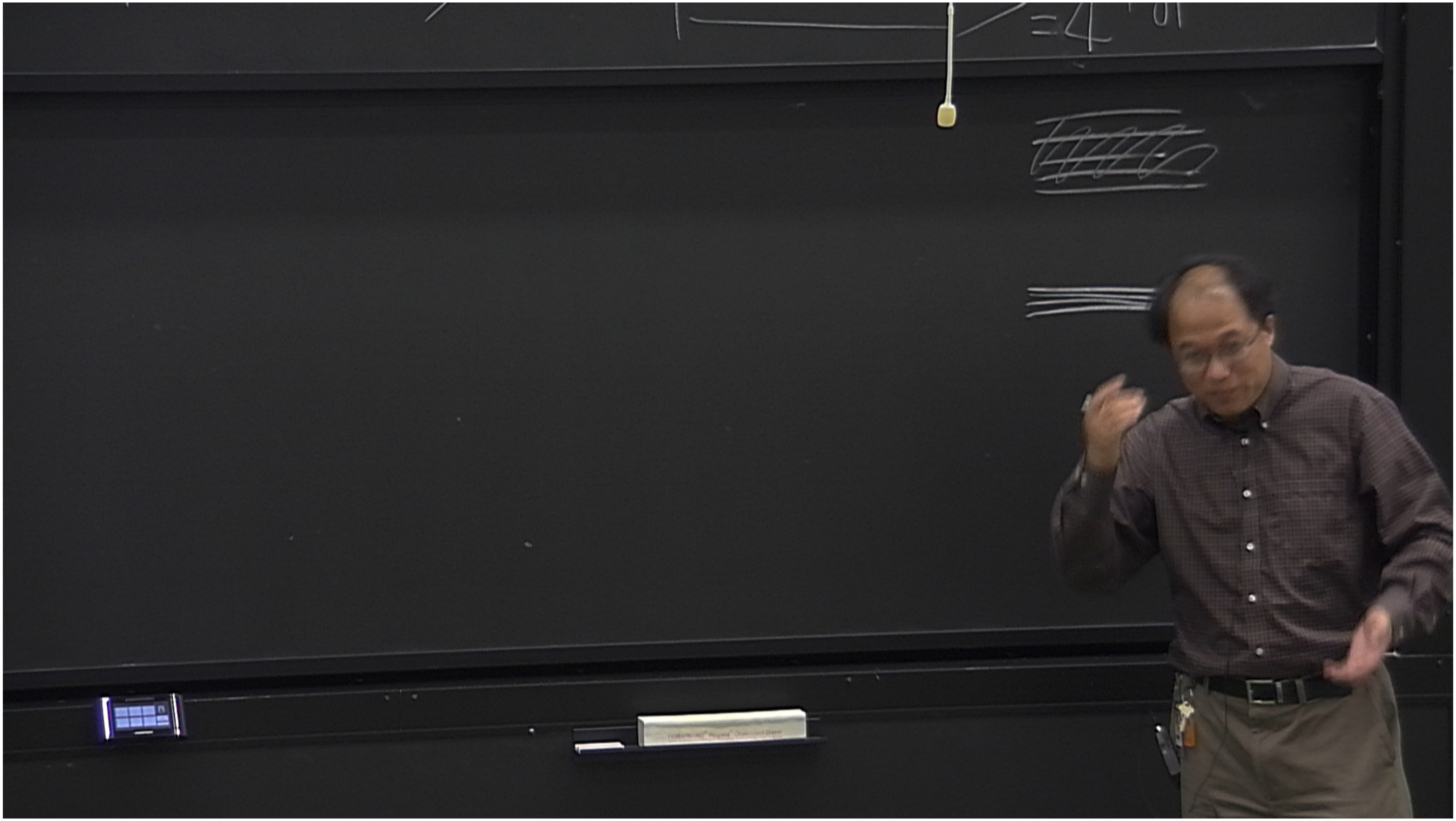

exchange
$R_{360°}$

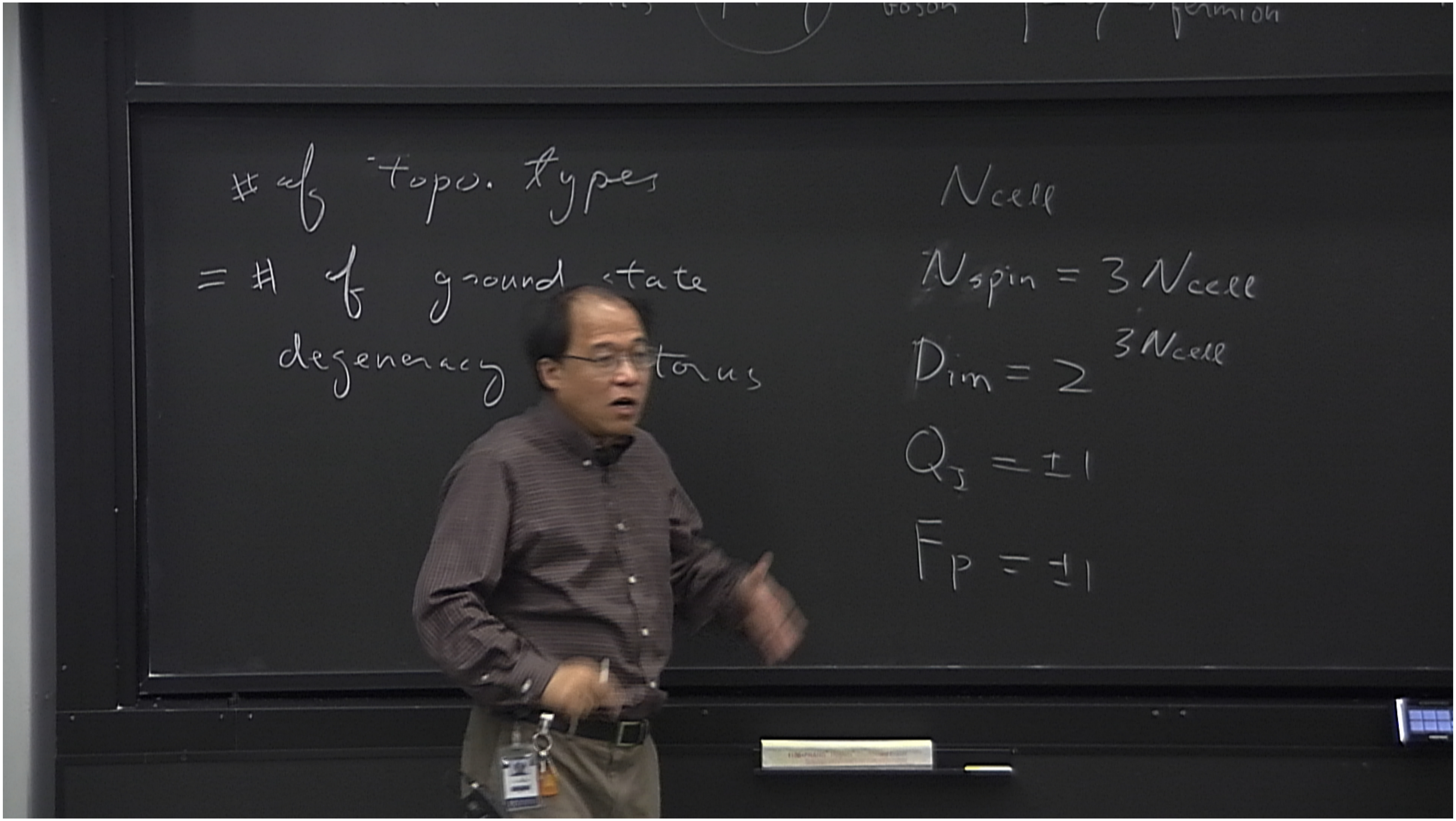

exchange
R360°

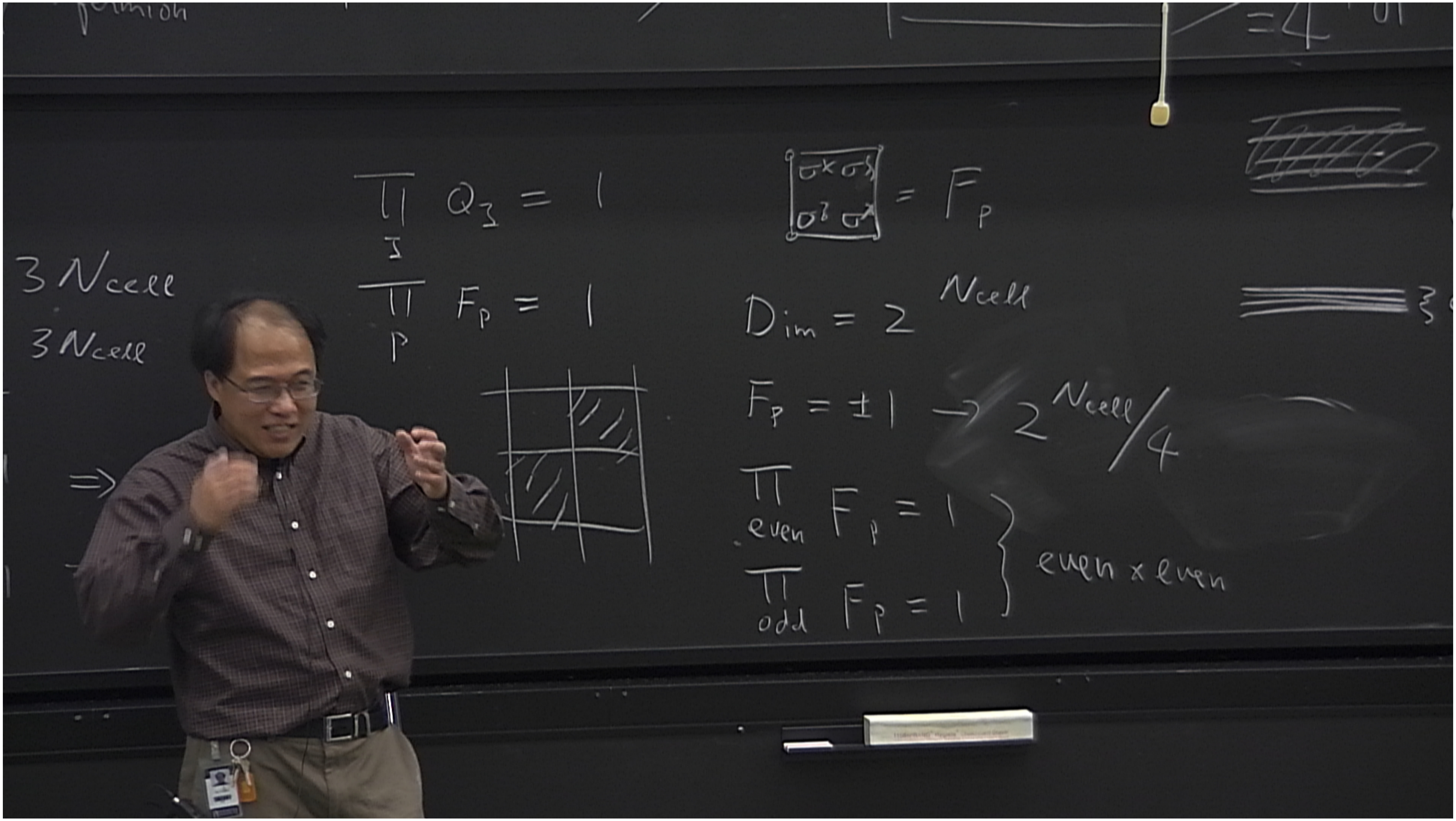

exchange
$R_{360°}$

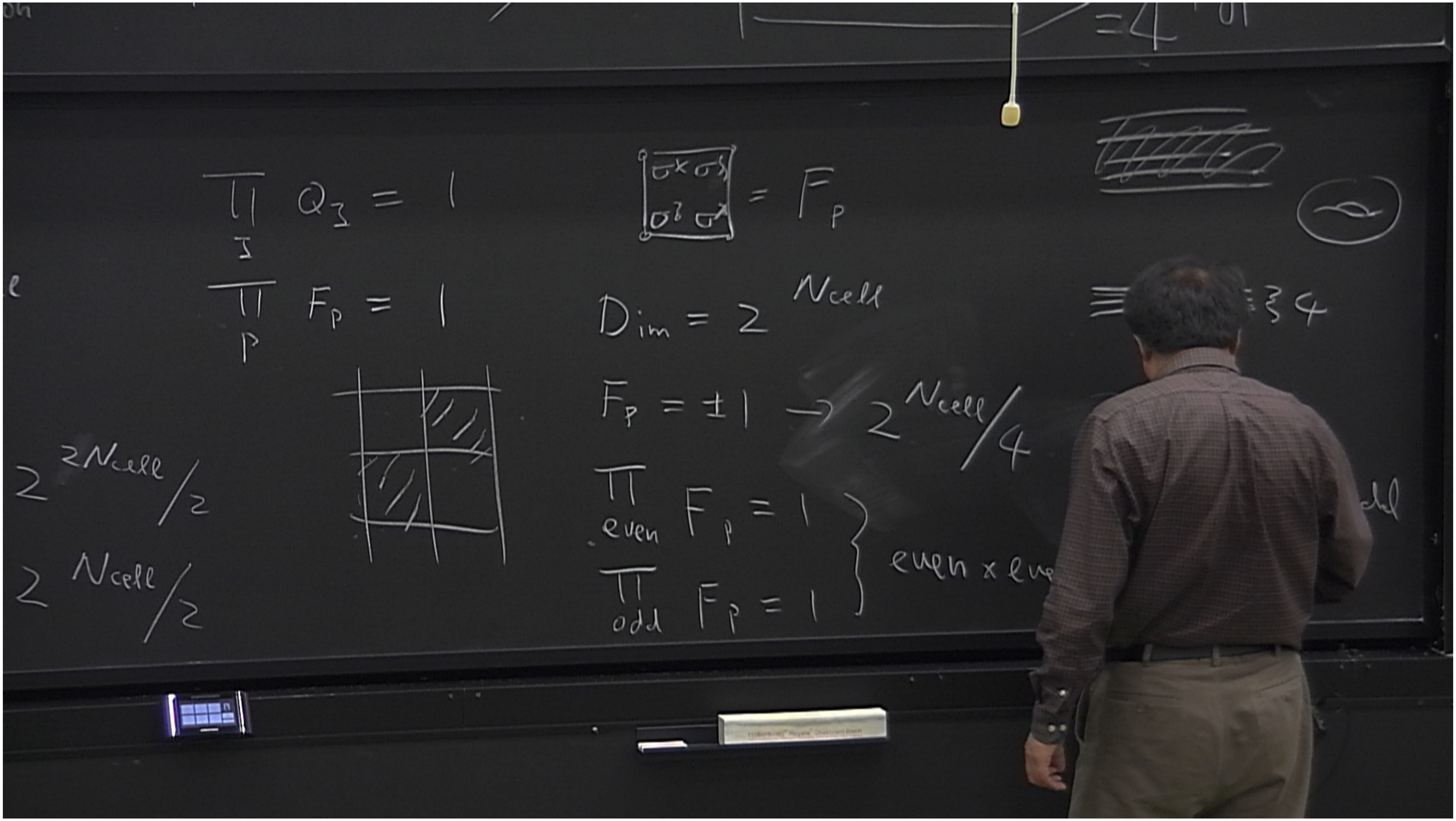

boson
fermion
# of topo. types
= # of ground state
degeneracy of torus

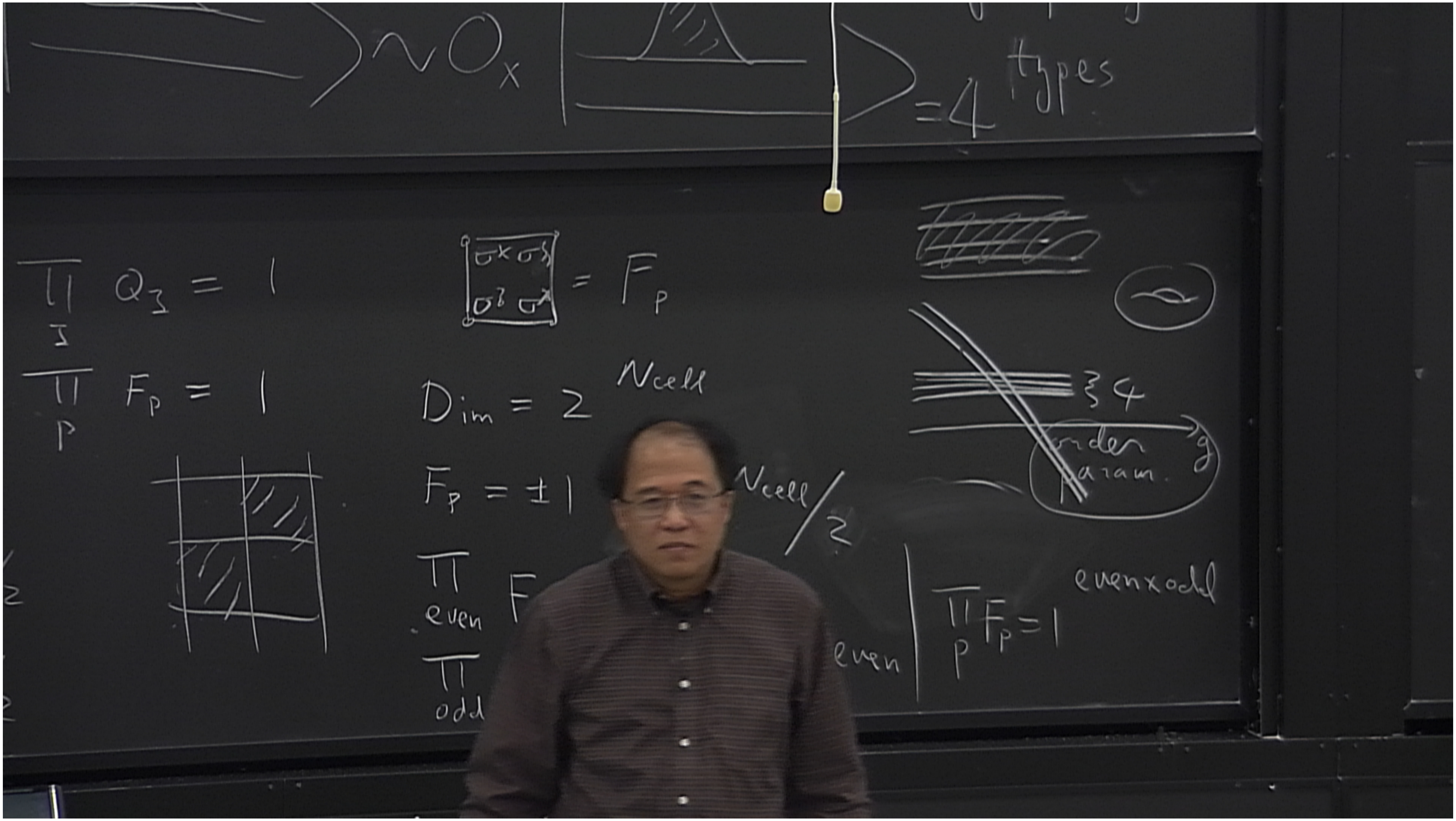

boson
fermion
# of topo. types
= # of ground state
degeneracy of torus

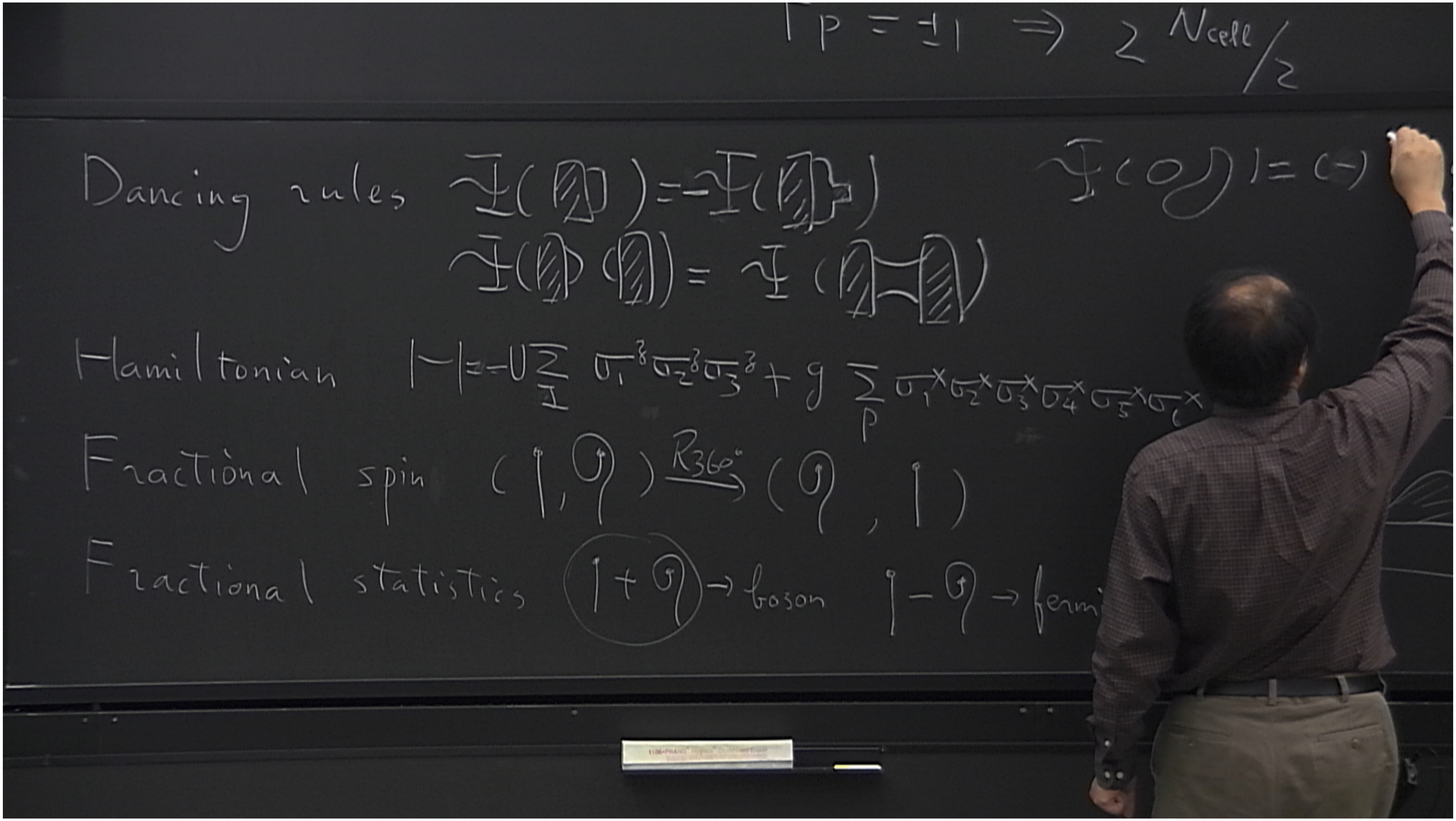


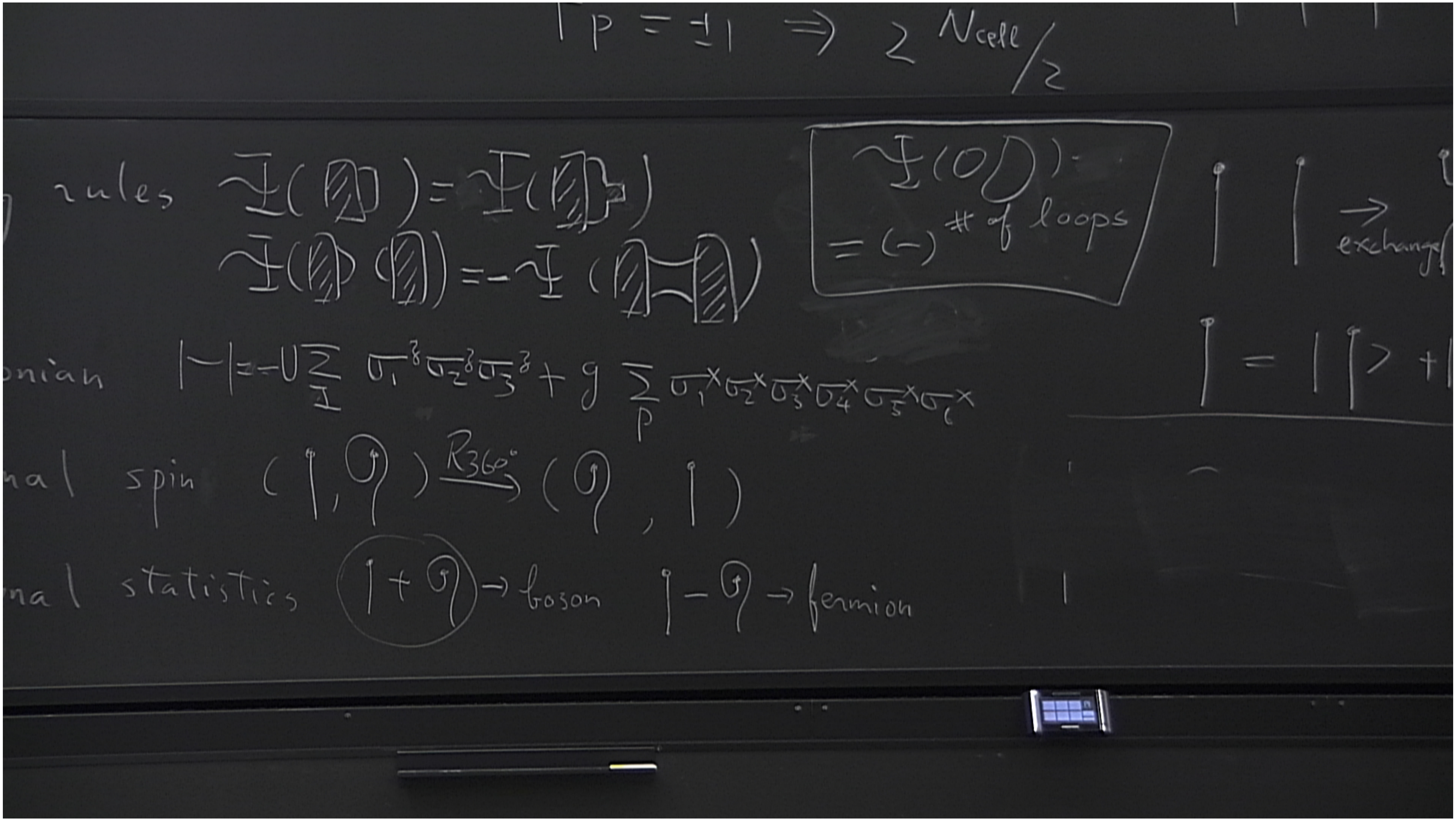

boson
fermion
# of topo. types
= # of ground state
degeneracy
torus
Ncell
Nspin = 3 Ncell
Dim = 2 3Ncell
QI = ±1
Fp = ±1




Π Q_J = 1
Π F_p = 1
= F_p
Dim = 2^Ncell
F_p = ±1 → 2^Ncell/4
Π even F_p = 1
Π odd F_p = 1
2^2Ncell/2
2^Ncell/2


$\sim O_x$
$= 4$ types
$\prod_s Q_s = 1$
$\prod_p F_p = 1$
$= F_p$
$Dim = 2^{N_{cell}}$
$F_p = \pm 1$
$N_{cell}/2$
even
odd
order param.
even x odd
$\prod_p F_p = 1$


$\Gamma_p = \pm 1 \Rightarrow 2^{N_{cell}/2}$
Dancing rules
$\Phi(\ ) = (-)$
Hamiltonian $H = -U \sum_I \sigma_1^z \sigma_2^z \sigma_3^z + g \sum_p \sigma_1^x \sigma_2^x \sigma_3^x \sigma_4^x \sigma_5^x \sigma_6^x$
Fractional spin
R_{360°
Fractional statistics
→ boson
→ fermi


rules
= (−) # of loops
exchange
onian
nal spin
R360°
nal statistics
→ boson
→ fermion

$\Gamma_p = \pm 1 \Rightarrow 2^{N_{cell}/2}$

Dancing rules $\tilde{\Phi}(\ ) = \tilde{\Phi}(\ )$

$\tilde{\Phi}(\ )(\ ) = -\tilde{\Phi}(\ )$

$$\boxed{\tilde{\Phi}(\ ) = (-)^{\#\text{ of loops}}}$$

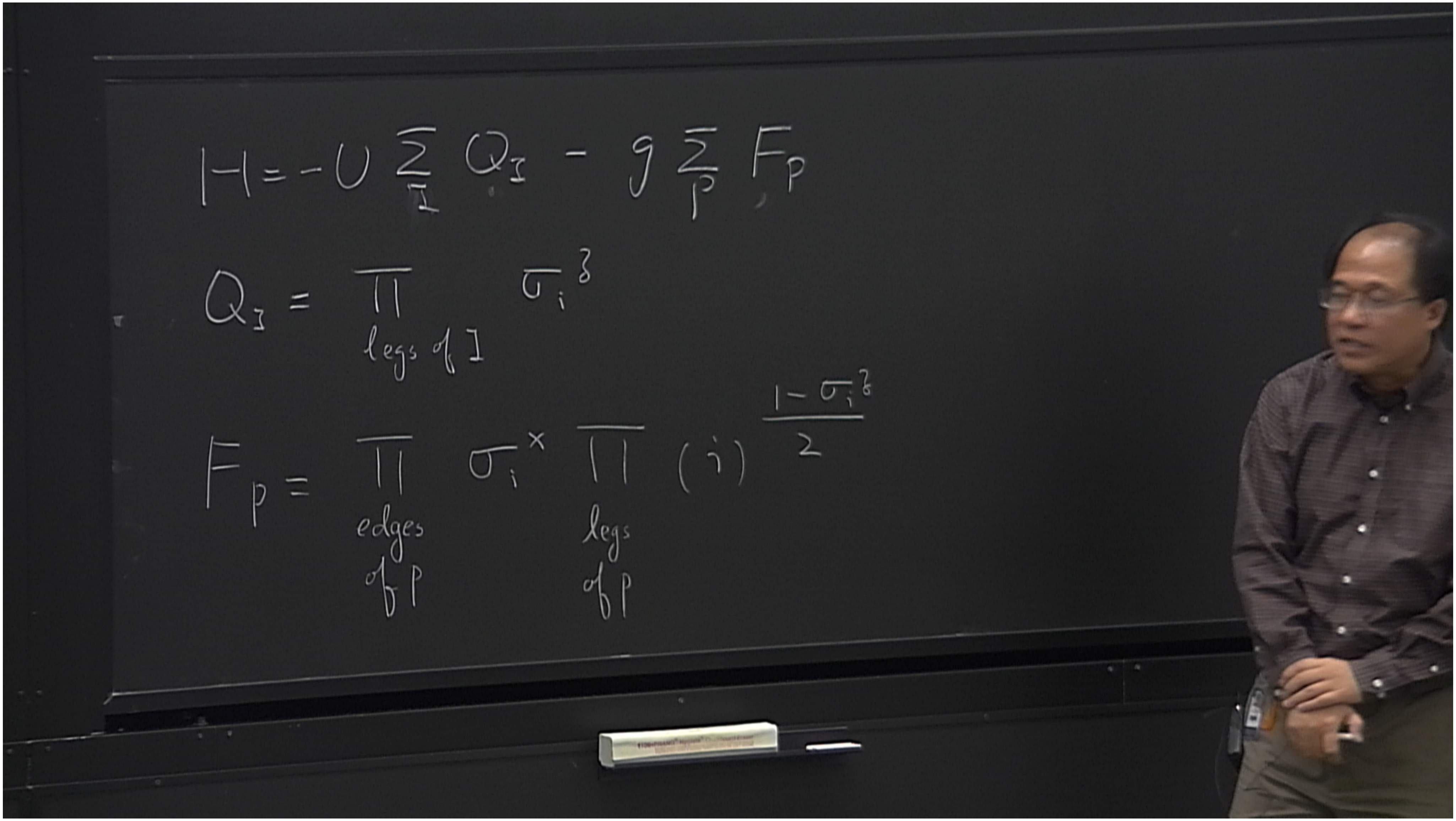
Hamiltonian $H = -U \sum_I \overbrace{\sigma_1^z \sigma_2^z \sigma_3^z}^{Q_I} + g \sum_p \overbrace{\sigma_1^x \sigma_2^x \sigma_3^x \sigma_4^x \sigma_5^x \sigma_6^x}^{F_p}$

Fractional spin $(\ ,\ ) \xrightarrow{R_{360^\circ}} (\ ,\ )$ i $-i$

R_{360}

Fractional statistics $\underset{\text{spin-}1/4}{|+i\ } \rightarrow$ boson $\underset{\text{spin-}-1/4}{|-i\ } \rightarrow$ fermion

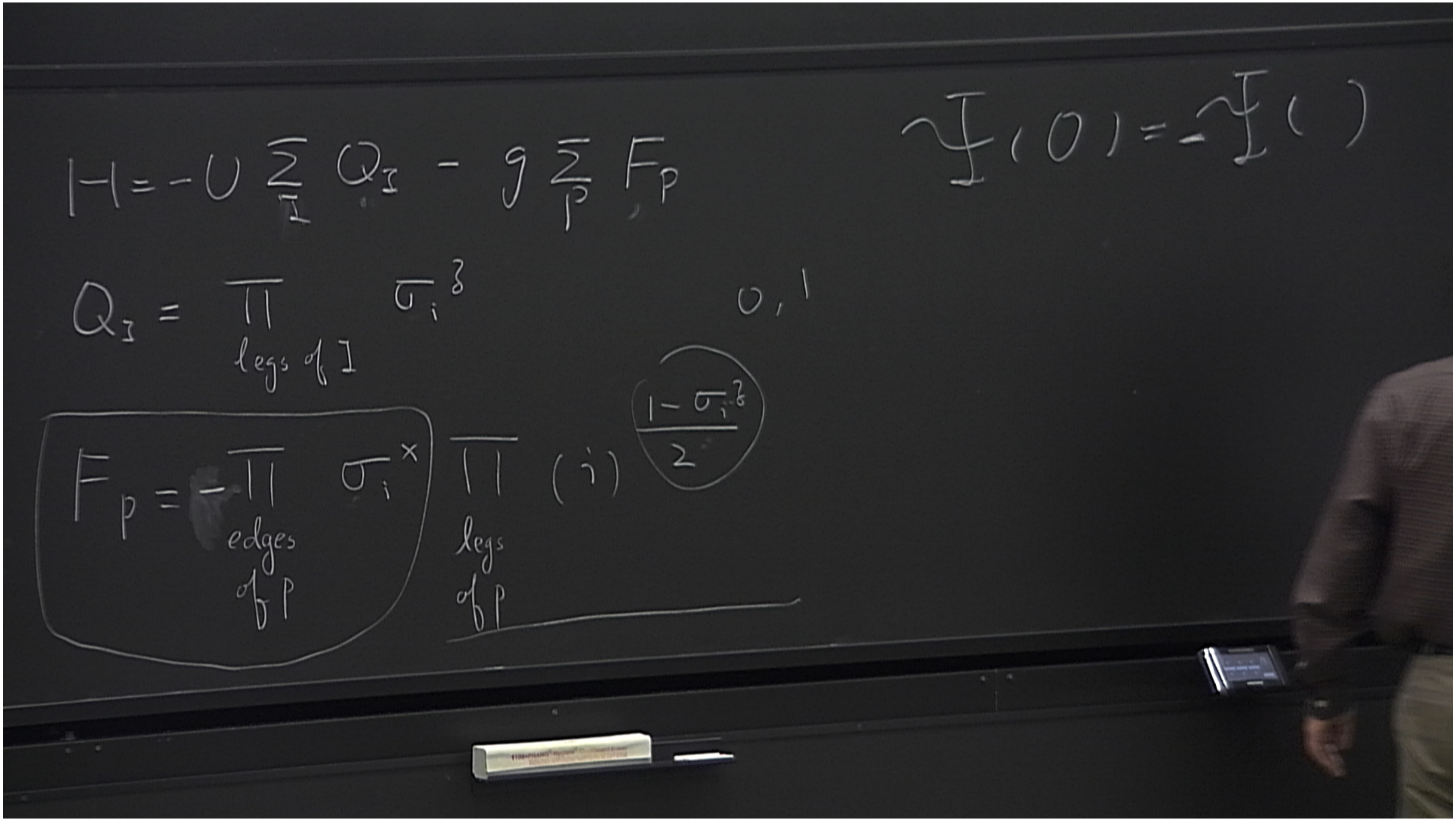
$= -$

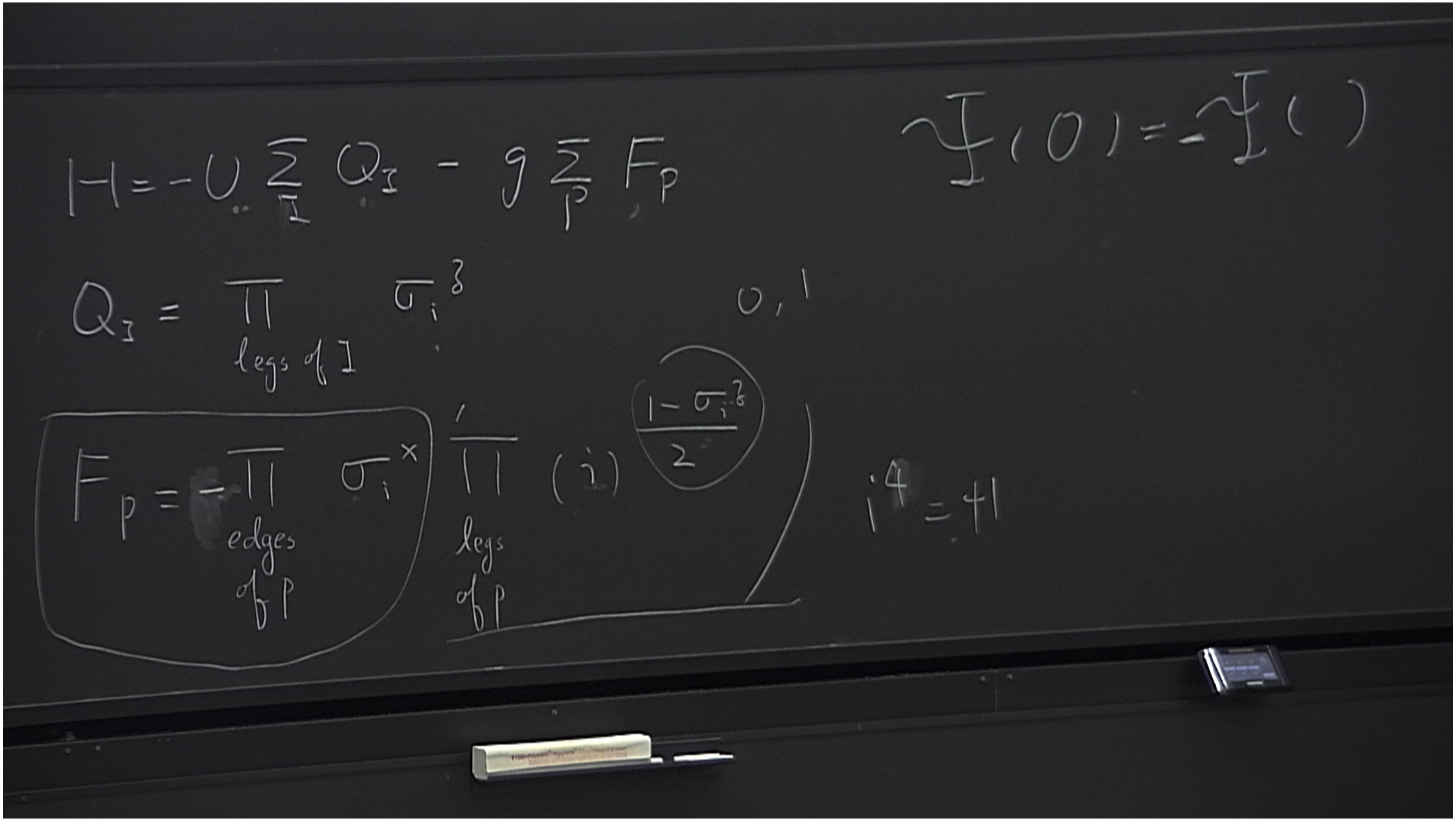

$H = -U \sum_{I} Q_I - g \sum_{p} F_p$
$Q_I = \prod_{\text{legs of } I} \sigma_i^z$
$F_p = \prod_{\text{edges of } p} \sigma_i^x \prod_{\text{legs of } p} (i)^{\frac{1-\sigma_i^z}{2}}$

$$H = -U \sum_{I} Q_I - g \sum_{p} F_p$$

$$Q_I = \prod_{\text{legs of } I} \sigma_i^z$$

$$\boxed{F_p = \prod_{\substack{\text{edges}\\ \text{of } p}} \sigma_i^x} \prod_{\substack{\text{legs}\\ \text{of } p}} (i)^{\frac{1-\sigma_i^z}{2}}$$


$H = -U \sum_{I} Q_I - g \sum_{p} F_p$
$\Psi(O) = -\Psi(\ )$
$Q_I = \prod_{\text{legs of } I} \sigma_i^z$
$0, 1$
$\boxed{F_p = -\prod_{\text{edges of } p} \sigma_i^x}\ \prod_{\text{legs of } p} (i)^{\frac{1-\sigma_i^z}{2}}$


$H = -U \sum_I Q_I - g \sum_p F_p$
$\Psi(0) = -\Psi(\ )$
$Q_I = \prod_{\text{legs of } I} \sigma_i^z$
$0, 1$
$F_p = -\prod_{\text{edges of } p} \sigma_i^x \prod_{\text{legs of } p} (i)^{\frac{1-\sigma_i^z}{2}}$
$i^4 = +1$