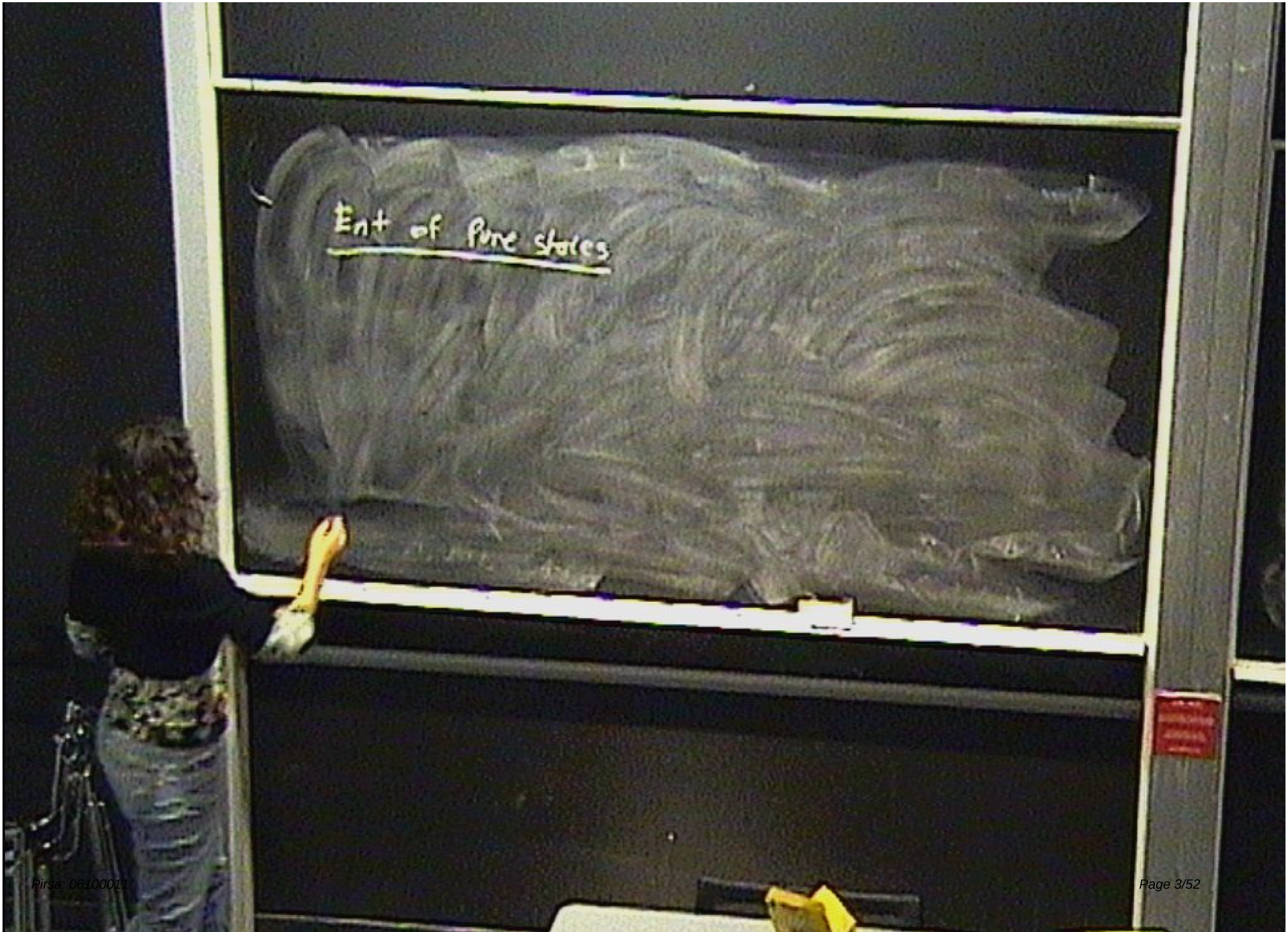
Title: Quantum Computing without Entanglement?

Date: Oct 11, 2006 04:00 AM

URL: http://pirsa.org/06100011

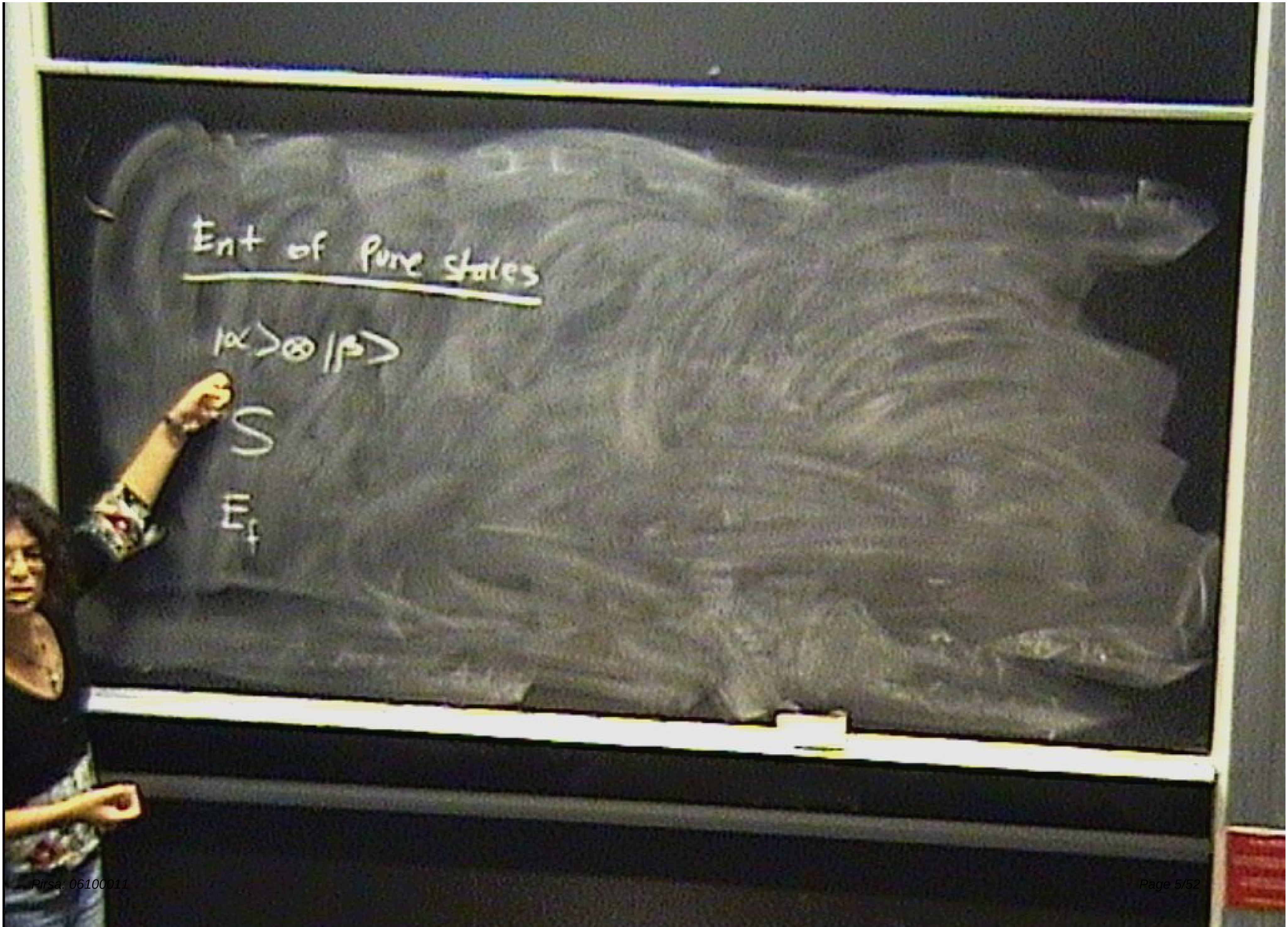
Abstract: TBA

Why we do not understand MSE?


Ent of Pure states

Ent of Pure states

$|\alpha\rangle \otimes |\beta\rangle$


Ent of Pure states
$|\alpha\rangle \otimes |\beta\rangle$
S
E_f

Ent of Pure states

$|\alpha\rangle \otimes |\beta\rangle$

S

$E_f(\rho) = S(\rho|_A)$

Ent of Pure states

$|\alpha\rangle \otimes |\beta\rangle$

S

$E_f(\rho) = S(\rho|_A)$

$E_f(\rho \otimes \rho') = E_f(\rho) + E_f(\rho')$

Ent of Pure states

$|\alpha\rangle \otimes |\beta\rangle$ $\qquad$ $|00\rangle + |11\rangle$

S

$E_f(\rho) = S(\rho|_A)$

$E_f(\rho \otimes \rho') = E_f(\rho) + E_f(\rho')$

Ent of Pure states

$|\alpha\rangle \otimes |\beta\rangle$ $\qquad$ $|00\rangle + |11\rangle$ $\quad$ | $\quad E_C$

S

$E_f(\rho) = S(\rho|_A)$

$E_f(\rho \otimes \rho') = E_f(\rho) + E_f(\rho')$

Ent of Pure states

$|\alpha\rangle \otimes |\beta\rangle$

$|00\rangle + |11\rangle$

E_c

S

$E_f(\rho) = S(\rho|_A)$

$E_f(\rho \otimes \rho') = E_f(\rho) + E_f(\rho')$

Ent of Pure states

$|\alpha\rangle \otimes |\beta\rangle$

$|00\rangle + |11\rangle$

S

$E_f(\rho) = S(\rho|_A)$

$E_f(\rho \otimes \rho') = E_f(\rho) + E_f(\rho')$

E_C, E_D

assymptotic

operational measures

Ent of Pure states

$|\alpha\rangle \otimes |\beta\rangle$ $\quad$ $|00\rangle + |11\rangle$

S

$E_f(\rho) = S(\rho|_A)$

$E_f(\rho \otimes \rho') = E_f(\rho) + E_f(\rho')$

E_C, E_D

assymptotic operational measures

efficient classical simulation of non entangled Q comp.

Ent of Pure states

$|\alpha\rangle \otimes |\beta\rangle$

$|00\rangle + |11\rangle$

S

$E_f(\rho) = S(\rho|_A)$

$E_f(\rho \otimes \rho') = E_f(\rho) + E_f(\rho')$

E_C, E_D

assymptotic

operational measures

efficient classical simulation of non entangled Q comp.

Why we do not understand MSE?

$\{p_i, |\alpha_i\rangle\}$

ρ

$|00\rangle \qquad \dfrac{|00\rangle + |11\rangle}{\sqrt{2}}$

$|11\rangle \qquad \dfrac{|00\rangle - |11\rangle}{\sqrt{2}}$

Why we do not understand MSE?

$$\{p_i, |\alpha_i\rangle\}$$

$$\rho \qquad |00\rangle \qquad \frac{|00\rangle + |11\rangle}{\sqrt{2}}$$

$$|11\rangle \qquad \frac{|00\rangle - |11\rangle}{\sqrt{2}}$$

Why we do not understand MSE?

$\{p_i, |\alpha_i\rangle\}$

ρ

$|00\rangle$ $\quad$ $\dfrac{|00\rangle + |11\rangle}{\sqrt{2}}$

$|11\rangle$ $\quad$ $\dfrac{|00\rangle - |11\rangle}{\sqrt{2}}$

$\sum p_i \rho_i$

$$E_f = \min_{\{p_i, \rho_i\}} \sum p_i E(\rho_i)$$

pure

Why we do not understand MSE?

$\{p_i, |\alpha_i\rangle\}$

ρ

$|00\rangle$

$|11\rangle$

$\frac{|00\rangle + |11\rangle}{\sqrt{2}}$

$\frac{|00\rangle - |11\rangle}{\sqrt{2}}$

$\sum p_i \rho_i$

$$E_f = \min_{\{p_i, \rho_i\}} \sum p_i E(\rho_i)$$

pure

Why we do not understand MSE?

$\{p_i, |\alpha_i\rangle\}$

ρ

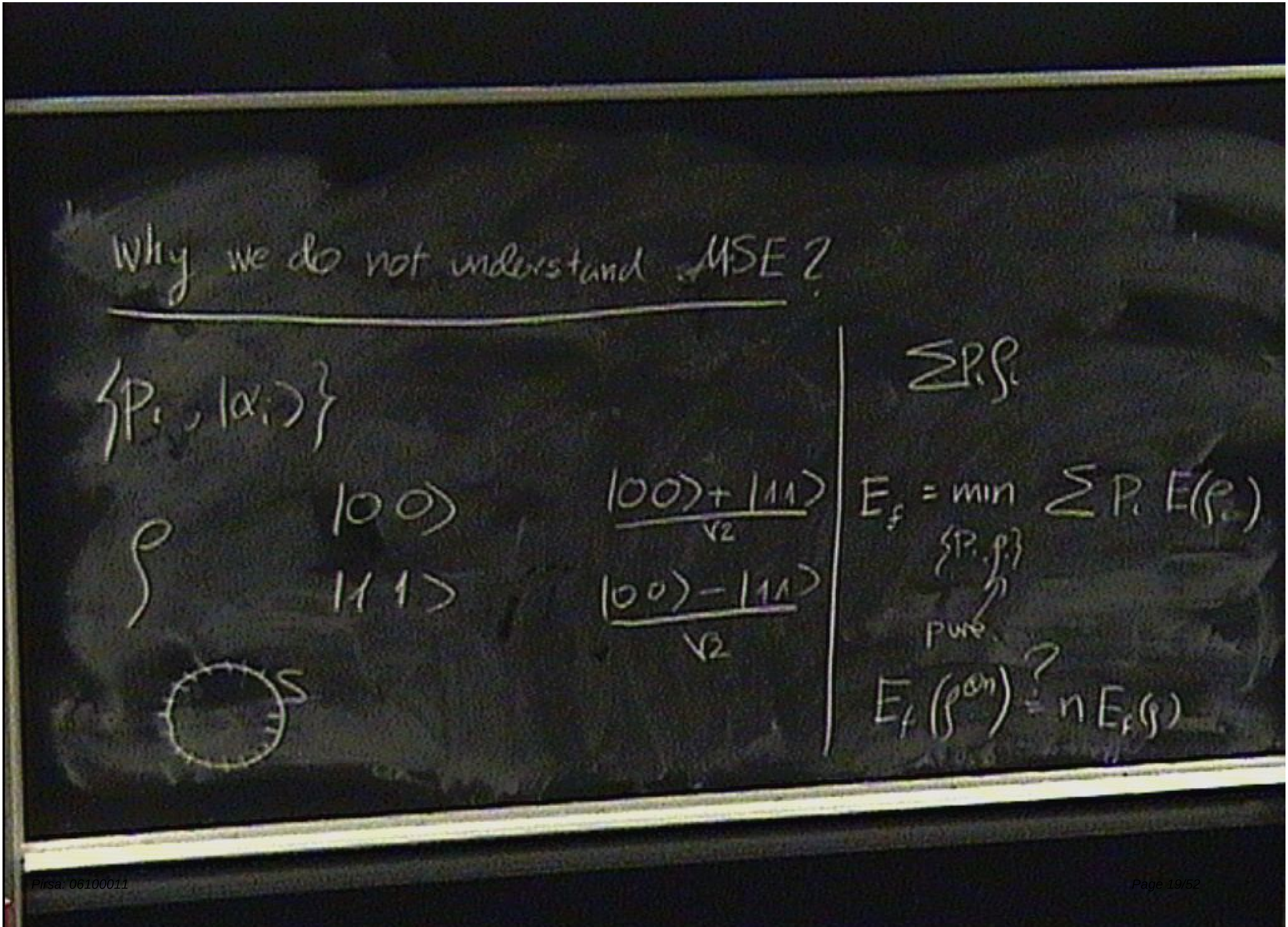
$|00\rangle$ $\qquad \frac{|00\rangle + |11\rangle}{\sqrt{2}}$

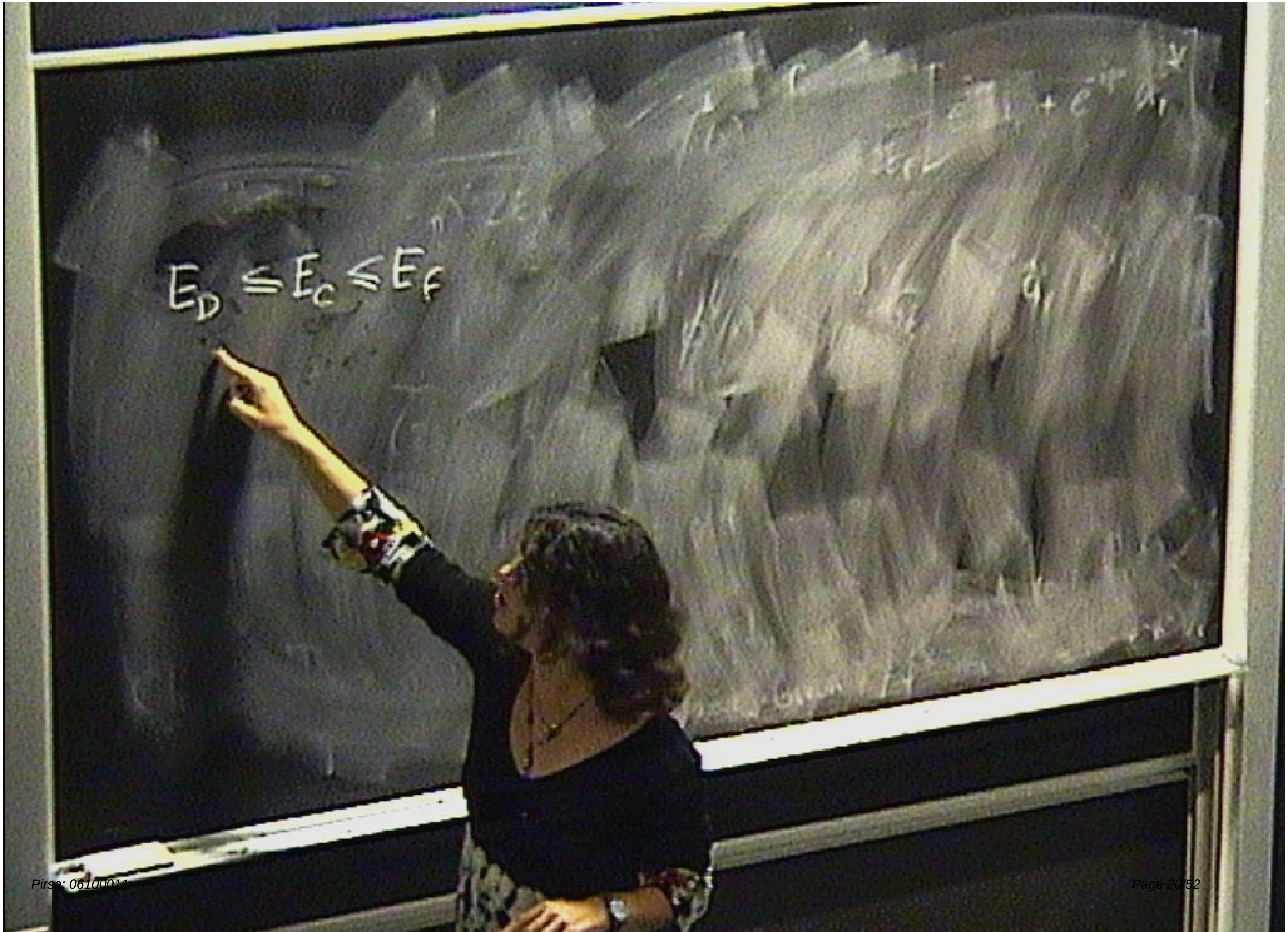
$|11\rangle$ $\qquad \frac{|00\rangle - |11\rangle}{\sqrt{2}}$

$\sum p_i \rho_i$

$$E_f = \min_{\{p_i, \rho_i\}} \sum p_i E(\rho_i)$$

pure


Why we do not understand MSE?
$\{p_i, |\alpha_i\rangle\}$
ρ
$|00\rangle$
$|11\rangle$
$\frac{|00\rangle + |11\rangle}{\sqrt{2}}$
$\frac{|00\rangle - |11\rangle}{\sqrt{2}}$
S
$\sum p_i \rho_i$
$E_f = \min_{\{p_i, \rho_i\}} \sum p_i E(\rho_i)$
pure
$E_f(\rho^{\otimes n}) \overset{?}{=} n E_f(\rho)$

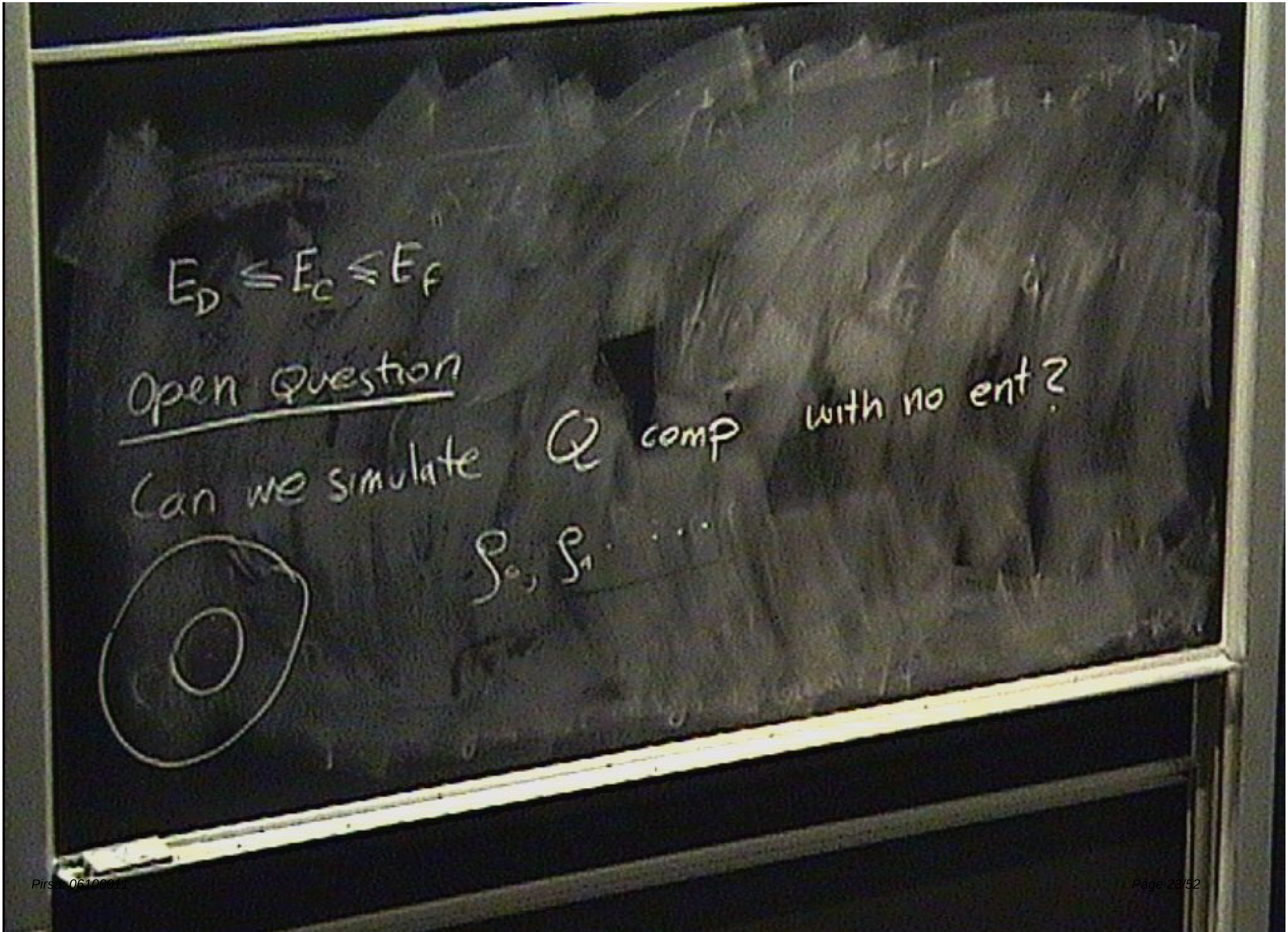

$E_D \leq E_C \leq E_F$

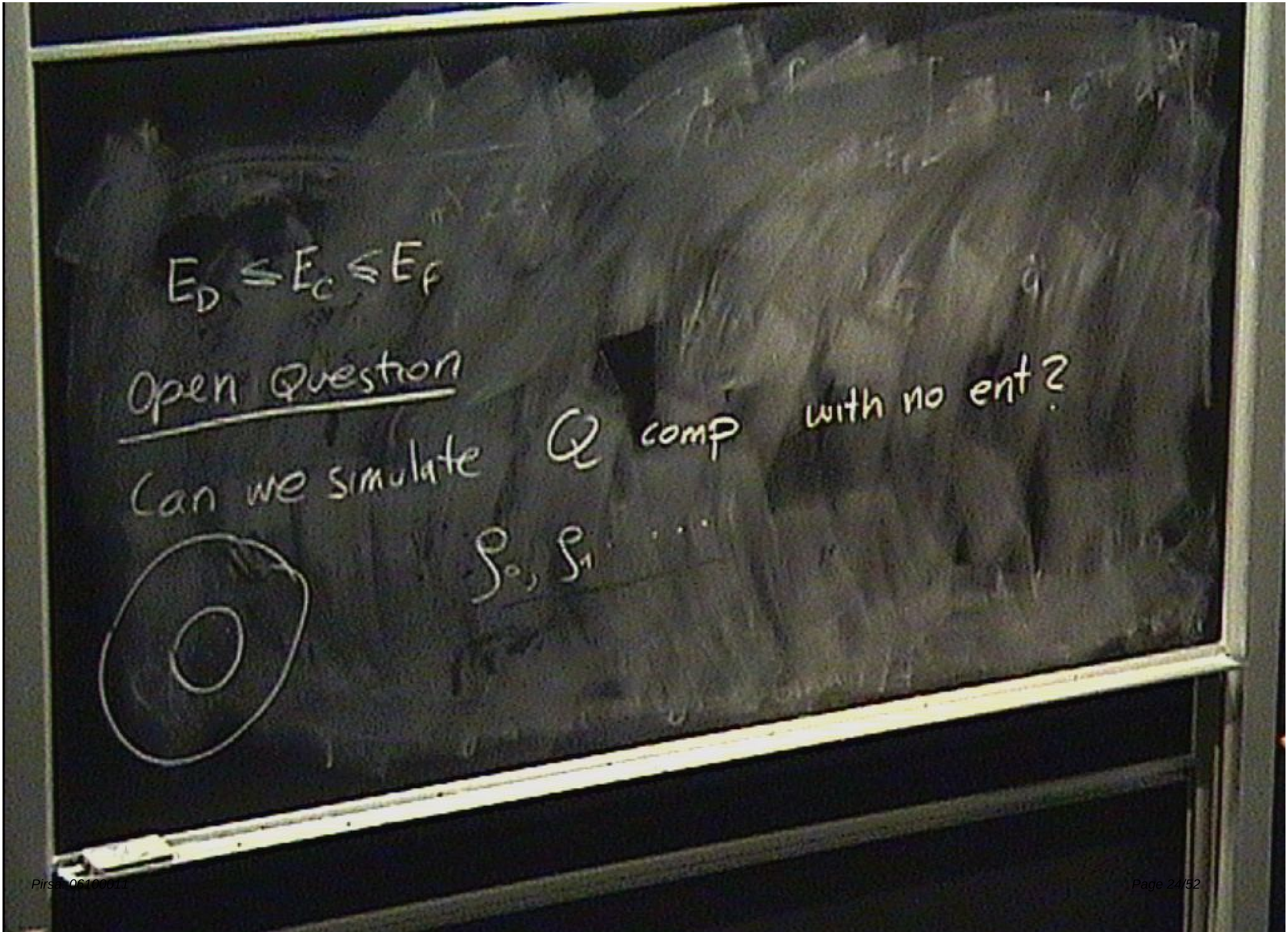
$E_D \leq E_C \leq E_F$

$E_D \leq E_C \leq E_F$

Open Question

Can we simulate Q comp with no ent?


$E_D \leq E_C \leq E_F$
Open Question
Can we simulate Q comp with no ent?
$\rho_0, \rho_1 \ldots$


$E_D \leq E_C \leq E_F$
Open Question
Can we simulate Q comp with no ent?
$\rho_0, \rho_1 \ldots$

$E_D \leq E_C \leq E_F$

Open Question

Can we simulate Q comp with no ent?

$\rho_0, \rho_1, \ldots$

p_i, q_i^0

$E_D \le E_C \le E_F$

Open Question

Can we simulate Q comp with no ent?

$\rho_0, \rho_1 \cdots$

p_i, q_i^0

fact 1

MSE

fact 1

$|00\rangle$

$|11\rangle$

$$|00\rangle|\alpha_0\rangle + |11\rangle|\alpha_1\rangle$$

fact 1

$|00\rangle$

$|11\rangle$

$|00\rangle|\alpha_0\rangle$
$+ |11\rangle|\alpha_1\rangle$

fact 1

MSE

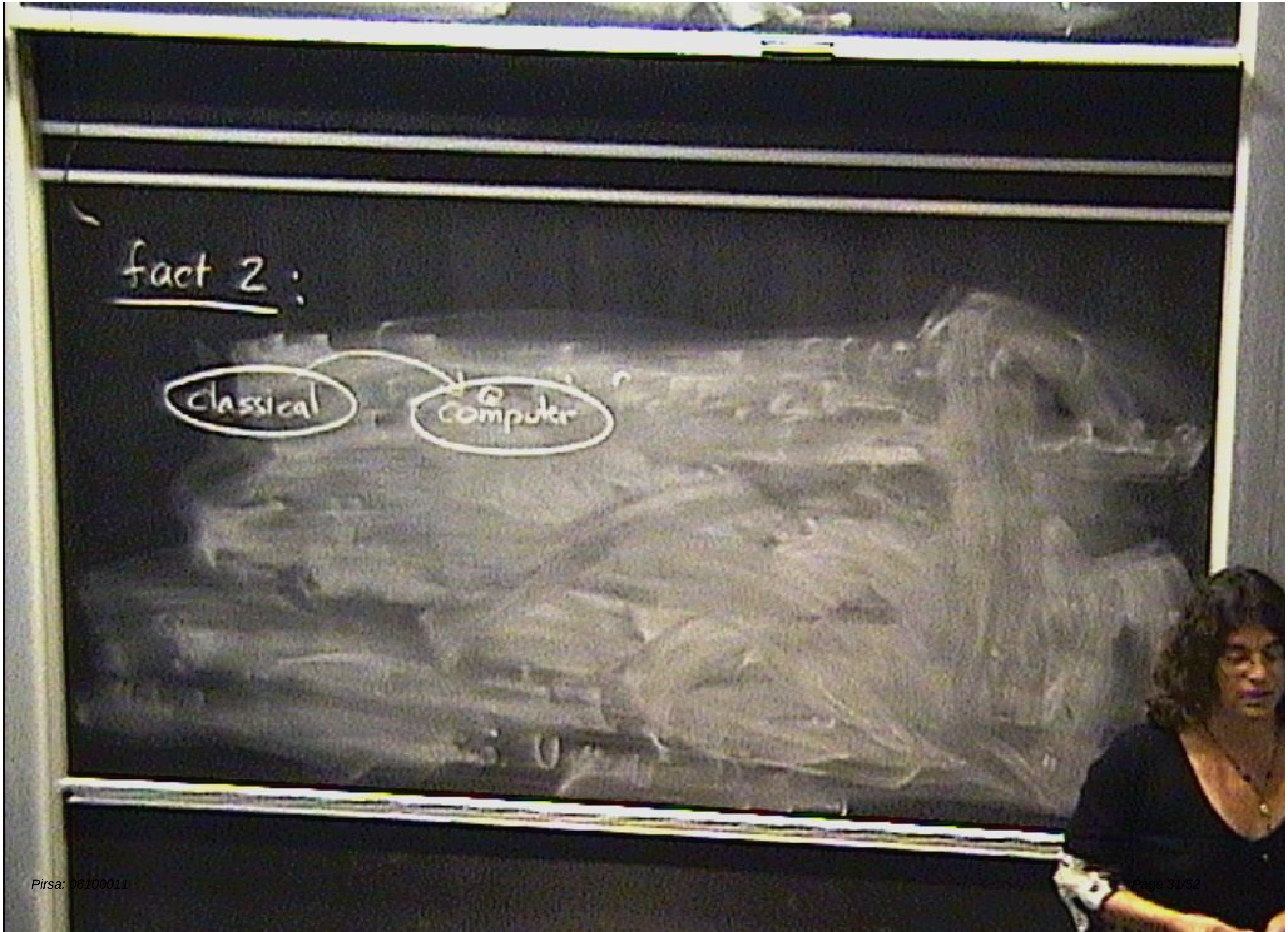
$|00\rangle$

$|11\rangle$

$|00\rangle|\alpha_0\rangle + |11\rangle|\alpha_1\rangle$

start with

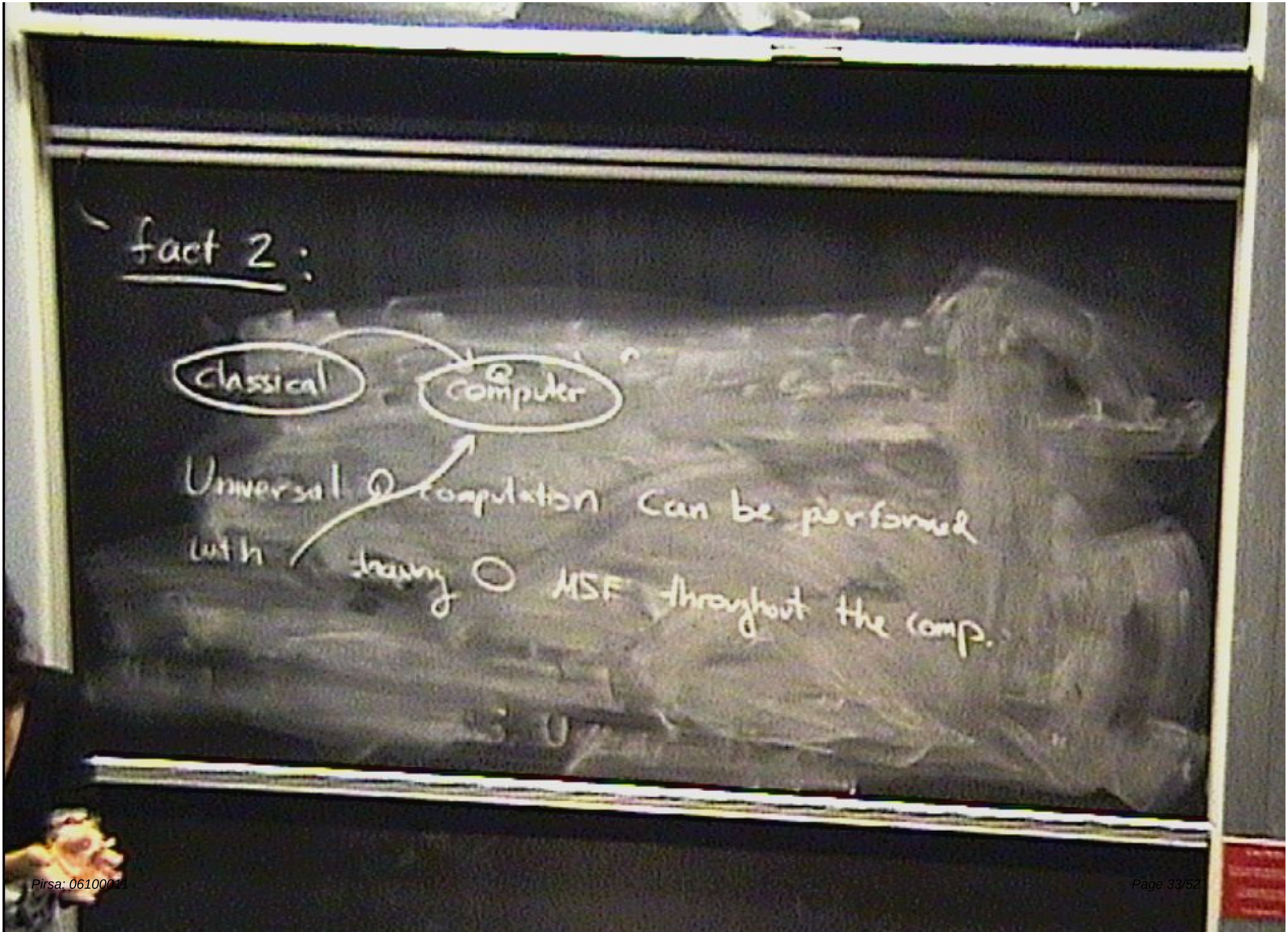
O MSE, somebody else acting on rest of world and saying something E changes.

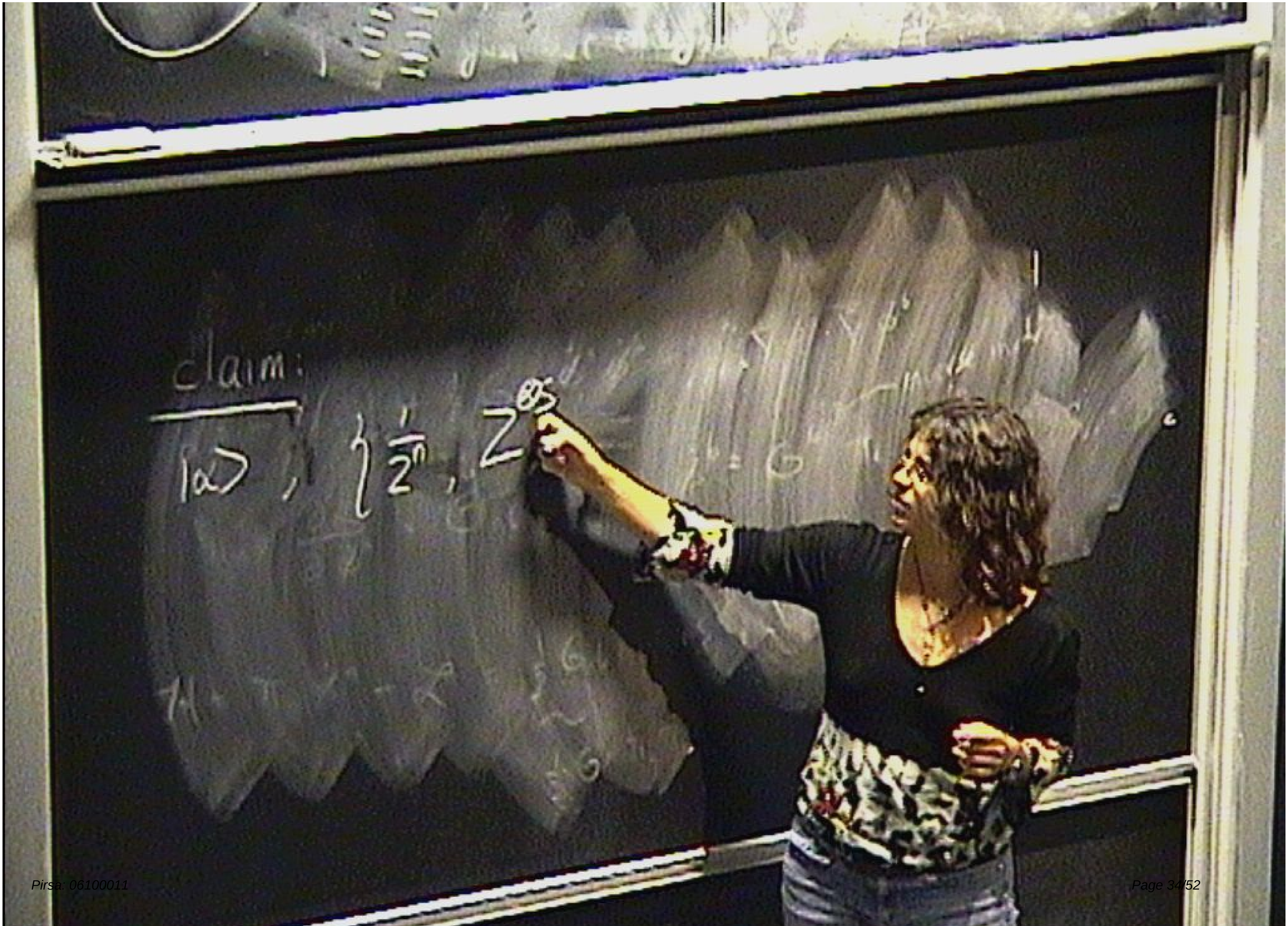

fact 2:
classical
Q computer

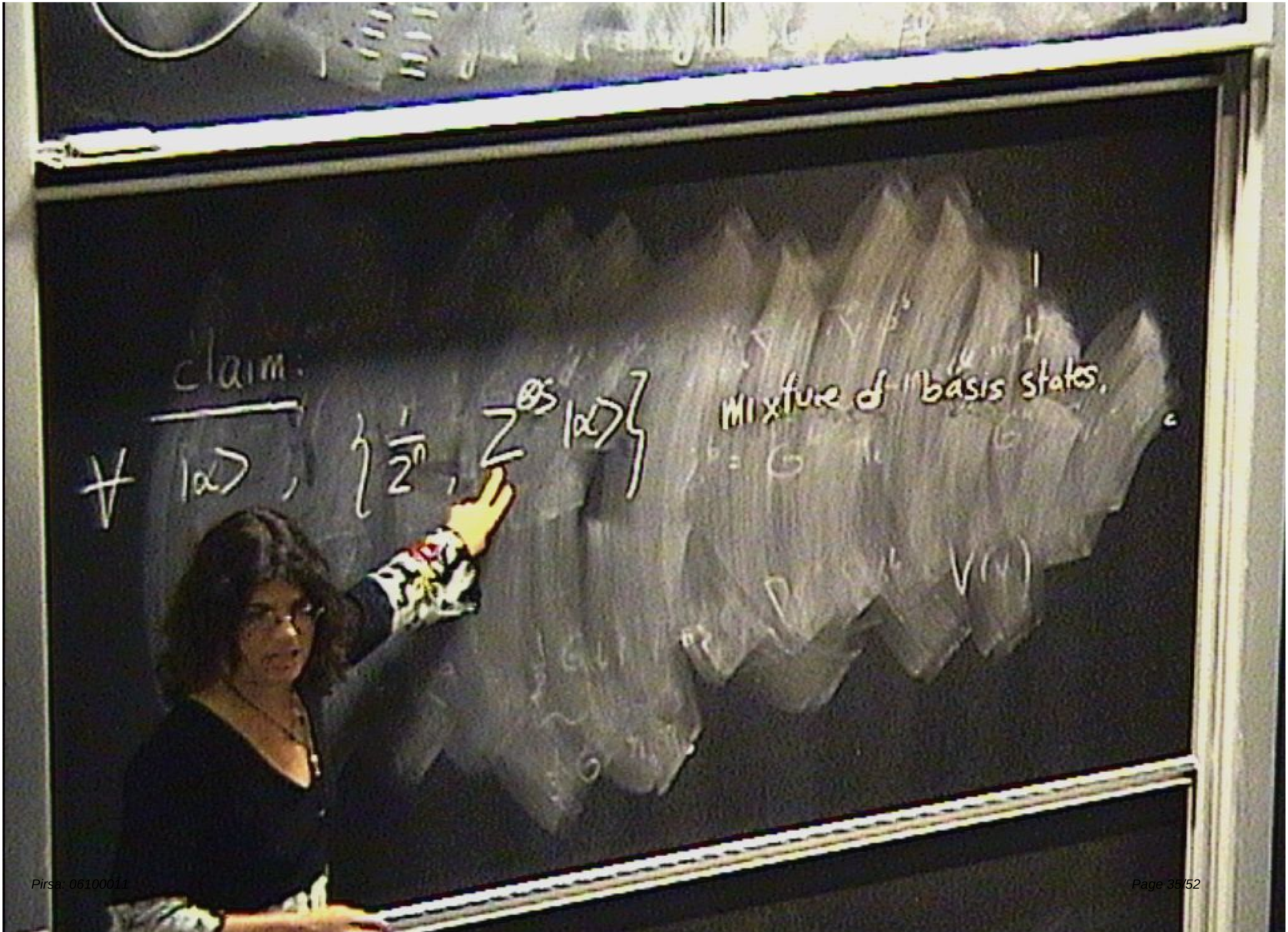
fact 2:

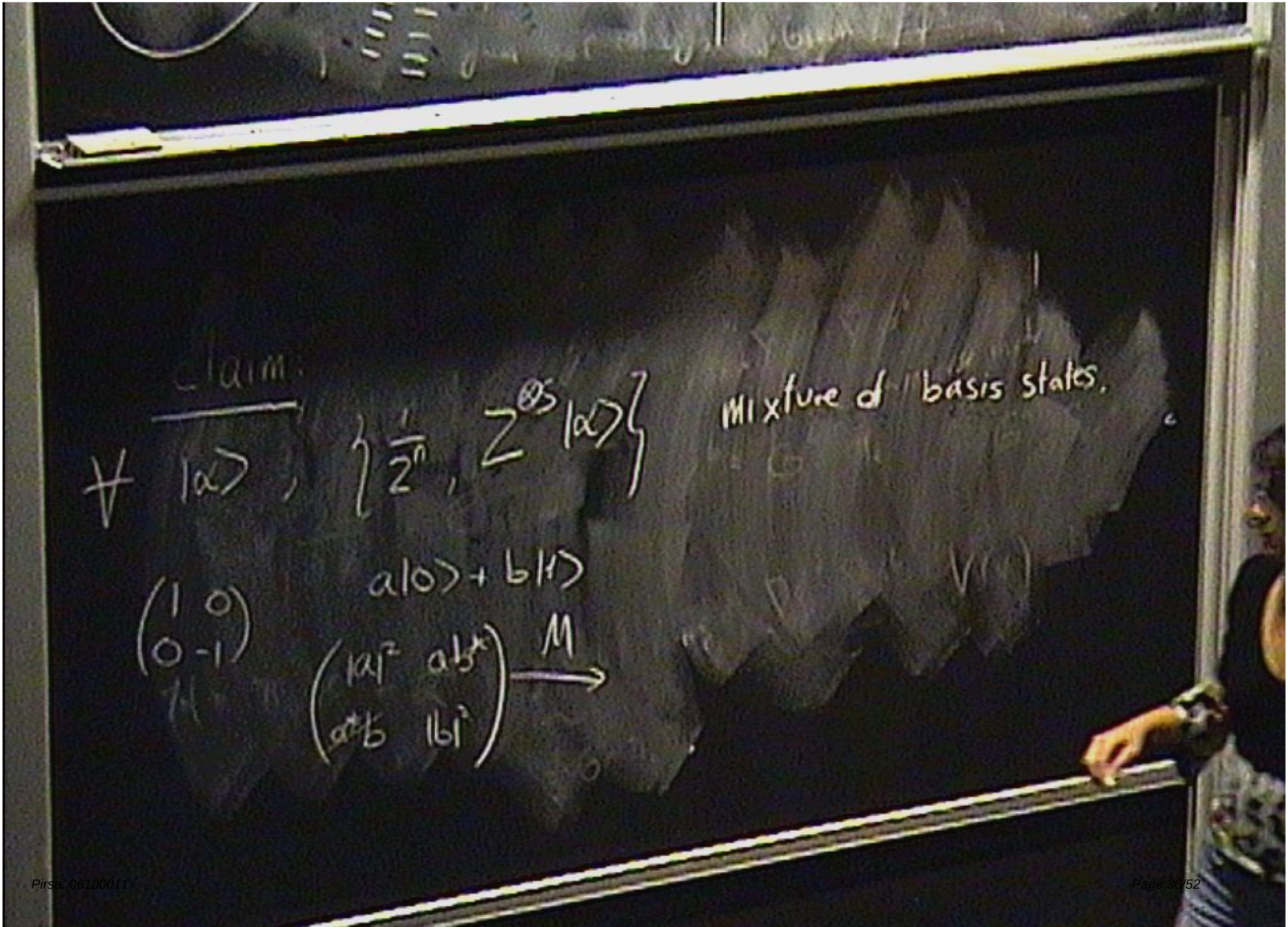
classical computer

Universal Q computation can be performed
with having Q MSF throughout the comp.


fact 2:
Classical
Q computer
Universal Q computation can be performed
with
keeping O MSF throughout the comp.


claim:


claim:
Mixture of basis states.


claim:
∀ |α⟩, {1/2^n, Z^{⊗s} |α⟩} mixture of basis states.
a|0⟩ + b|1⟩
(1 0; 0 -1)
(|a|² ab*; a*b |b|²) —M→

Claim:

$\forall\ |\alpha\rangle,\ \left\{ \frac{1}{2^n},\ Z^{\otimes S}|\alpha\rangle \right\}$ mixture of basis states.

$\frac{1}{2}|a|^2\ ab^*$

$\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$ $a|0\rangle + b|1\rangle$

$\begin{pmatrix} |a|^2 & ab^* \\ a^*b & |b|^2 \end{pmatrix} \xrightarrow{M} \begin{pmatrix} |a|^2 & 0 \\ 0 & |b|^2 \end{pmatrix}$ $\frac{1}{2}I, \frac{1}{2}Z$

Claim:

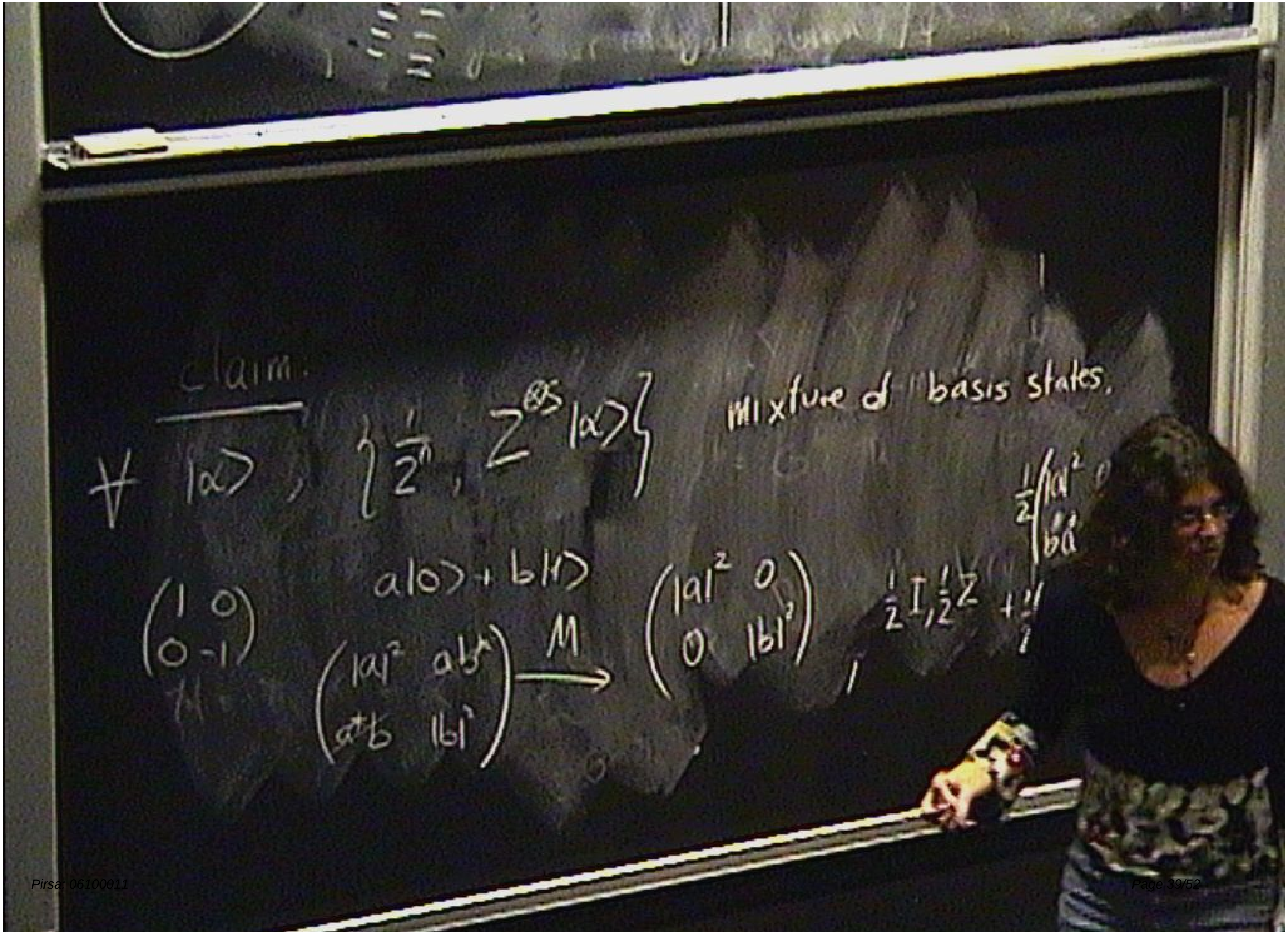
$\forall\ |\alpha\rangle, \ \left\{ \frac{1}{2^n}, Z^{\otimes s}|\alpha\rangle \right\}$ mixture of basis states.

$\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$ Z

$a|0\rangle + b|1\rangle$

$\frac{1}{2}\begin{pmatrix} |a|^2 & ab^* \\ ba^* & |b|^2 \end{pmatrix}$

$\begin{pmatrix} |a|^2 & ab^* \\ a^*b & |b|^2 \end{pmatrix} \xrightarrow{M} \begin{pmatrix} |a|^2 & 0 \\ 0 & |b|^2 \end{pmatrix}, \quad \frac{1}{2}I, \frac{1}{2}Z \ + \frac{1}{2}\big(|a$


claim:
∀ |α⟩, {1/2^n, Z^⊗S |α⟩} mixture of basis states.
a|0⟩ + b|1⟩
M
1/2 I, 1/2 Z

claim:

$\forall\ |\alpha\rangle,\ \left\{ \frac{1}{2^n},\ Z^{\otimes S}|\alpha\rangle \right\}$ mixture of basis states.

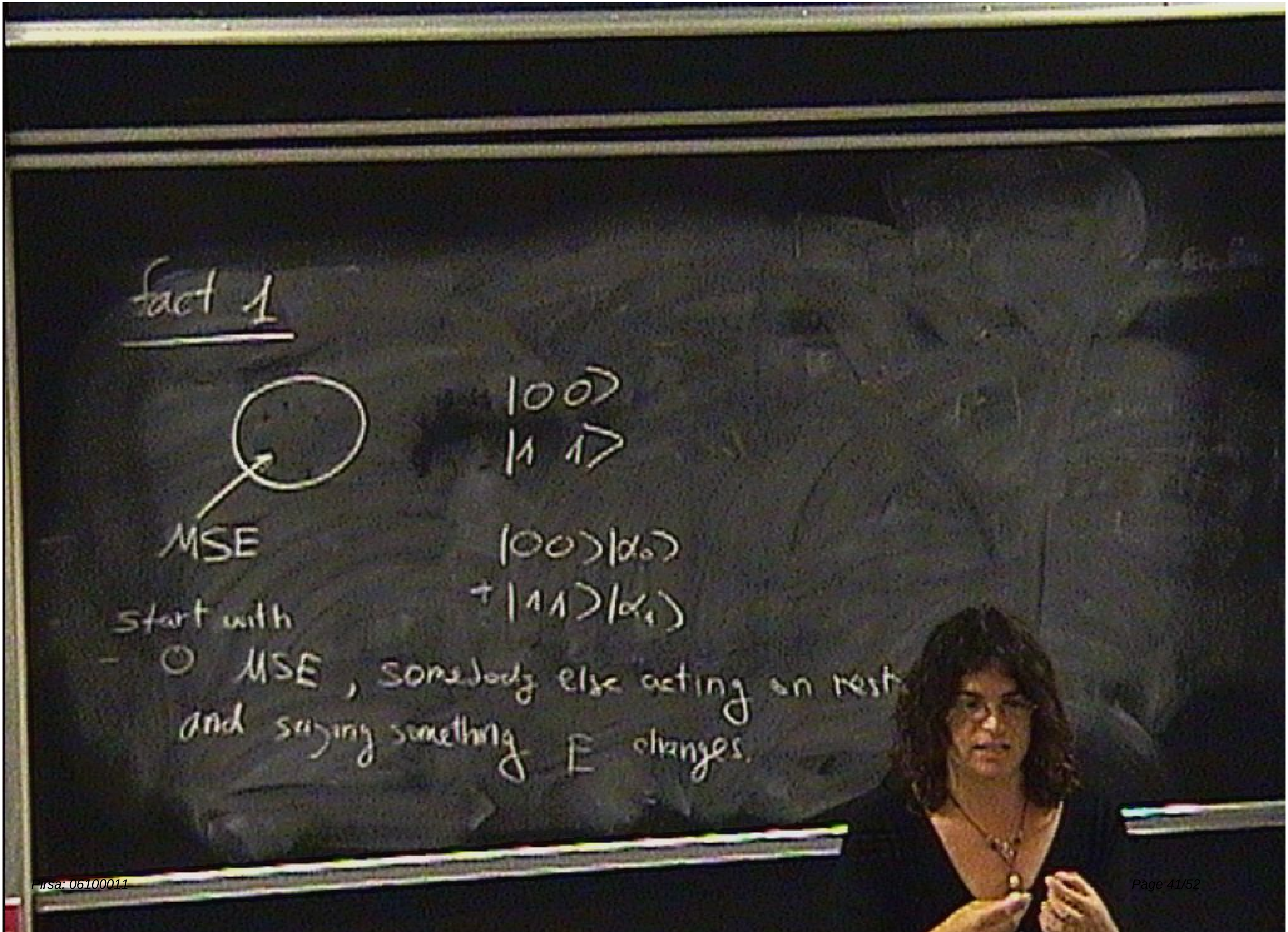
$a|0\rangle + b|1\rangle$

$\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$

$\begin{pmatrix} |a|^2 & ab^* \\ a^*b & |b|^2 \end{pmatrix} \xrightarrow{M} \begin{pmatrix} |a|^2 & 0 \\ 0 & |b|^2 \end{pmatrix}$

$\frac{1}{2}\begin{pmatrix} |a|^2 & ab^* \\ ba^* & |b|^2 \end{pmatrix}$

$\frac{1}{2}I,\ \frac{1}{2}Z \quad + \frac{1}{2}\begin{pmatrix} |a|^2 & -ab^* \\ -ba^* & |b|^2 \end{pmatrix}$


fact 1
$|00\rangle$
$|11\rangle$
MSE
$|00\rangle|\alpha_0\rangle$
$+|11\rangle|\alpha_1\rangle$
start with
- 0 MSE, somebody else acting on rest
and saying something E changes.

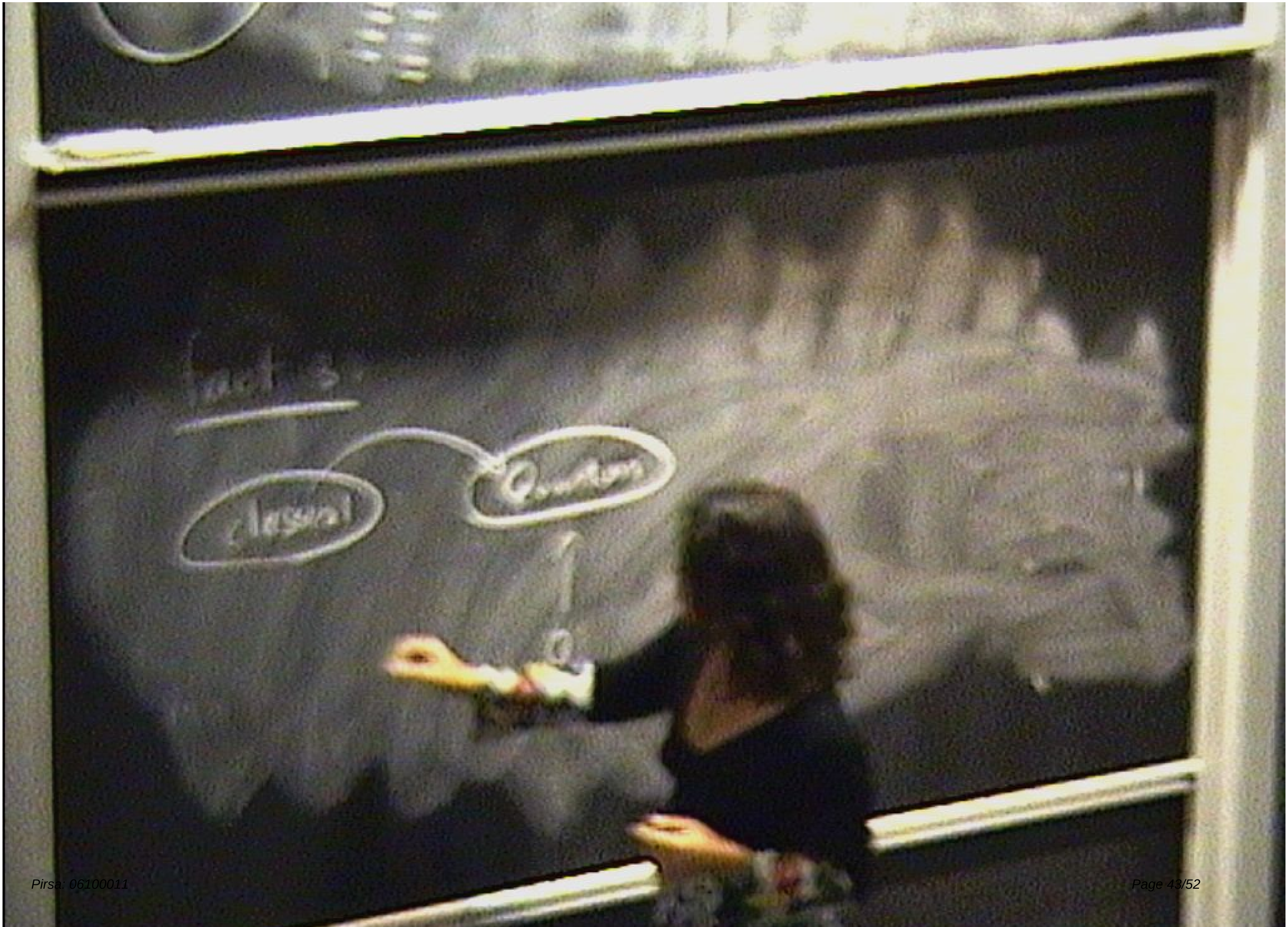
fact 2:

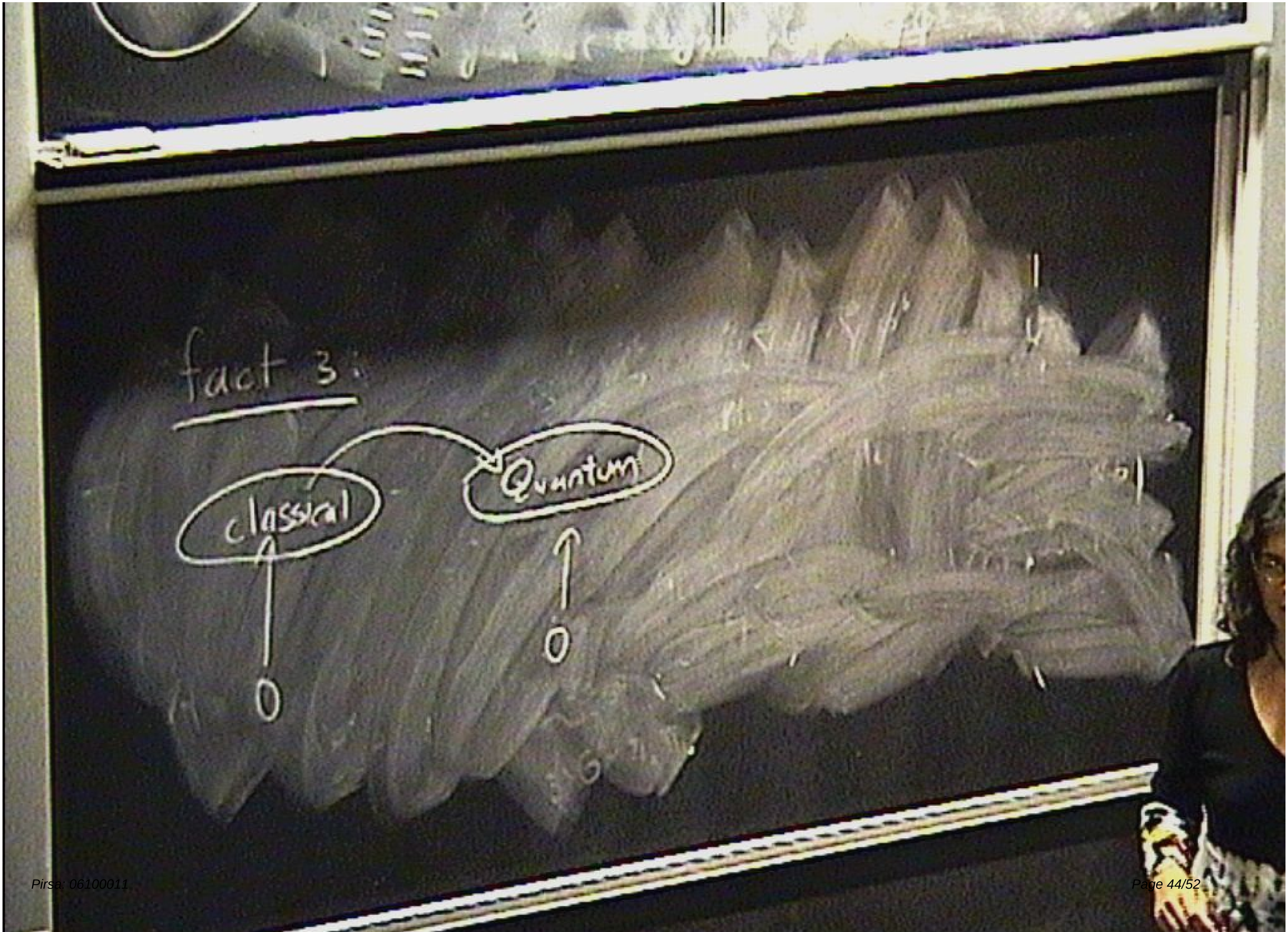
$|\beta_0\rangle$ $\vdots$ $|\beta_r\rangle$

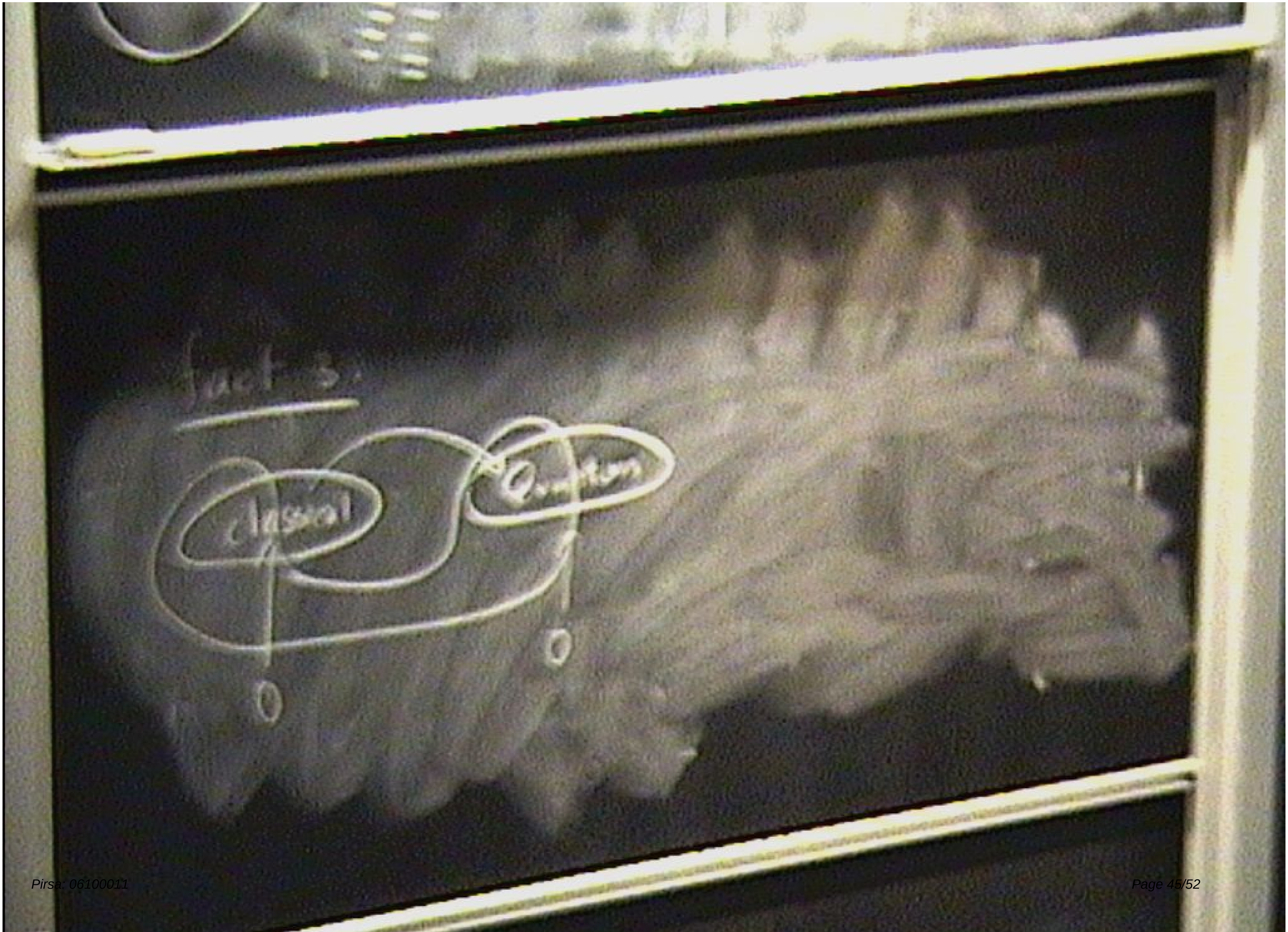
$|\alpha_0\rangle$ $|\alpha_1\rangle$ $\vdots$ $|\alpha_r\rangle$

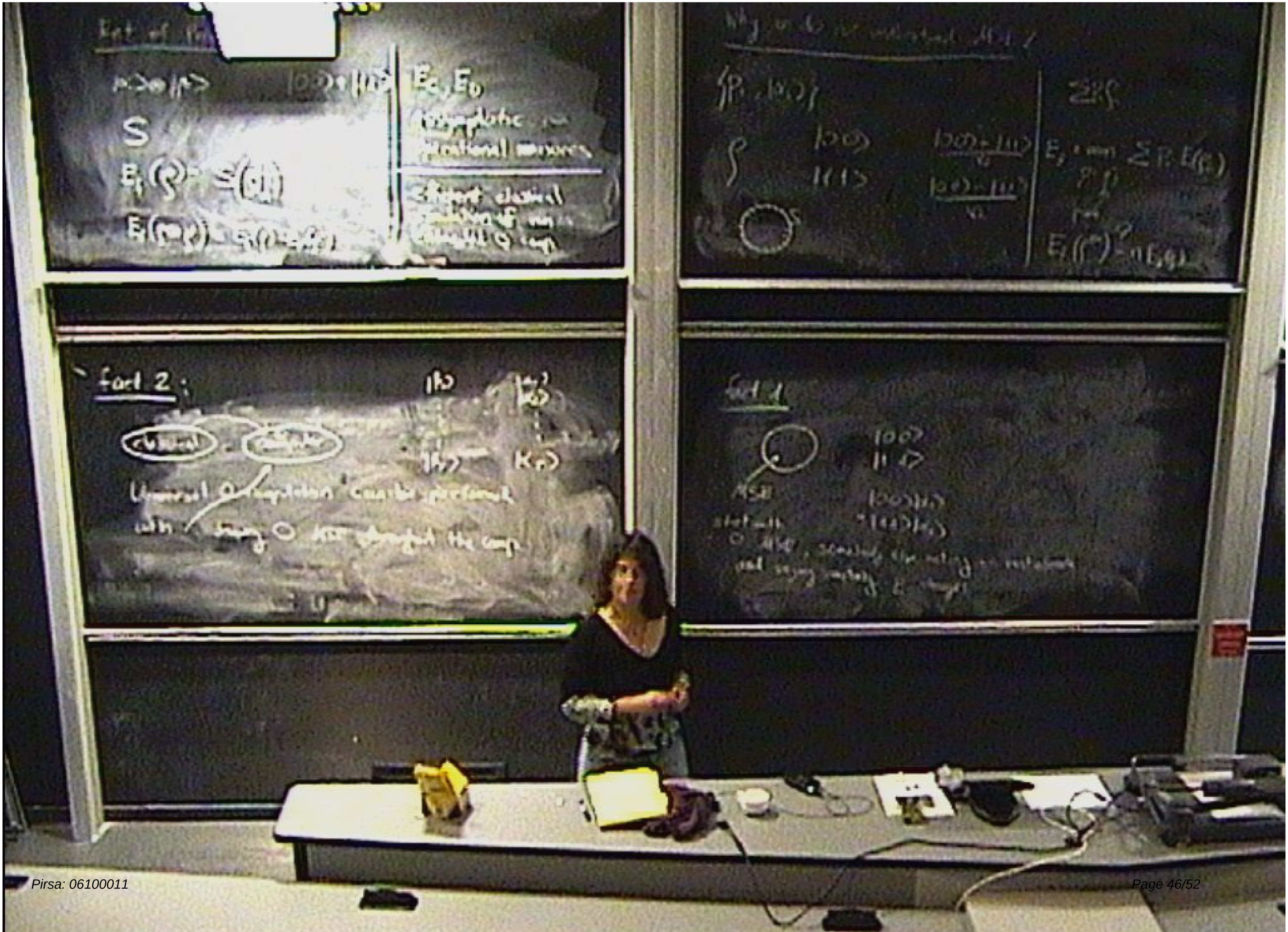
Classical Q computer

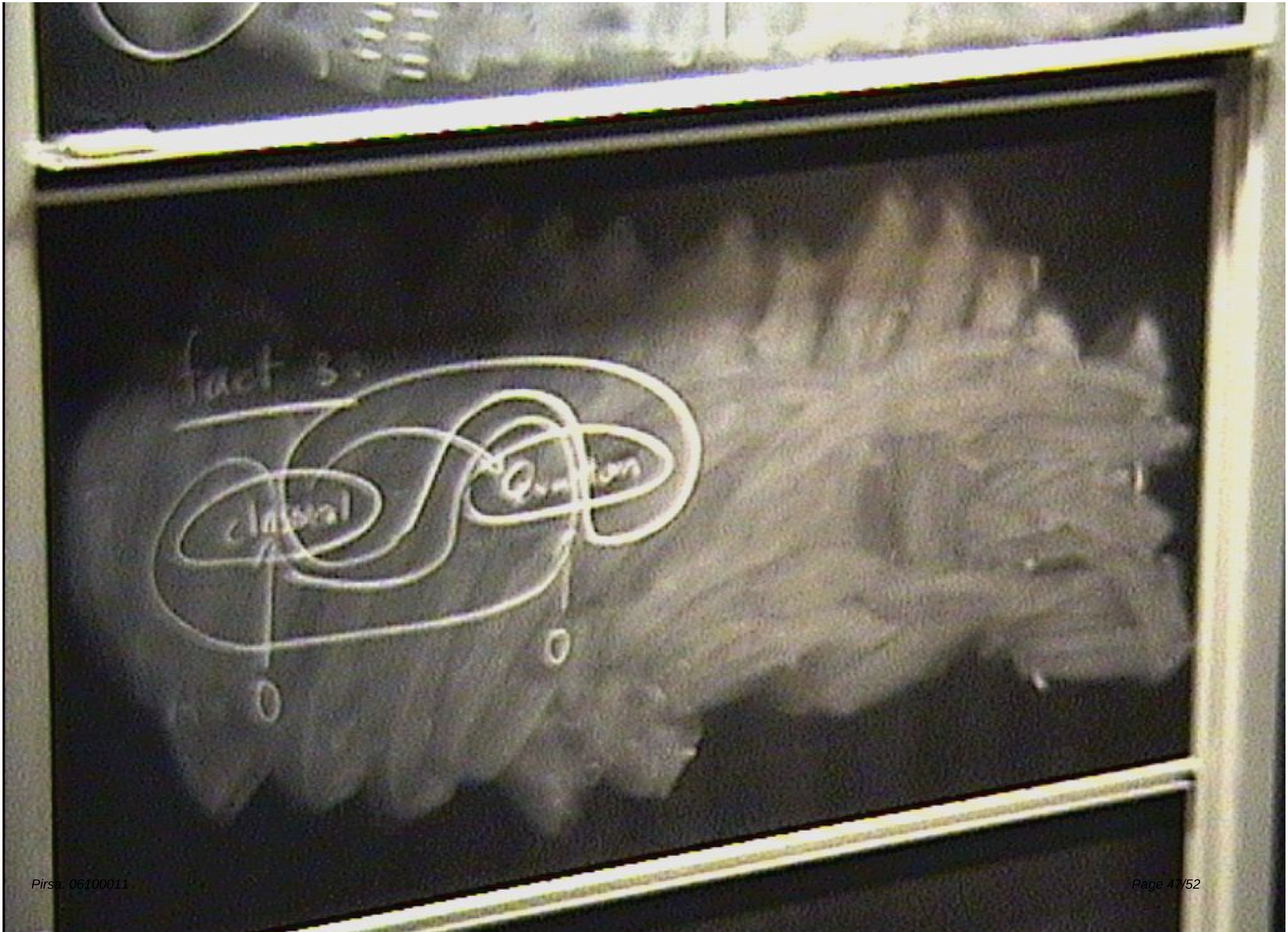
Universal Q computation can be performed with having 0 MSF throughout the comp.


Classical
Quantum

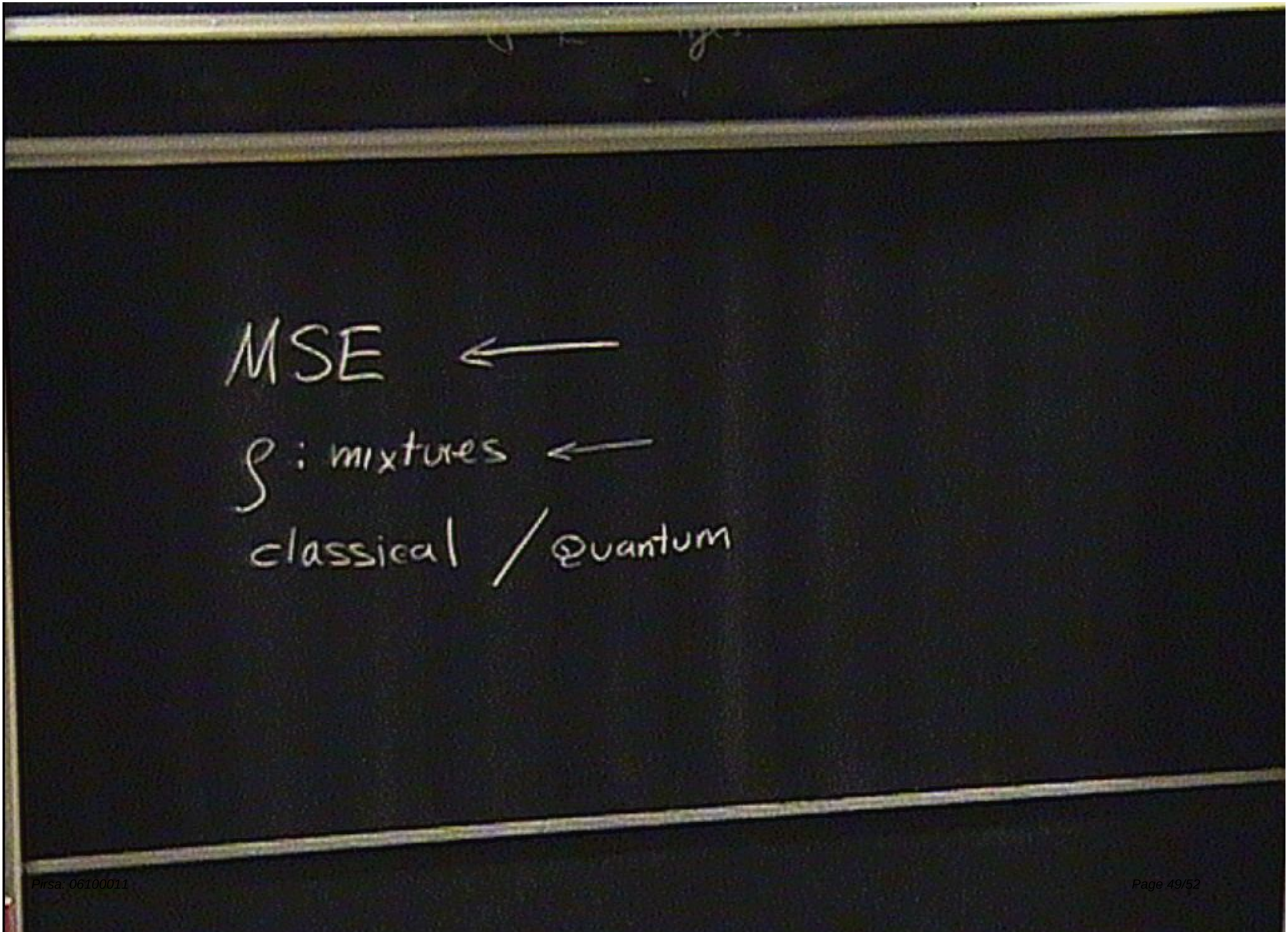

fact 3:
classical
Quantum
0
0

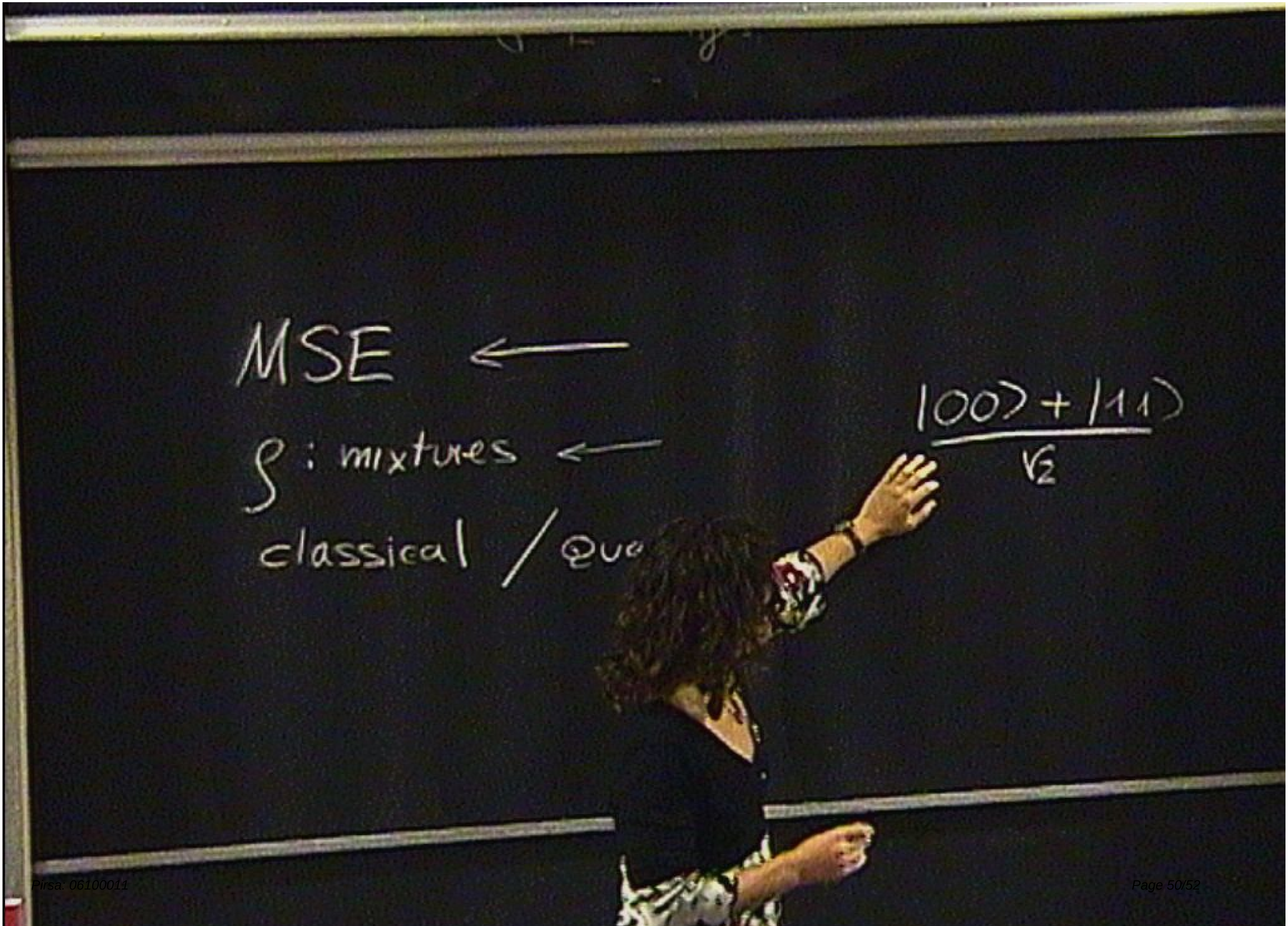

facts:
classical
Quantum
0
0

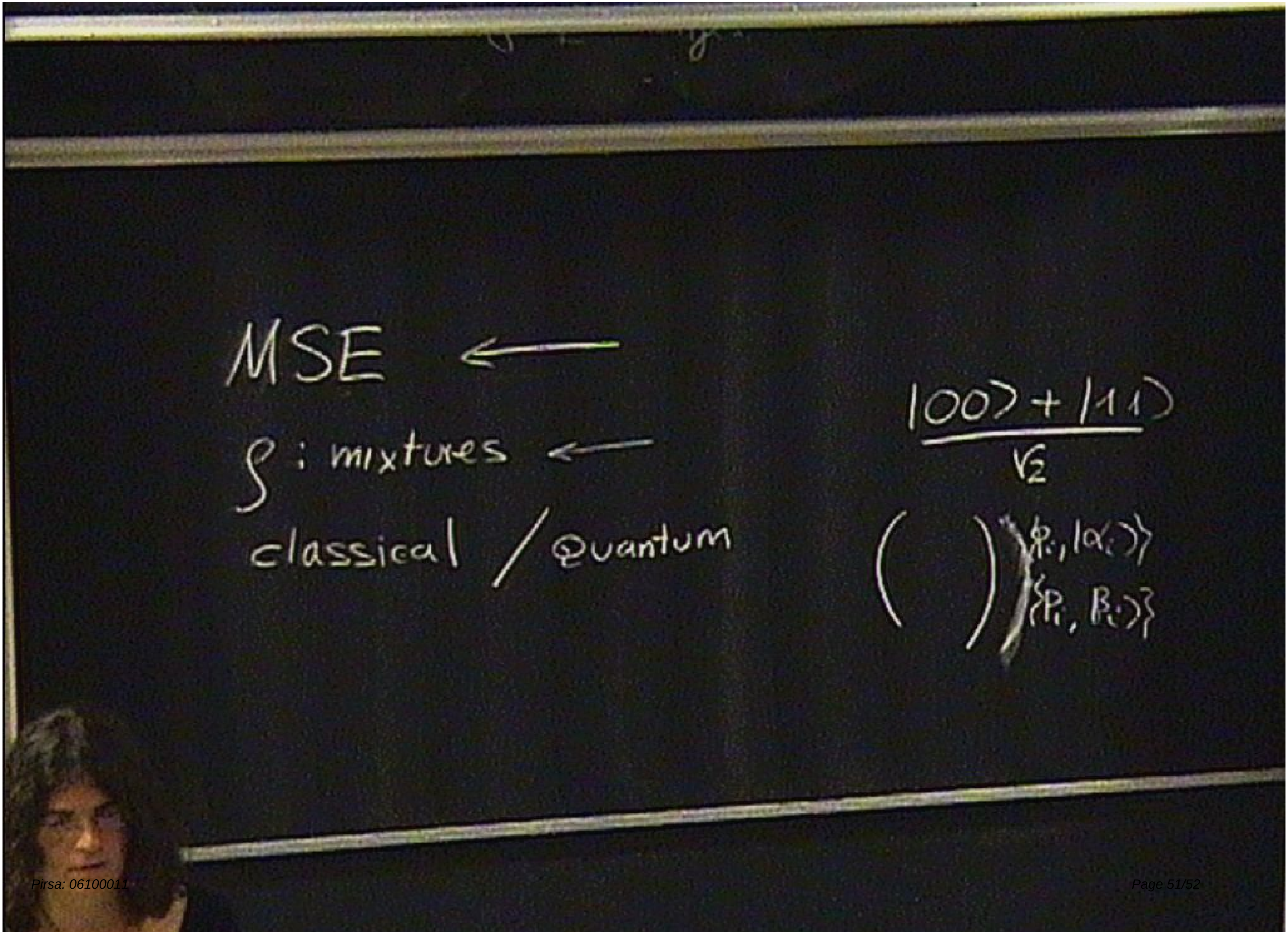

fact 2
fact 1
MSE


fact 3:
classical
Quantum
0
0

MSE ←


MSE ←
ρ : mixtures ←
classical / quantum


MSE ←
ρ : mixtures ←
classical / qua
$\frac{|00\rangle + |11\rangle}{\sqrt{2}}$


MSE
ρ : mixtures
classical / quantum
(|00⟩ + |11⟩)/√2
{pᵢ, |αᵢ⟩}
{Pᵢ, |βᵢ⟩}

fact 2:

$|\beta_0\rangle \quad |\alpha_0\rangle$

$|\alpha_1\rangle$

$\vdots \qquad \vdots$

$|\beta_T\rangle \quad |\alpha_T\rangle$

Classical Q computer

Universal Q computation can be performed with having Q MSE throughout the comp.