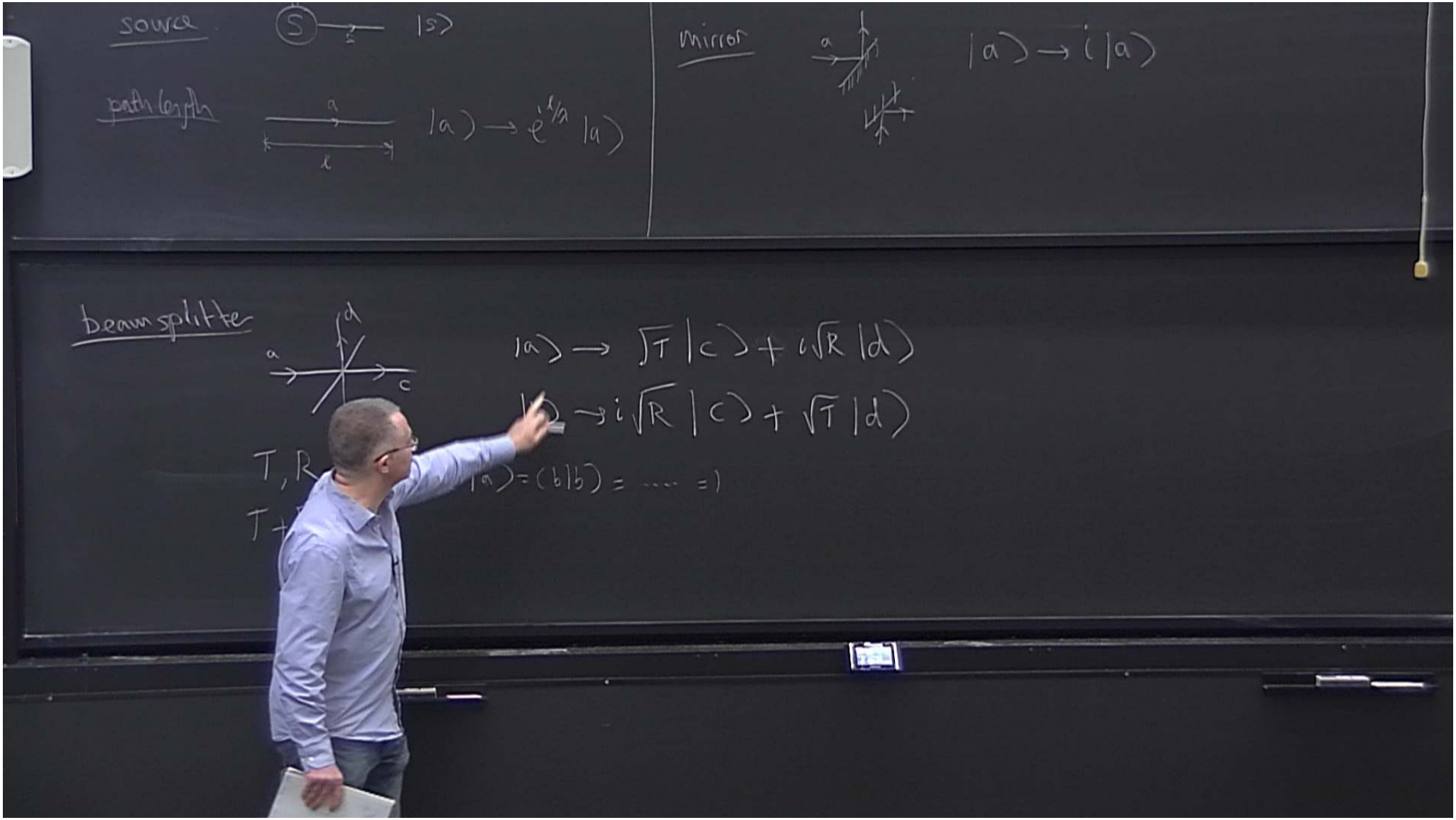
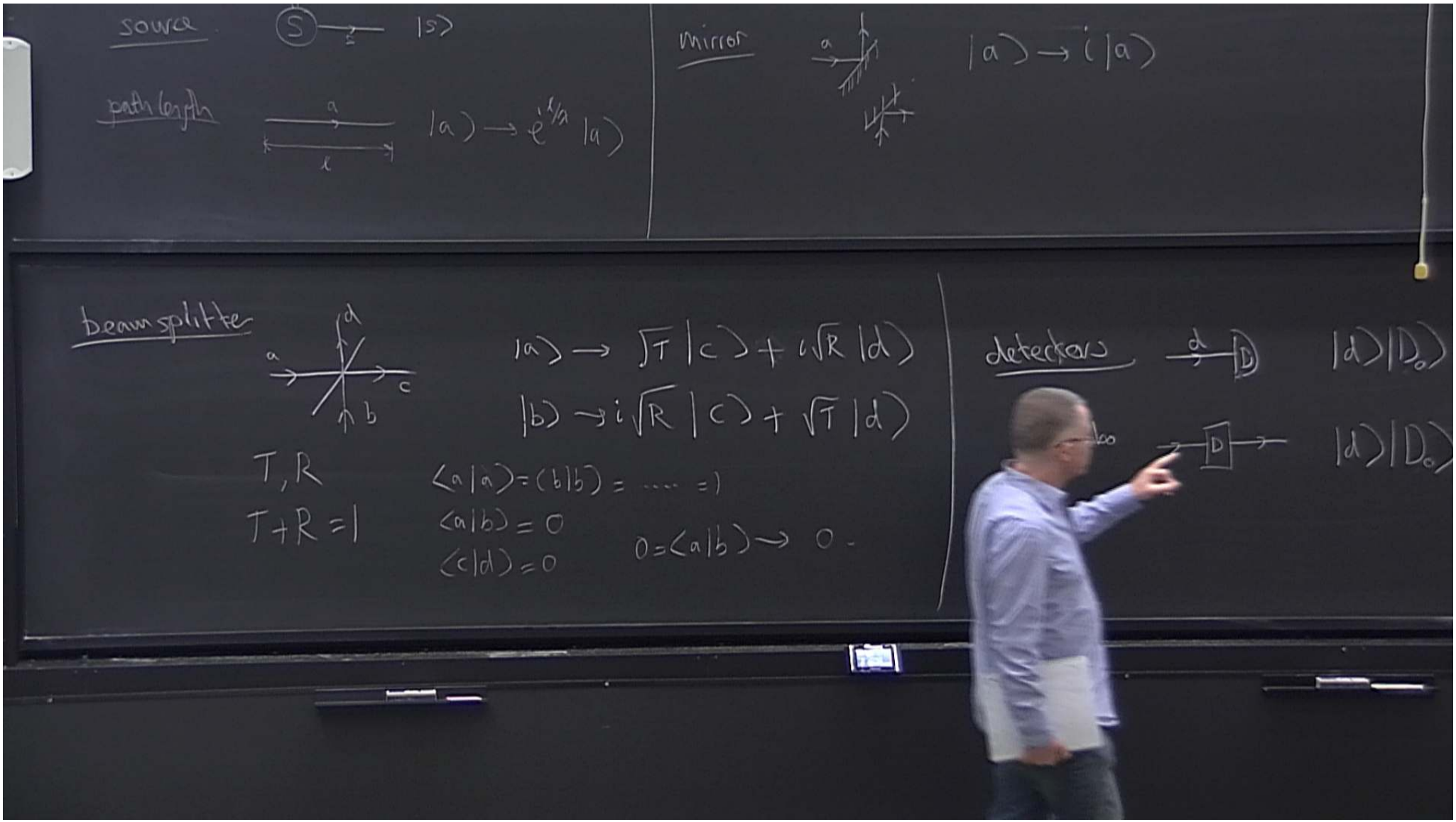
Title: PSI 2015/2016 Foundations of Quantum Mechanics - Lecture 1

Date: Jan 04, 2016 11:30 AM

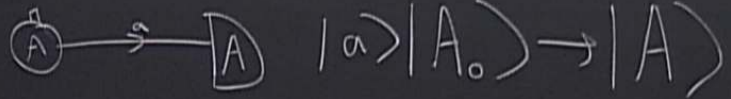
URL: http://pirsa.org/16010054

Abstract:


source
S
|s⟩
path length
a
ℓ
|a⟩ → e^{iℓ/a} |a⟩
mirror
a
|a⟩ → i|a⟩
beam splitter
a
c
d
|a⟩ → √T |c⟩ + i√R |d⟩
|b⟩ → i√R |c⟩ + √T |d⟩
T, R
⟨a|b⟩ = ⟨b|b⟩ = ... = 1


source
|s⟩
path length
|a⟩ → e^{iℓ/λ} |a⟩
mirror
|a⟩ → i|a⟩
beam splitter
|a⟩ → √T |c⟩ + i√R |d⟩
|b⟩ → i√R |c⟩ + √T |d⟩
T, R
T + R = 1
⟨a|a⟩ = ⟨b|b⟩ = ... = 1
⟨a|b⟩ = 0
⟨c|d⟩ = 0
0 = ⟨a|b⟩ → 0.
detectors
|d⟩|D₀⟩
|d⟩|D₀⟩

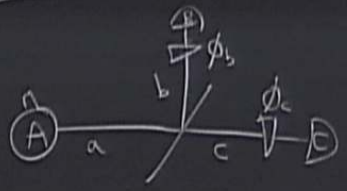
Zero example

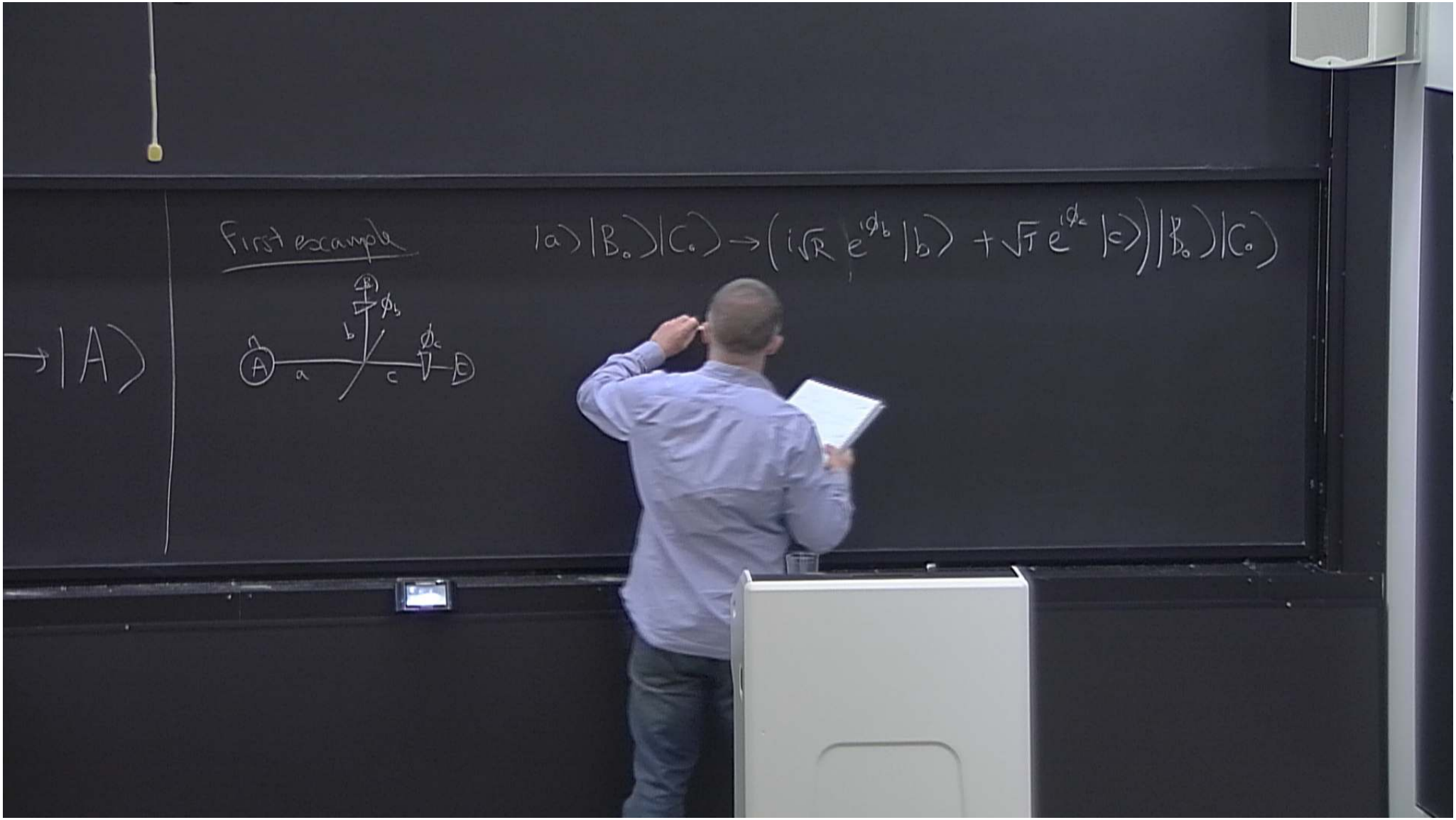


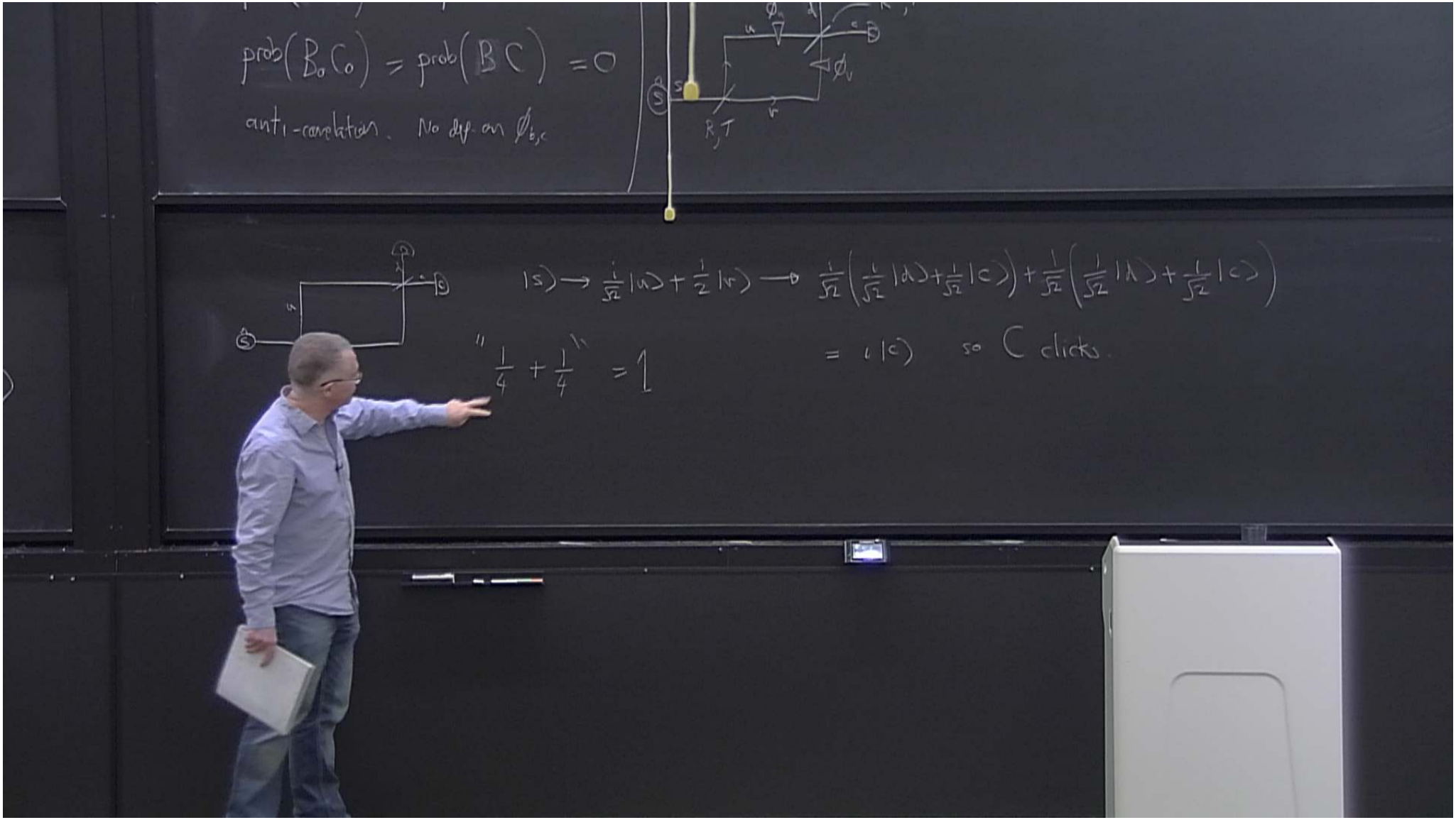
$|a\rangle|A_0\rangle \rightarrow |A\rangle$

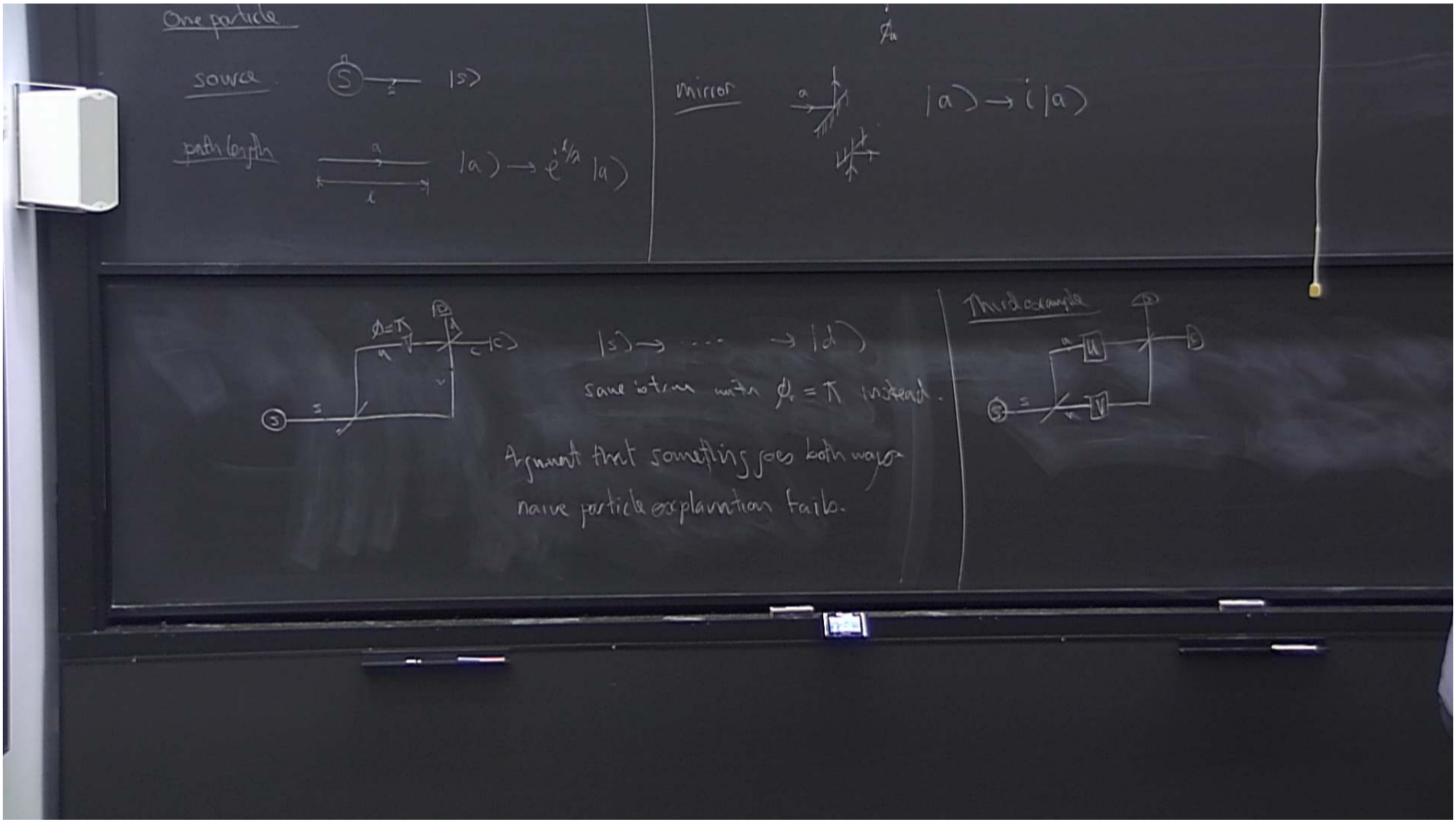
First example

$|a\rangle|B_0\rangle|C_0\rangle$ –



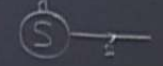

First example
$|a\rangle|B_0\rangle|C_0\rangle \rightarrow \left(i\sqrt{R}\, e^{i\phi_b}|b\rangle + \sqrt{T}\, e^{i\phi_c}|c\rangle\right)|B_0\rangle|C_0\rangle$
$\rightarrow |A\rangle$
A
B
D
a
b
c
ϕ_b
ϕ_c


prob(B₀C₀) = prob(BC) = 0
anti-correlation. No dep. on φ_{b,c}
R, T
|s⟩ → 1/√2 |u⟩ + 1/√2 |v⟩ → 1/√2 (1/√2 |a⟩ + 1/√2 |c⟩) + 1/√2 (1/√2 |a⟩ + 1/√2 |c⟩)
" 1/4 + 1/4 " = 1
= |c⟩ so C clicks.


One particle
source
|s⟩
path length
|a⟩ → e^{iℓ/λ} |a⟩
mirror
|a⟩ → i |a⟩
|s⟩ → ... → |d⟩
same is true with φ = π instead.
Argument that something goes both ways
naive particle explanation fails.
Third example

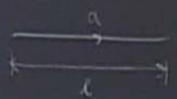
One particle

source



$|s\rangle$

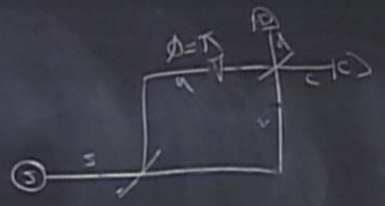
path length



$|a\rangle \rightarrow e^{ika}|a\rangle$

mirror

$|a\rangle \rightarrow i|a\rangle$

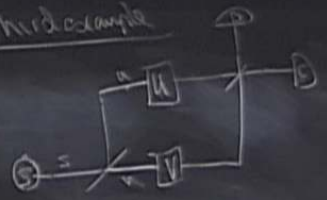


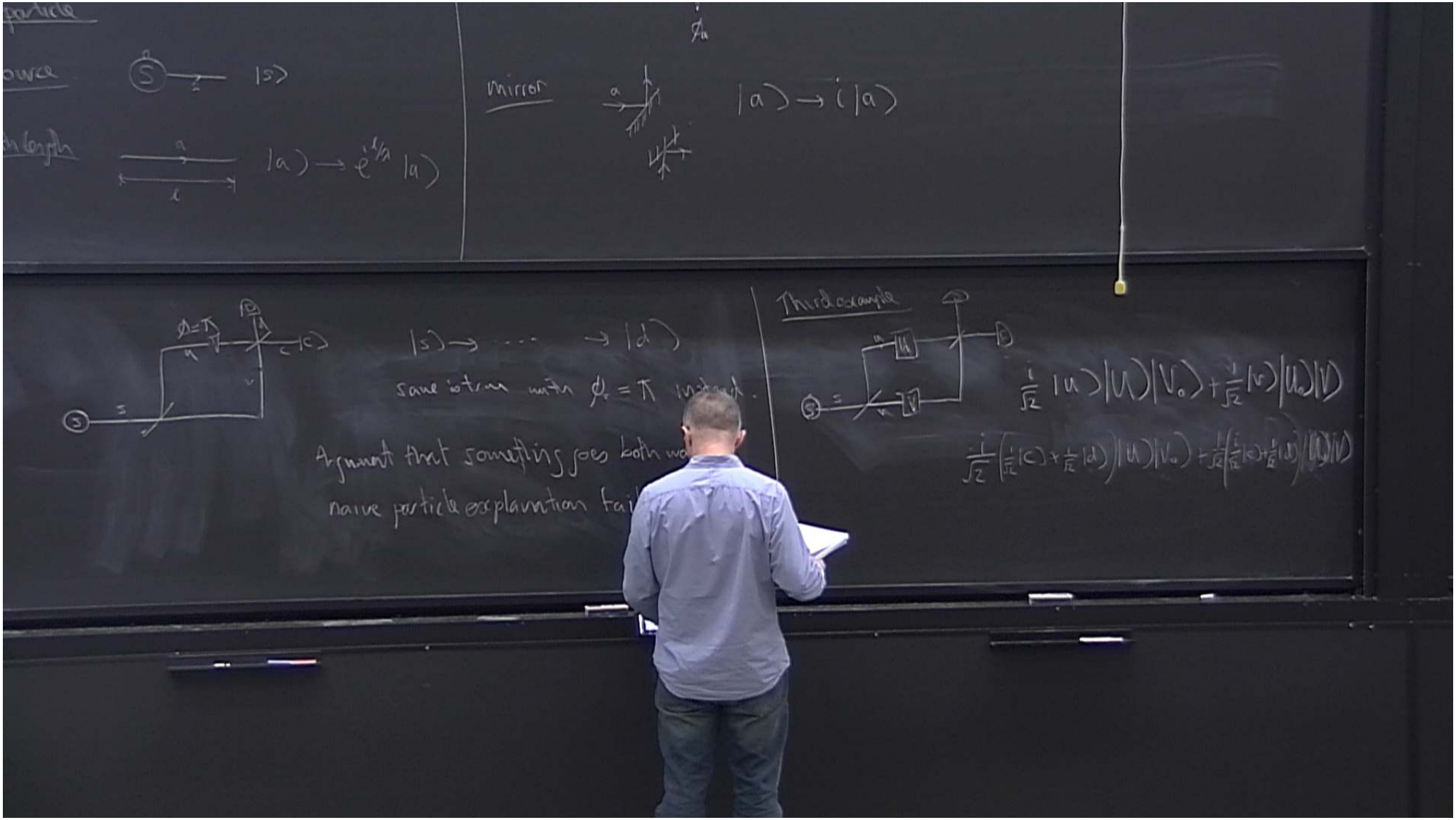
$|s\rangle \rightarrow \cdots \rightarrow |d\rangle$

same as term with $\phi_r = \pi$ instead.

Argument that something goes both ways → naive particle explanation fails.

Third example



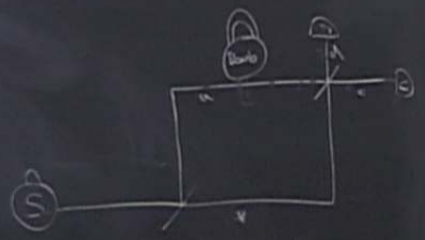

mirror
|a⟩ → i|a⟩
|s⟩ → ... → |d⟩
Third example
Argument that something goes both wa
naive particle explanation fai

same setup with $\phi_r = \pi$ instead.

Argument that something goes both ways → naive particle explanation fails.

$$\frac{1}{\sqrt{2}}|u\rangle|u\rangle|V_0\rangle + \frac{1}{\sqrt{2}}|v\rangle|u_0\rangle|V\rangle$$

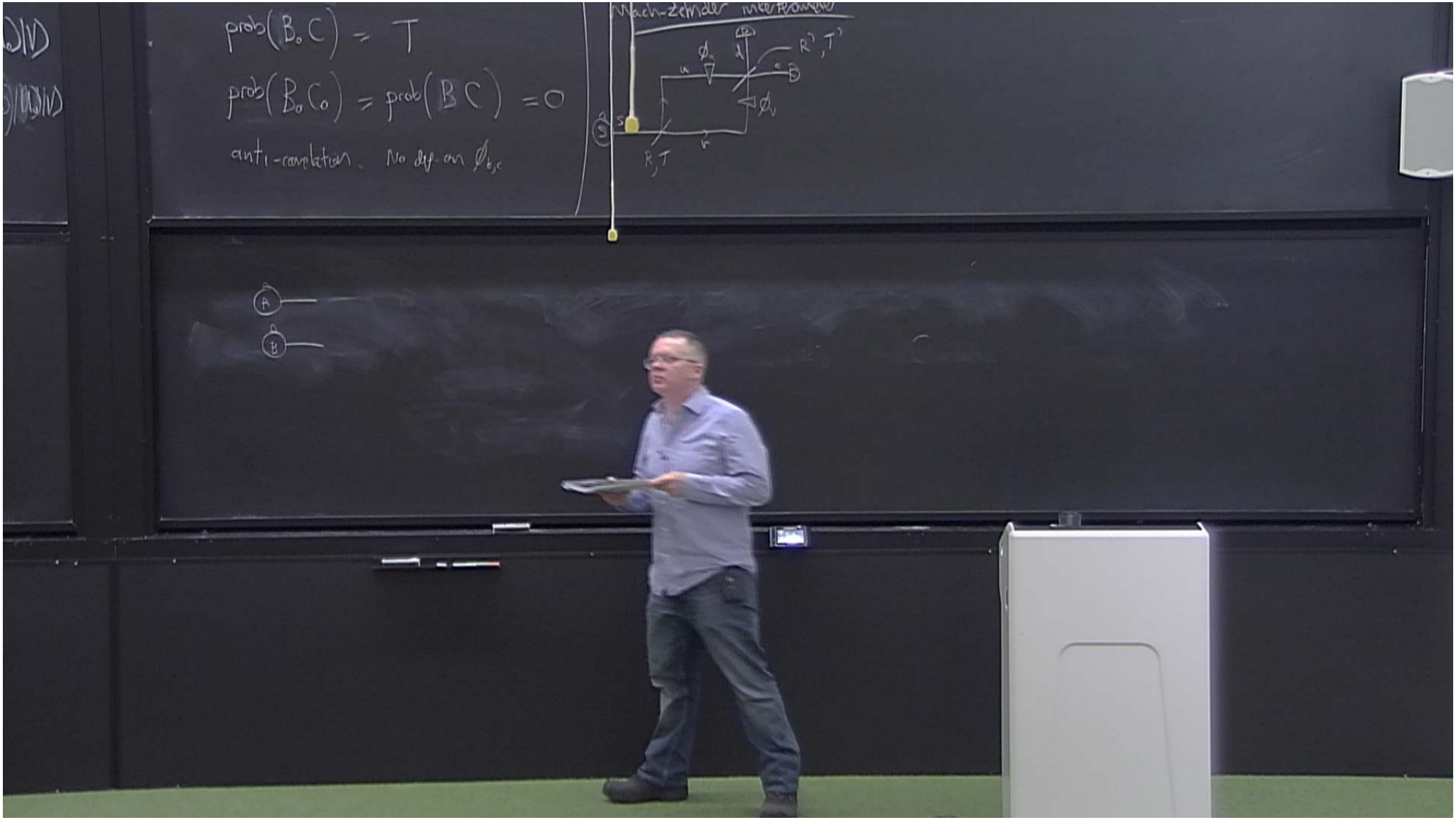
$$\frac{1}{\sqrt{2}}\left(\frac{1}{\sqrt{2}}|C\rangle + \frac{1}{\sqrt{2}}|D\rangle\right)|u\rangle|V_0\rangle + \frac{1}{\sqrt{2}}\left(\frac{1}{\sqrt{2}}|C\rangle - \frac{1}{\sqrt{2}}|D\rangle\right)|v\rangle|u_0\rangle|V\rangle$$



Bomb explodes

C fires. no conclusion

D fires. ⇒ have a good bomb but not exploded.


prob(B, C) = T
prob(B, C0) = prob(B C) = 0
anti-correlation. No dep. on
Mach-Zehnder
A
B