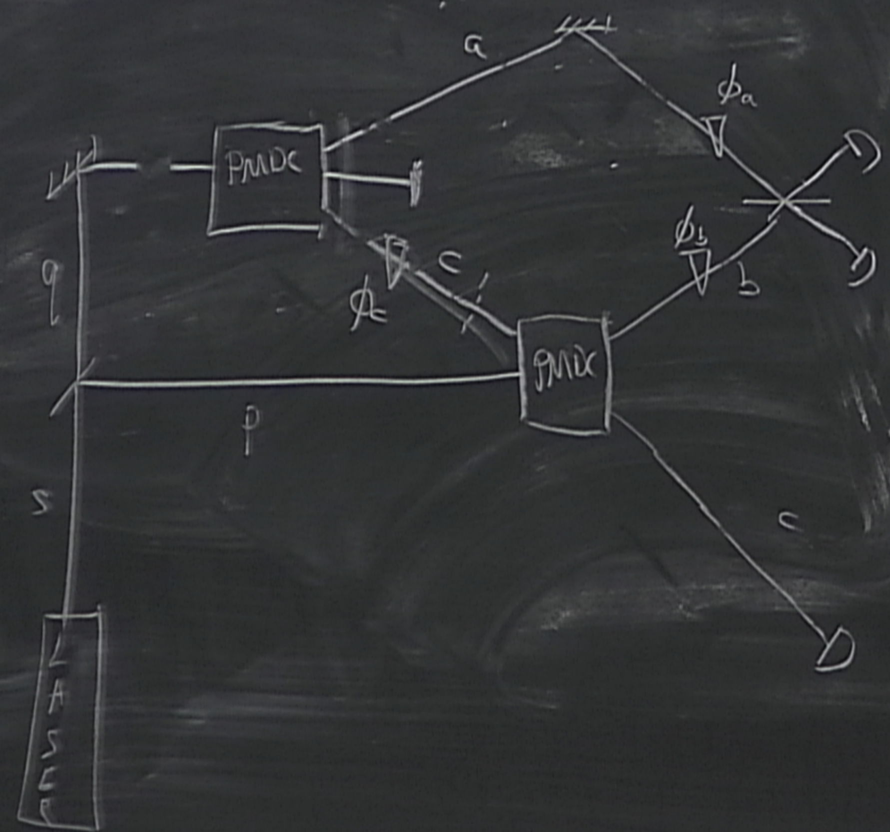
Title: 13/14 PSI - Foundations of Quantum Mechanics - Lecture 4

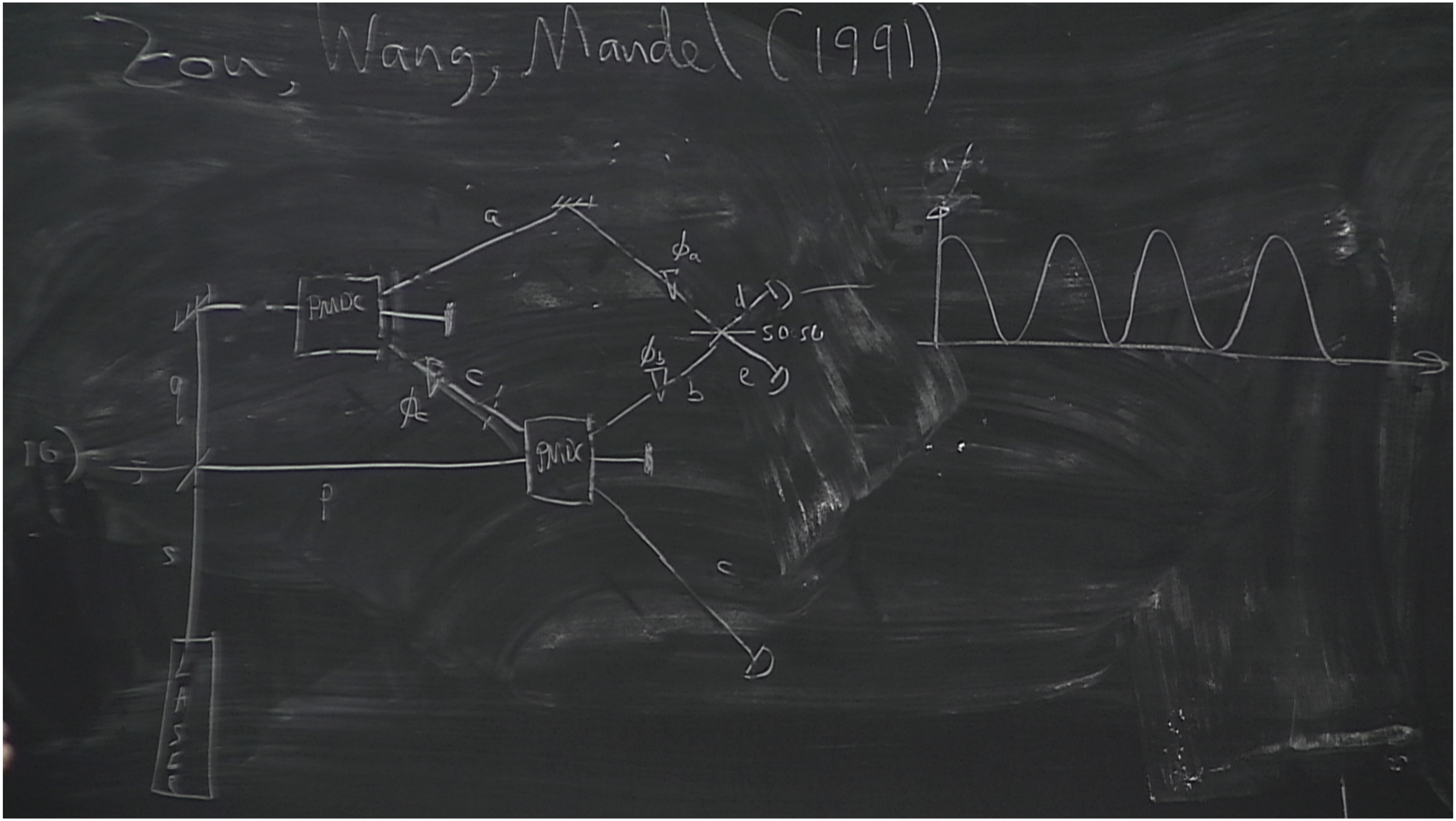
Date: Jan 13, 2014 11:30 AM

URL: http://pirsa.org/14010049

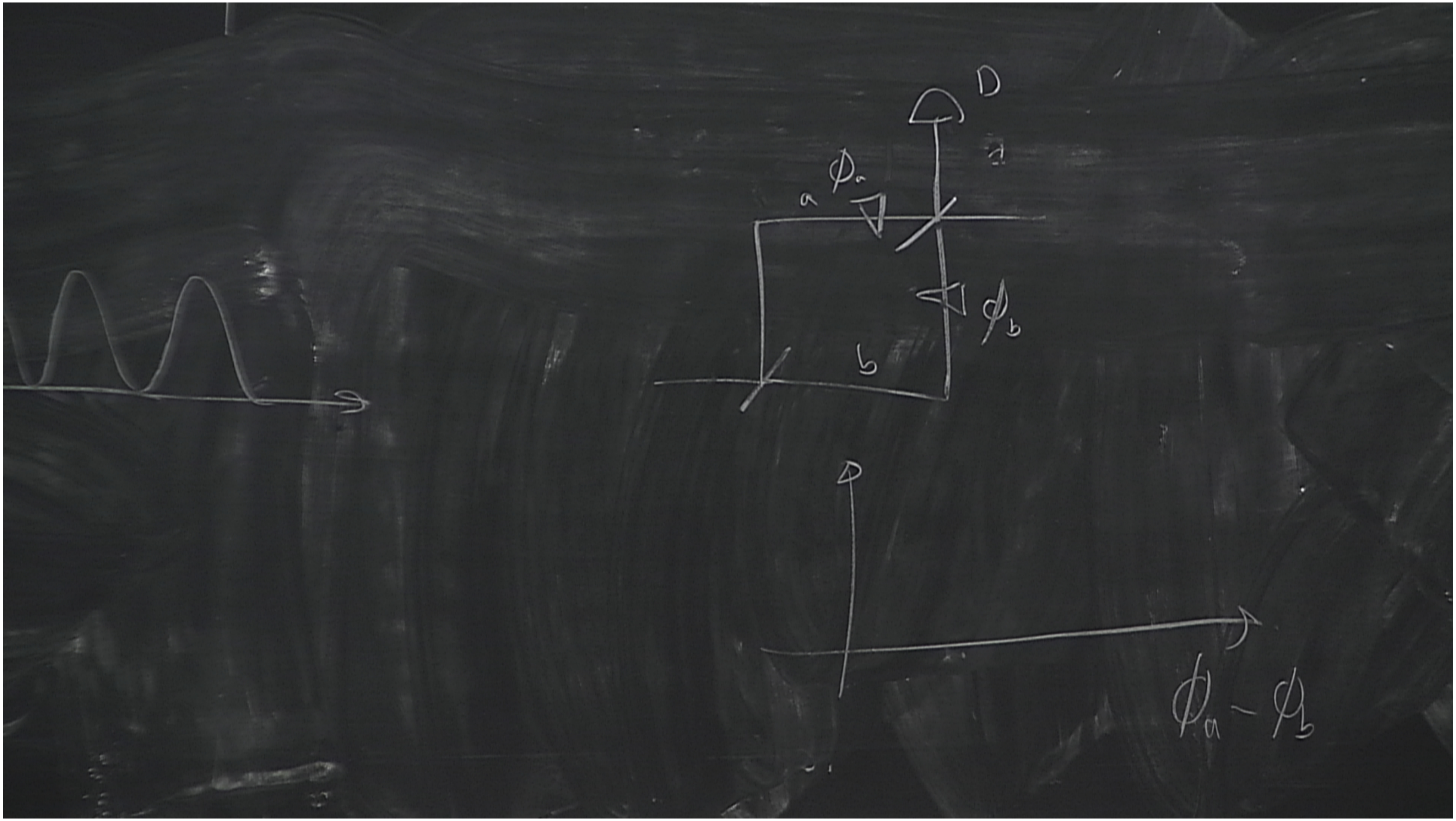
Abstract:

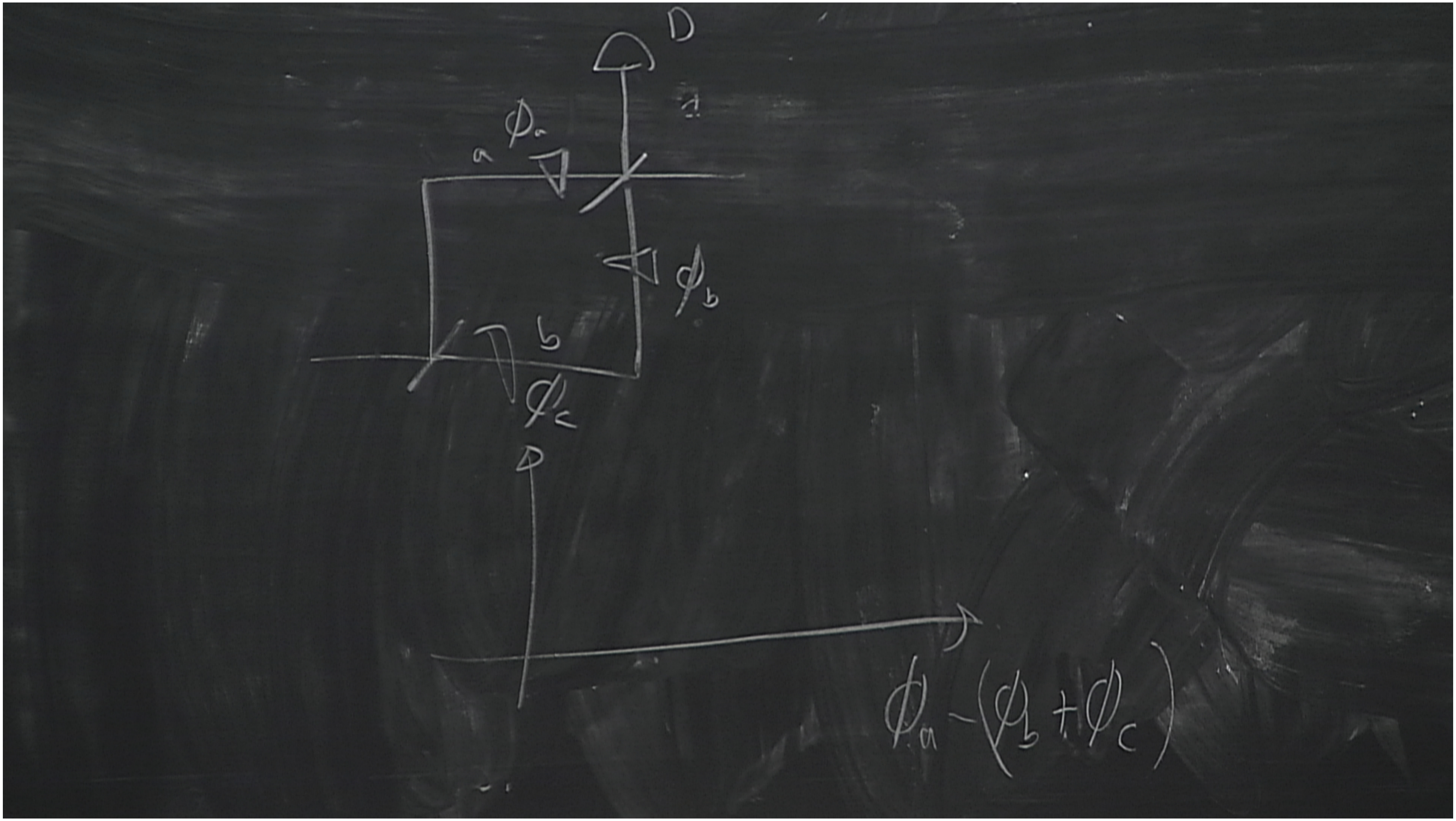
Zou, Wang, Mandel (1991)

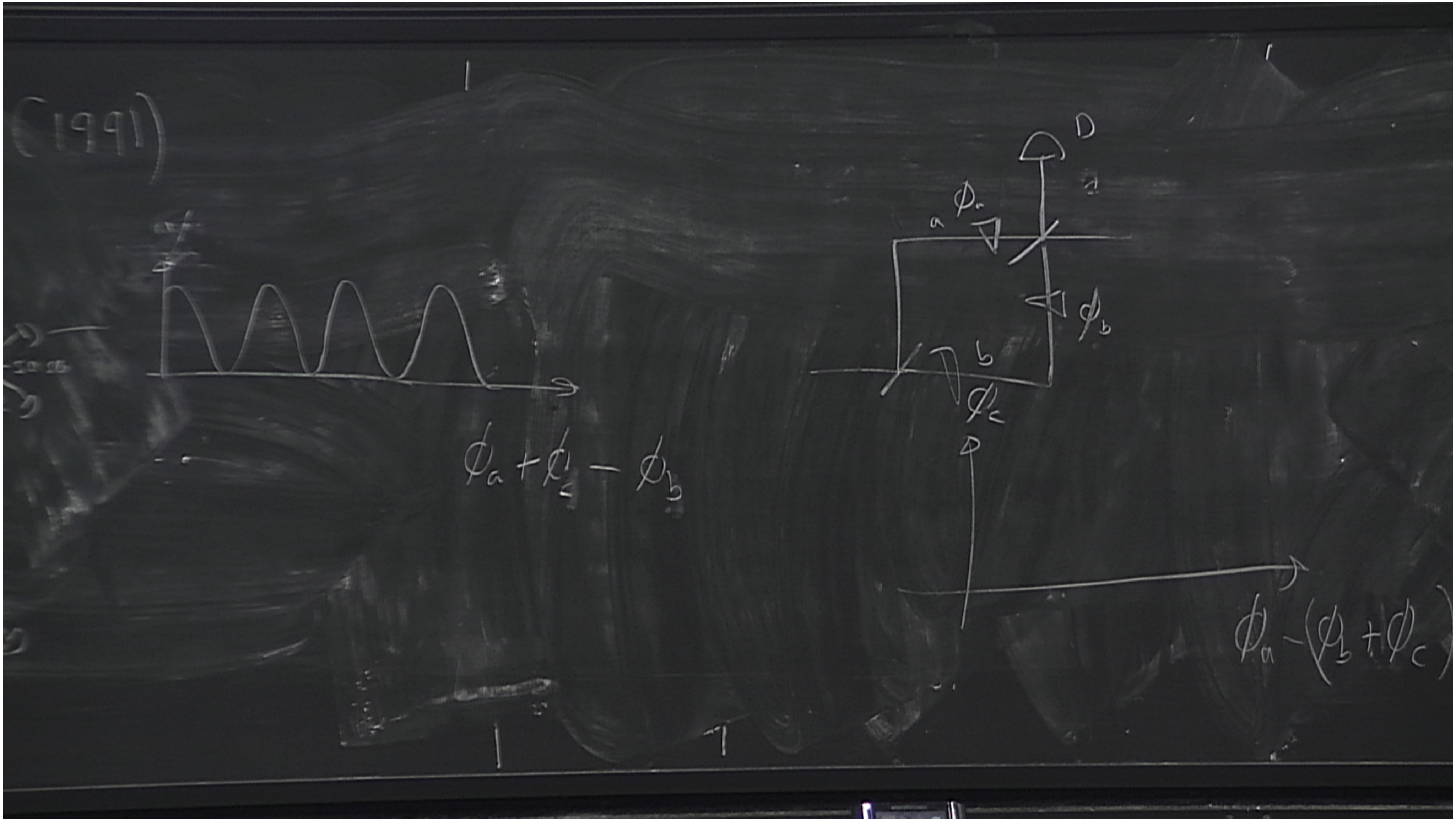


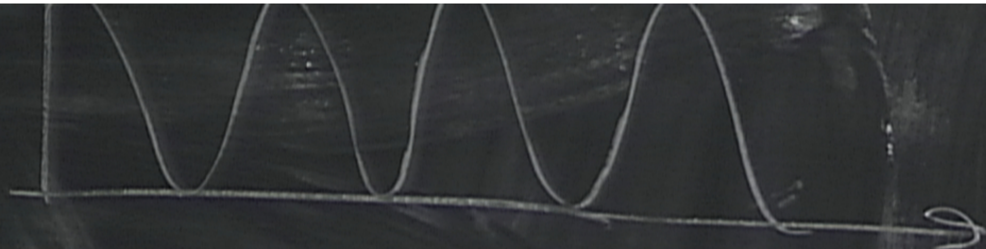


Zou, Wang, Mandel (1991)
a
ϕ_a
PMDC
d
50:50
e
ϕ_b
b
c
ϕ_c
PMDC
q
p
s
LASER


D
ϕ_a
a
ϕ_b
b
$\phi_a - \phi_b$

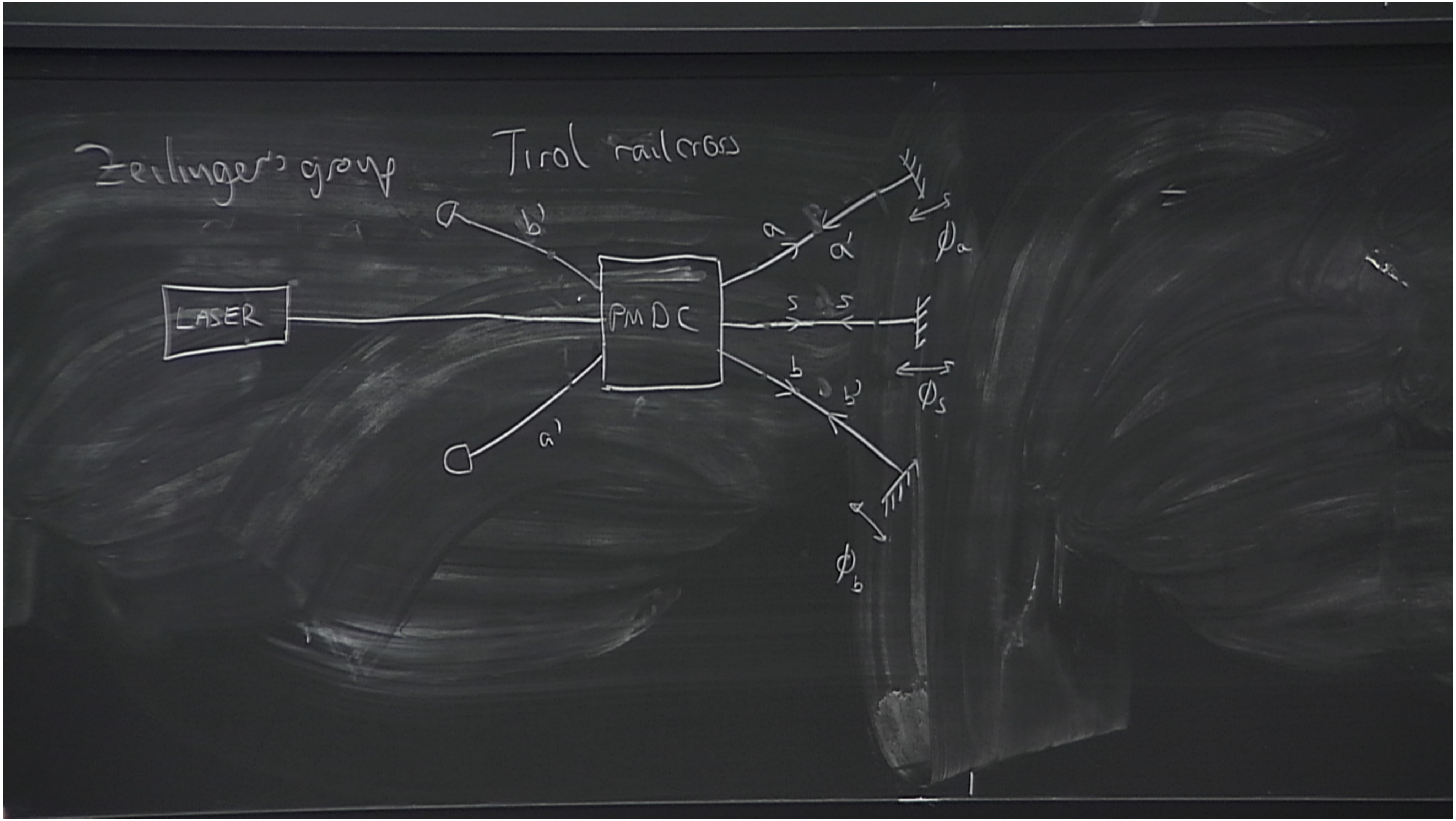

D
ϕ_a
a
ϕ_b
b
ϕ_c
D
$\phi_a - (\phi_b + \phi_c)$

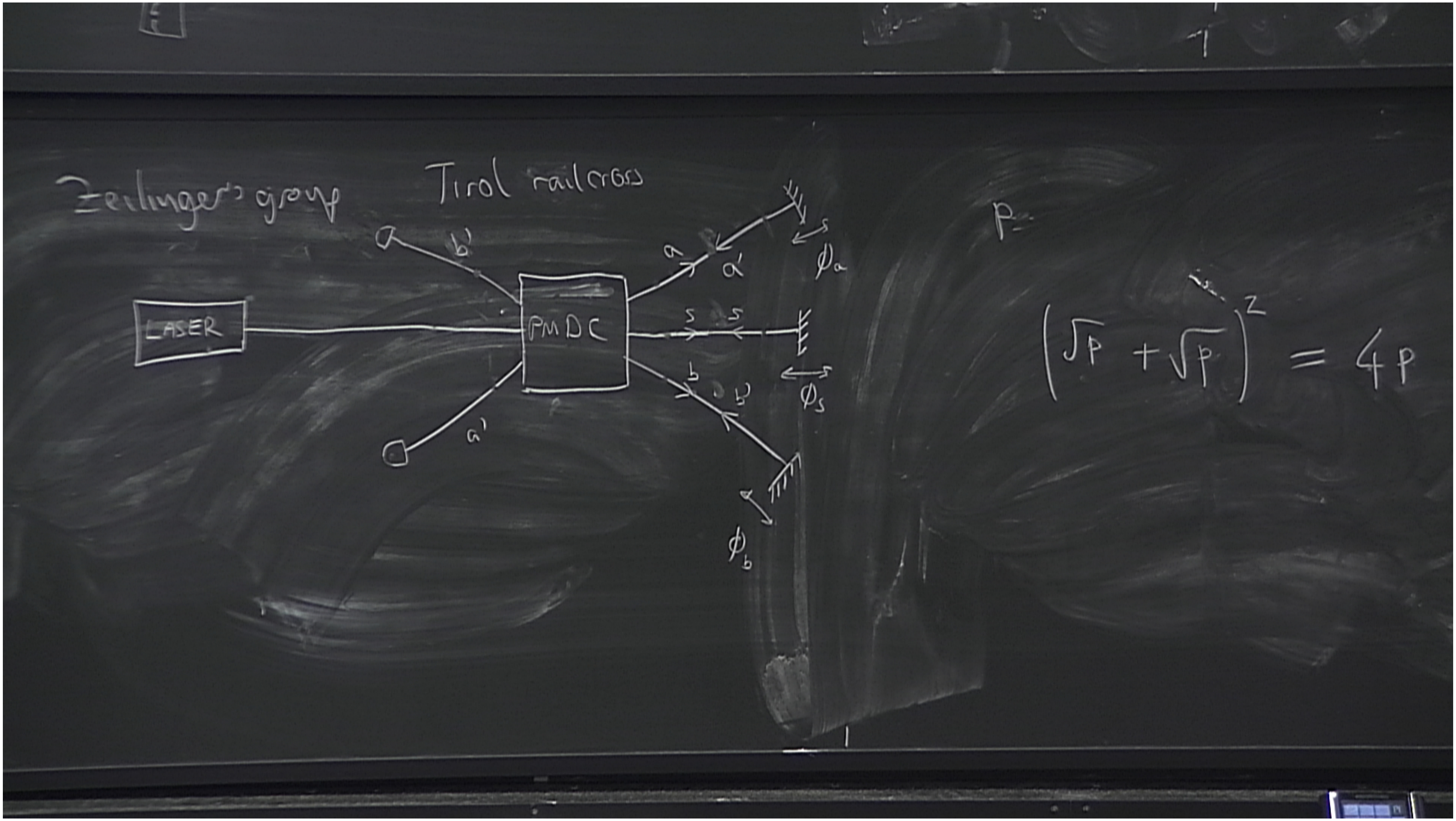

(1991)
D
ϕa
a
ϕb
b
ϕc
ϕa + ϕc − ϕb
ϕa − (ϕb + ϕc)

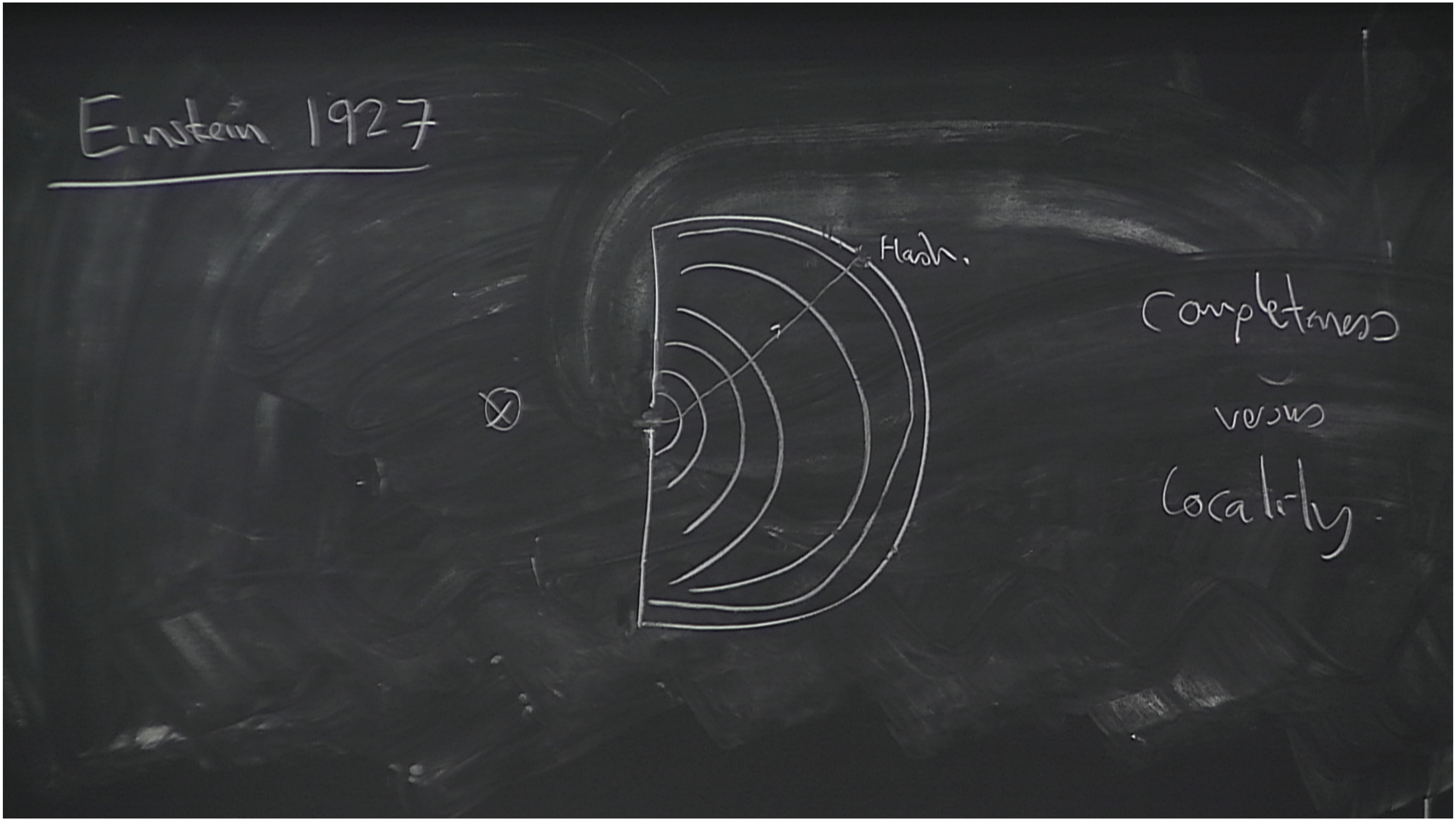


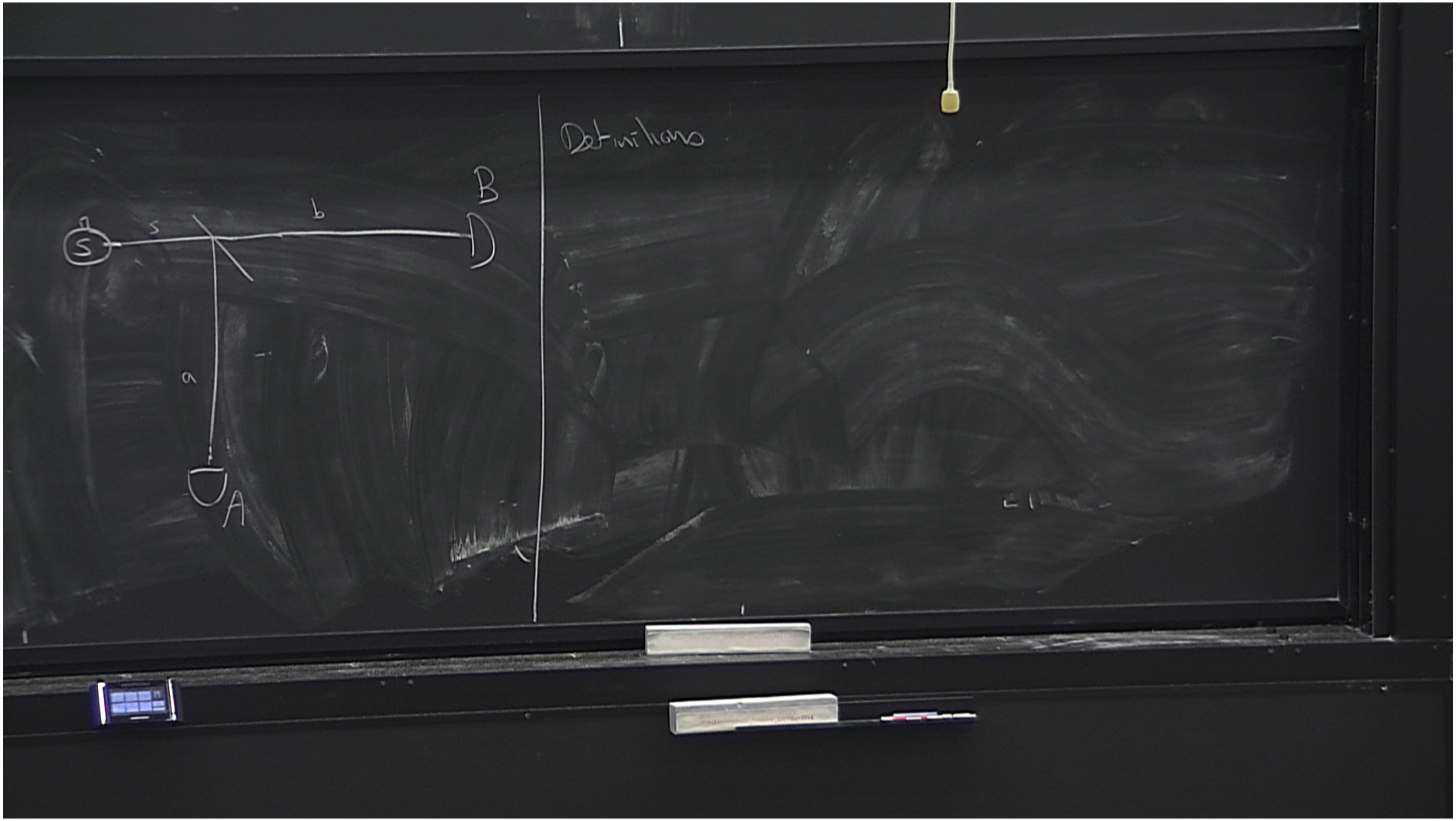
$$\phi_a + \phi_c - \phi_b$$

$$a^{\dagger} c^{\dagger} q + b^{\dagger} c^{\dagger} p$$


Zeilinger's group
Tirol railcross
LASER
PMDC
a
a'
b
b'
s
ϕ_a
ϕ_s
ϕ_b


Zeilinger's group
Tirol railcross
LASER
PMDC
ϕ_a
ϕ_s
ϕ_b
$(\sqrt{p} + \sqrt{p})^2 = 4p$


Einstein 1927
Flash.
Completeness
versus
Locality.



Definitions
B
b
s
S
a
A

Completeness.

In a "complete theory" every element of physical reality must have a counterpart in the physical theory"

Completeness. (EPR 1935)

"In a complete theory every element of physical reality must have a counterpart in the physical theory"

ψ-completeness   All elements of reality (eprs)

Completeness. (EPR 1935)

In a complete theory "every element of physical reality must have a counterpart in the physical theory"

ψ-completeness All elements of reality (eprs) follow from the state vector

In particular, $[A=\alpha]_\alpha$

2 1935)

theory "every element of physical reality

ounter part in the physical theory"

All elements of reality (epr's) follow from

$$P_{(A=\alpha)_a} = |a\rangle\langle a|$$

tor

$[A=\alpha]_a$ is an epr iff $\langle\psi|P_{(A=\alpha)_a}|\psi\rangle=1$

EPR

A sufficient condition for the existence of an epr.

"If, without in any way disturbing a system, we can predict with certainty (i.e with probability equal to unity) the value of a physical quantity, then there exists an epr corresponding to this quantity"

I.e.

If $\text{prob}\left((A=\alpha)_a \,\middle|\, (B=\beta)_b \right) = 1$

and if measurement B does not disturb a then

there exists an epr

$$[A=\alpha]_a$$

i.e.

If $\text{prob}\left((A=\alpha)_a \,\middle|\, (B=\beta)_b \right) = 1$

and if measurement B does not disturb a then there exists an epr

$$[A=\alpha]_a$$

even if we don't measure A or B

Locality: the epr's for a system are undisturbed by choices made at a space-like separation from it.

$QT \wedge \psi\text{-completeness} \wedge \text{locality} \Rightarrow \text{contradiction}$.

We have

$$\text{prob}\left(\left(A = \substack{1 \\ 0}\right)_a \,\middle|\, \left(B = \substack{0 \\ 1}\right)_b \right) = 1$$

locality $\Rightarrow$ we have $[A = 1]_a$ or $[A = 0]_a$

(even when we don't measure A & B.

$|\psi\rangle$

$$|\psi\rangle = \frac{1}{\sqrt{2}}\left(i\,|a\rangle + |b\rangle \right)$$

And

$$\langle\psi|\, P_{(A=\alpha)_a}\, |\psi\rangle = \frac{1}{2}$$

Assume ψ-completeness $\Longrightarrow$ neither $[A=1]_a$ or $[A=0]_a$ are ep[illegible].