

Title: PSI Special Lecture - Ignacio Cirac

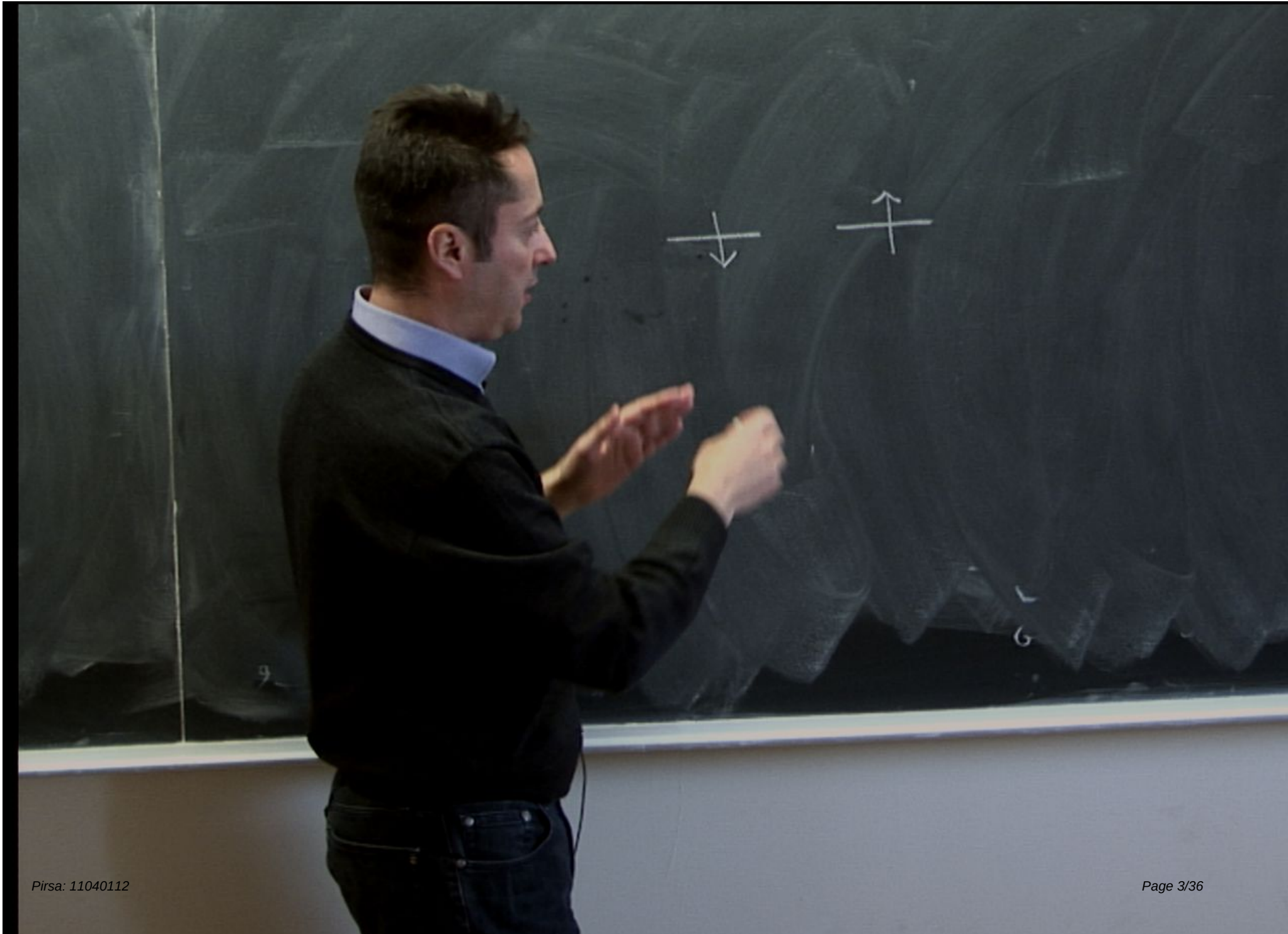
Date: Apr 08, 2011 01:30 PM

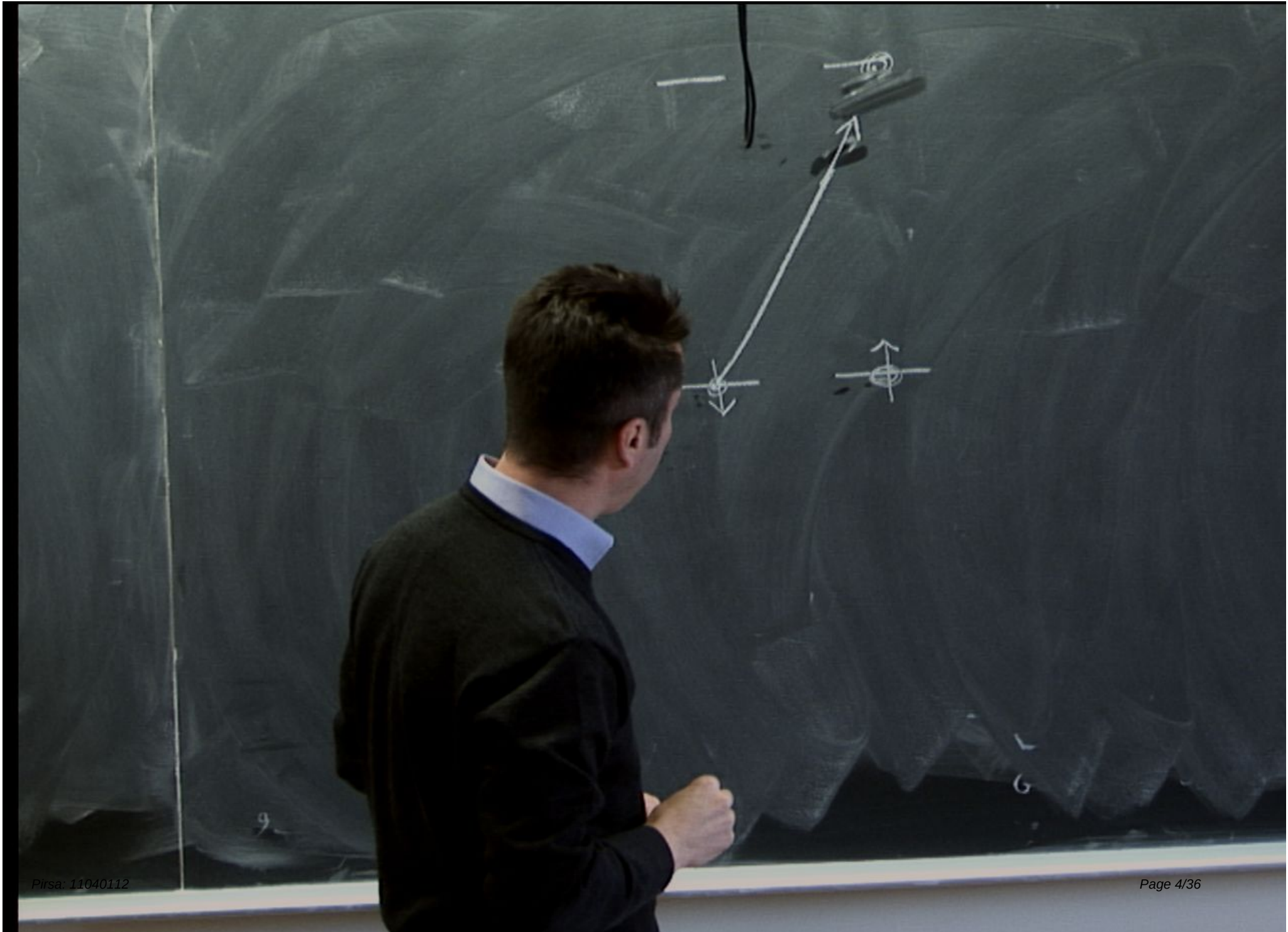
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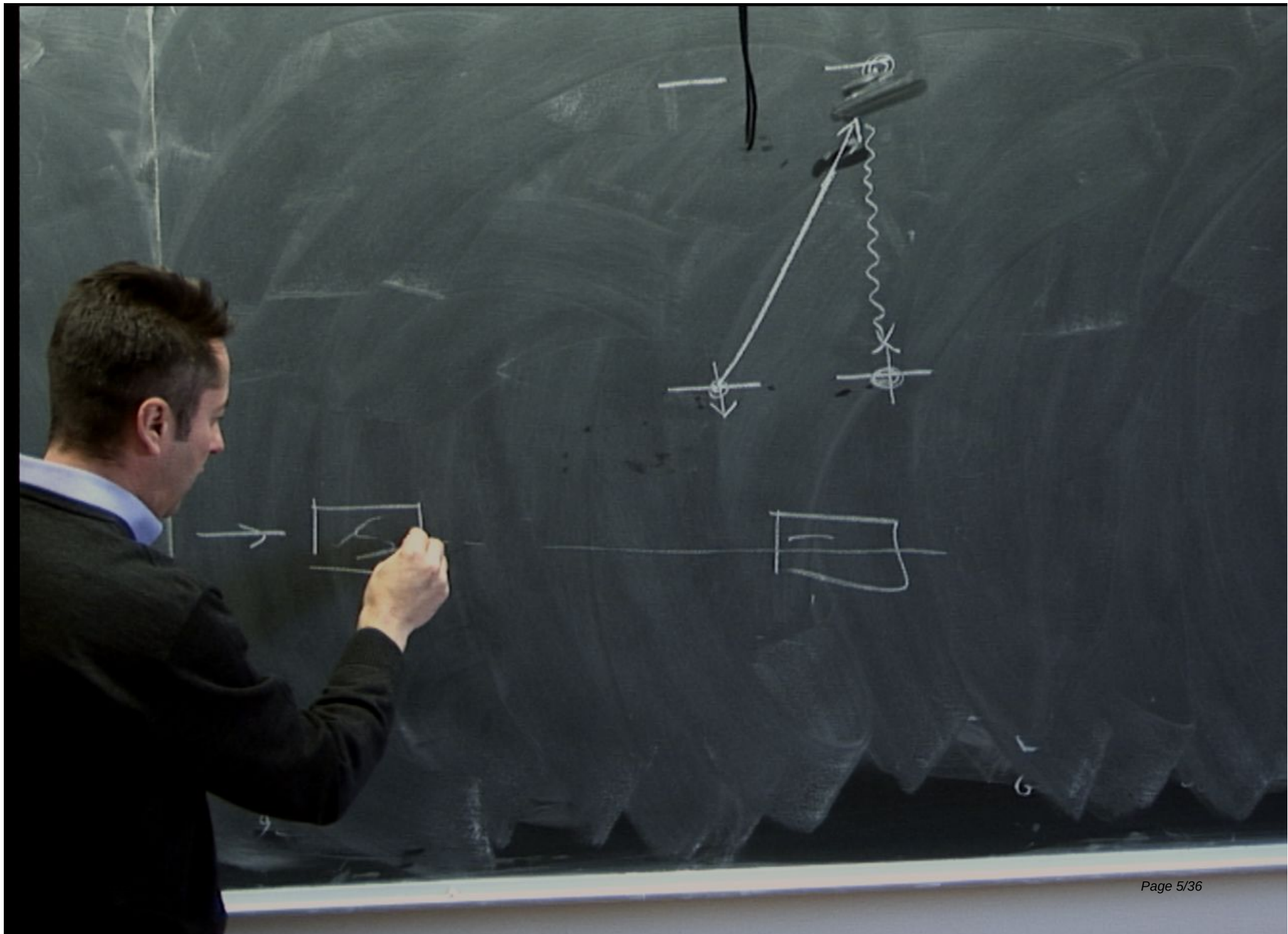
Abstract:

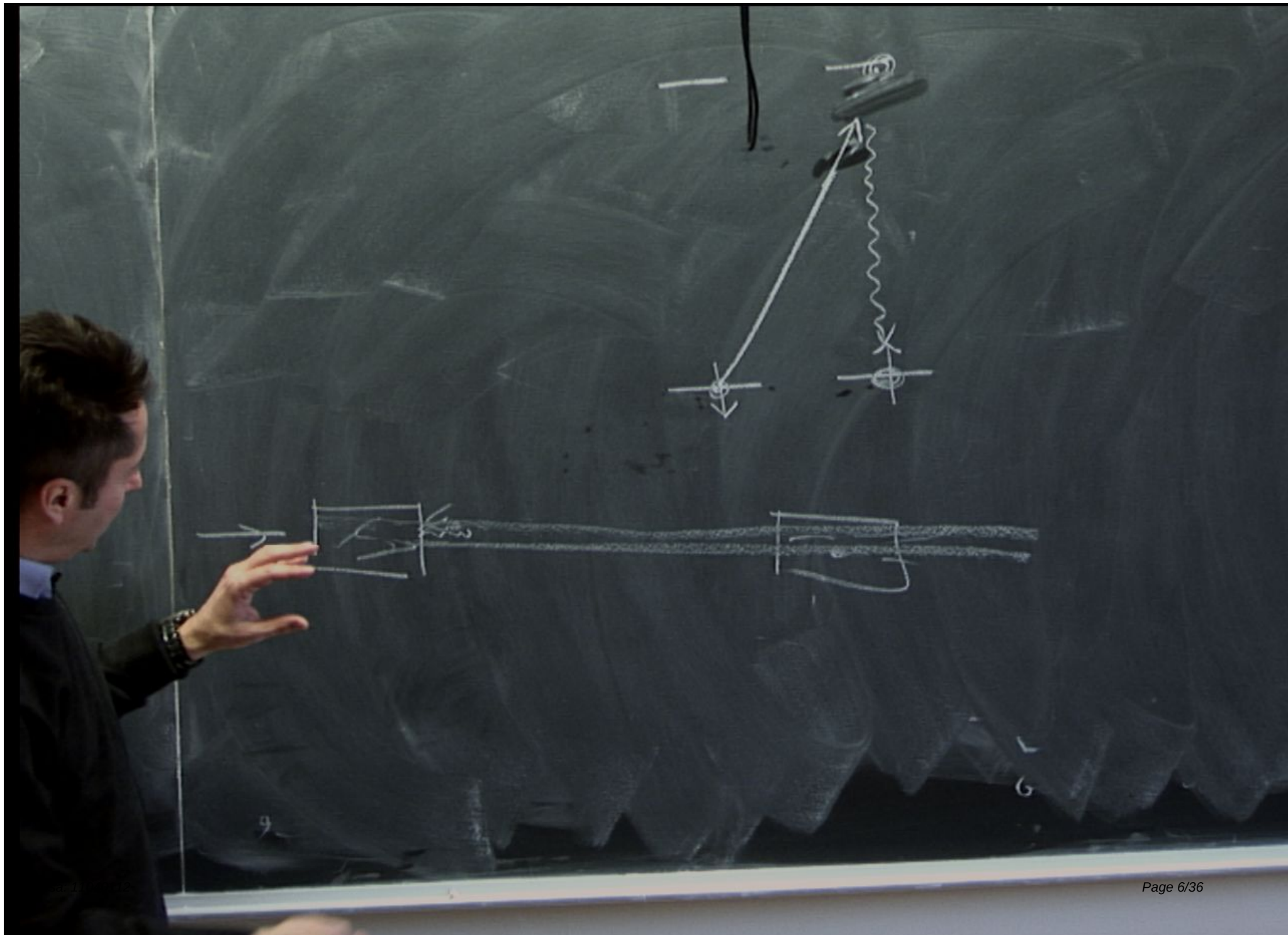


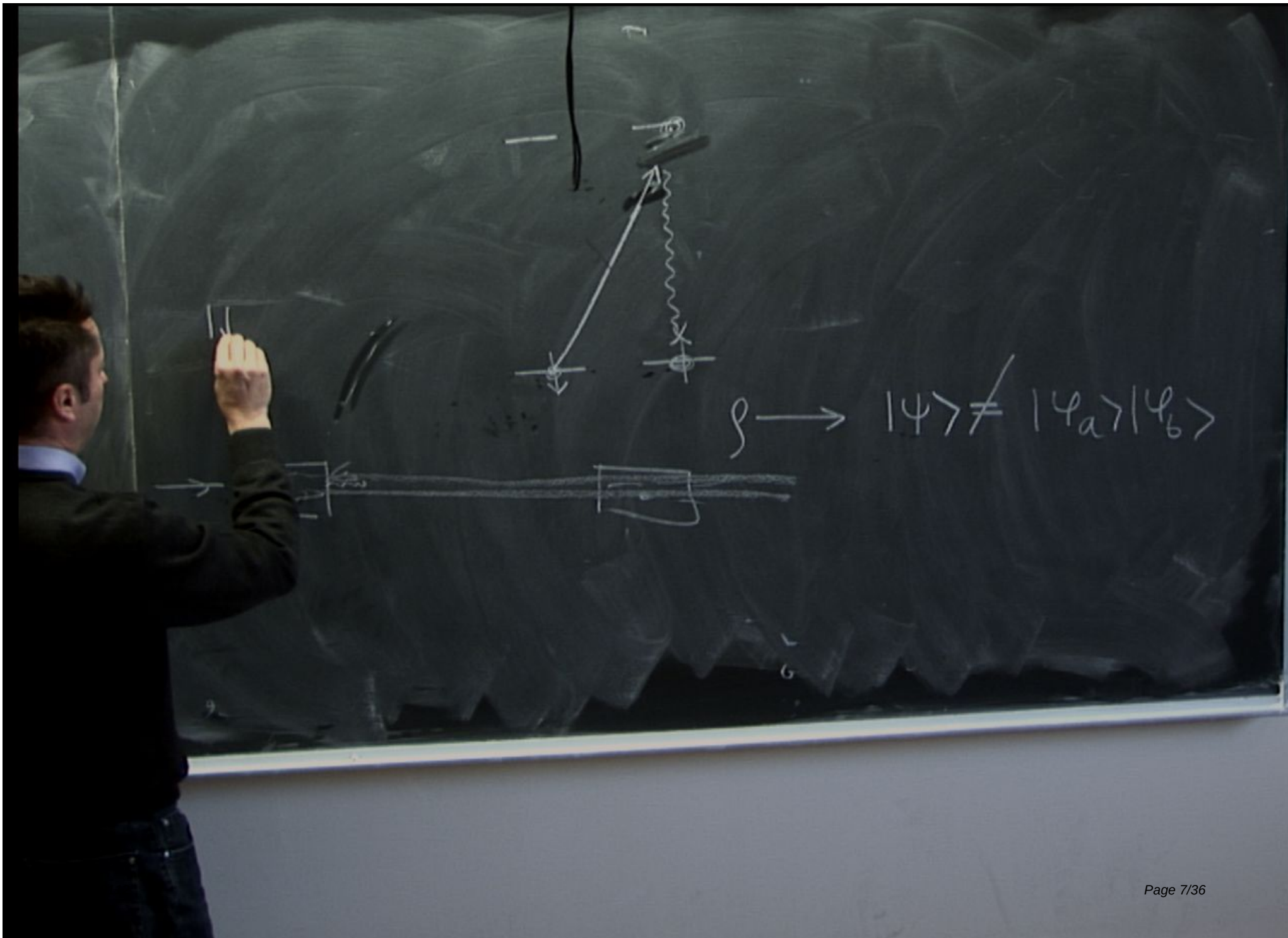
perimeter scholars
INTERNATIONAL



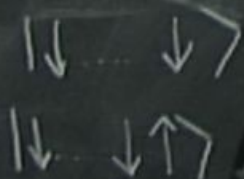




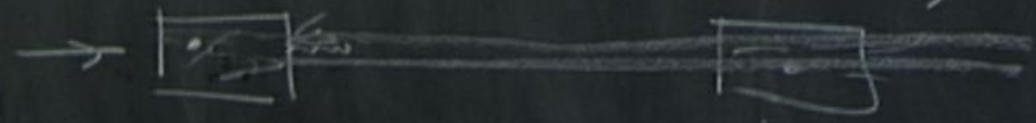




$$\rho \rightarrow |\psi\rangle \neq |\psi_a\rangle |\psi_b\rangle$$



$$g \rightarrow |4\rangle \neq |4_a\rangle |4_b\rangle$$



$$\begin{aligned}
 & \gg = \begin{array}{c} \downarrow \downarrow \\ \downarrow \end{array} \\
 & \uparrow + \begin{array}{c} \downarrow \downarrow \\ \downarrow \uparrow \end{array} + \begin{array}{c} \downarrow \downarrow \\ \downarrow \uparrow \end{array} \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow
 \end{aligned}$$



$$g \rightarrow |\psi\rangle \neq |\psi_a\rangle |\psi_b\rangle$$



$$\begin{aligned}
 |0\rangle &= |\downarrow \downarrow\rangle \\
 |1\rangle &= |\uparrow \downarrow\rangle + |\downarrow \uparrow\rangle \\
 |2\rangle &= |\uparrow \uparrow\rangle
 \end{aligned}$$

$\rho \rightarrow |4\rangle$

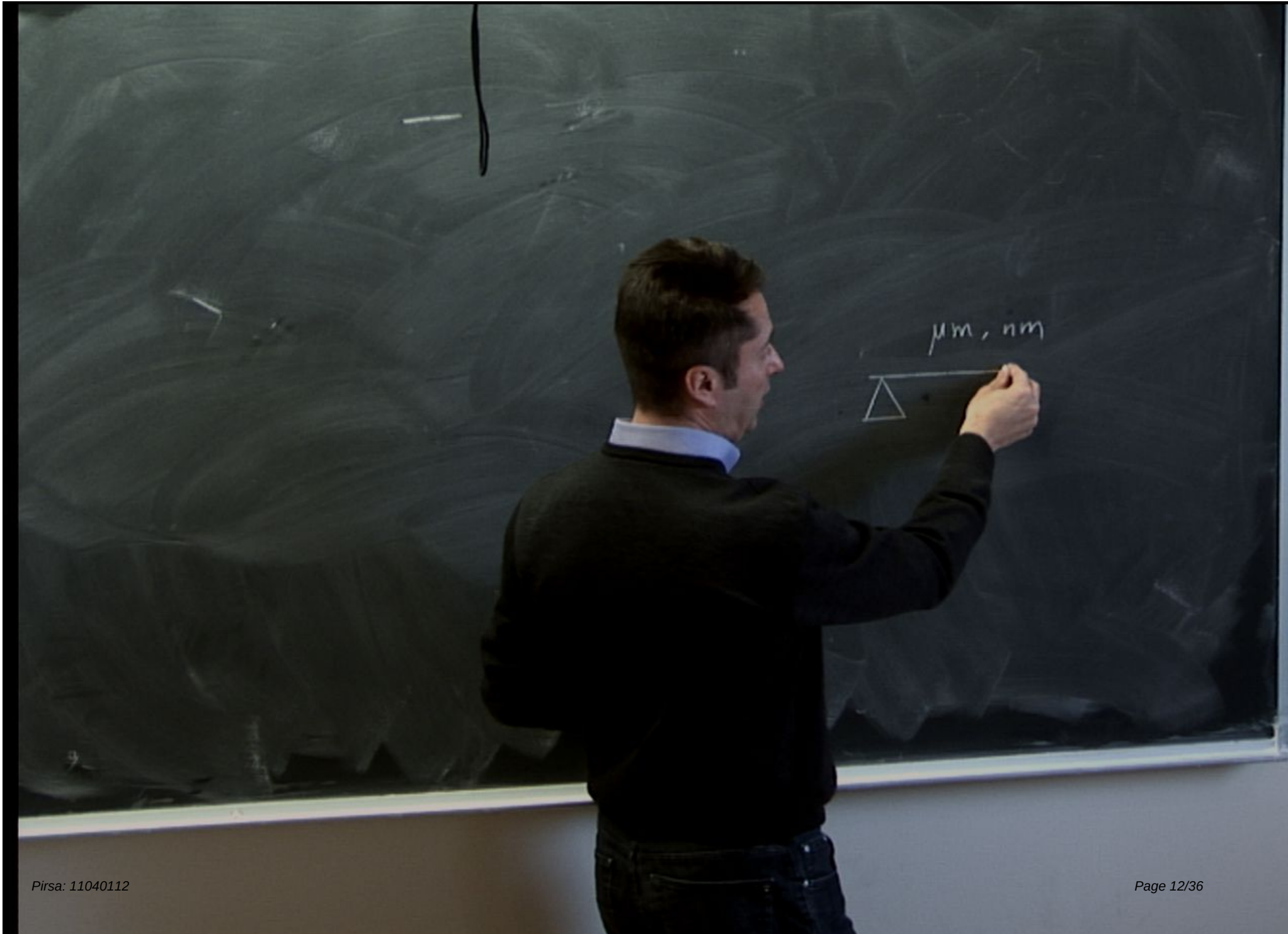
$$|0\rangle = |\downarrow\downarrow\rangle$$

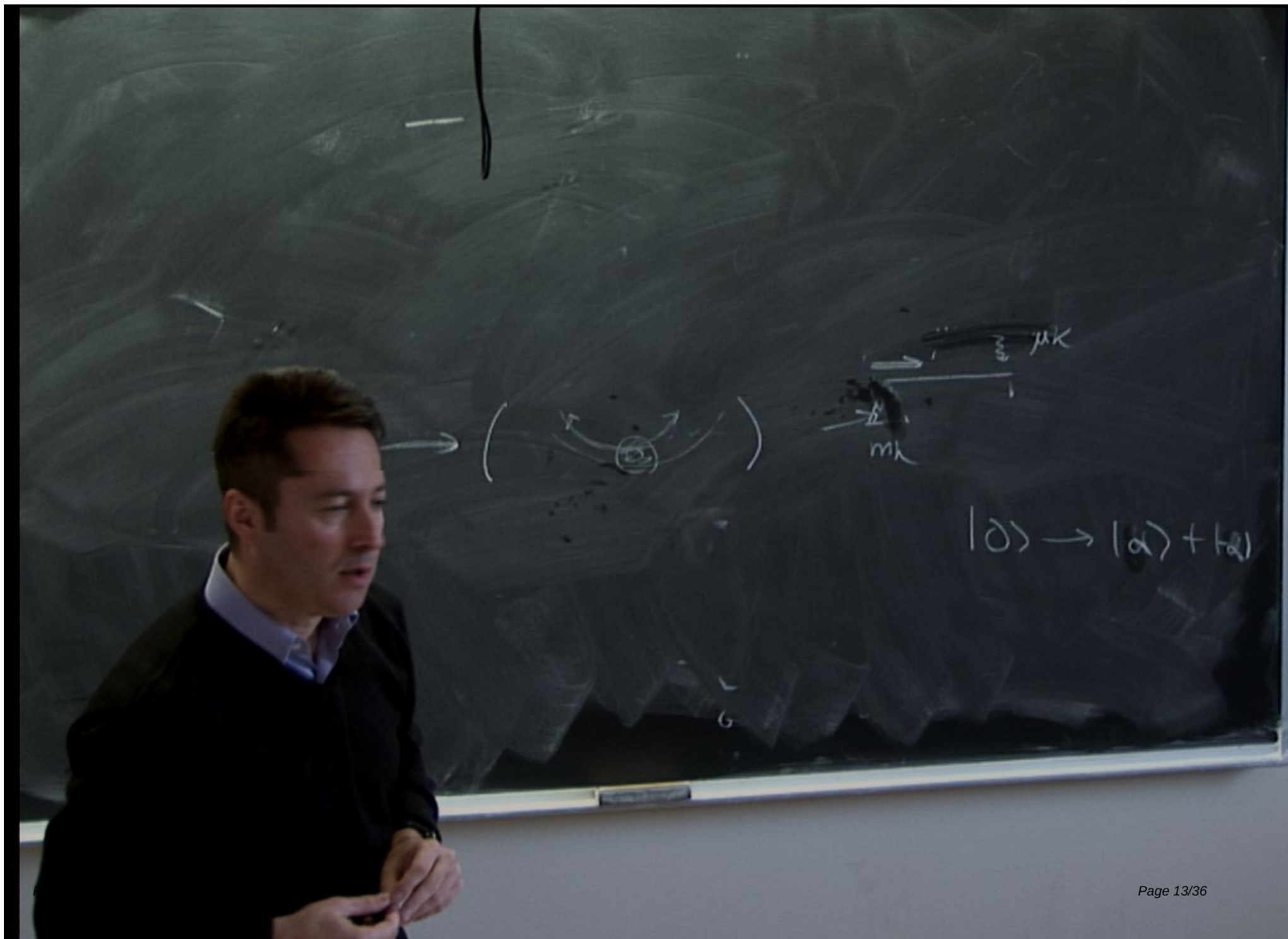
$$= \frac{1}{\sqrt{2}} (|\downarrow\uparrow\rangle + |\uparrow\downarrow\rangle)$$



$$|0,0\rangle + \Lambda|1,1\rangle + \Lambda^2|2,2\rangle$$

$$\rho \rightarrow |\psi\rangle \neq |\psi_a\rangle |\psi_b\rangle$$

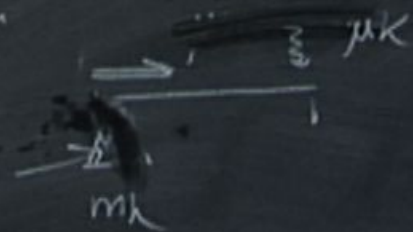






$\vec{Dg}$

50nm + 300nm

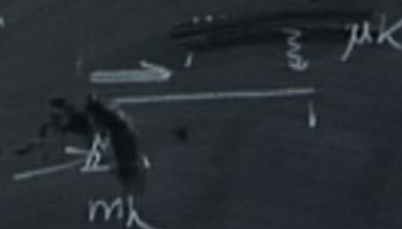


$$|0\rangle \rightarrow |\alpha\rangle + |\beta\rangle$$

10^{-11} Torr

50 nm → 300 nm

$\vec{D}_g$



$$|0\rangle \rightarrow |\alpha\rangle + |\beta\rangle$$

$$|4\rangle \rightarrow e^{-i m g \frac{1}{2} z} |4_1\rangle + e^{-i m g \frac{1}{2} z} |4_2\rangle$$

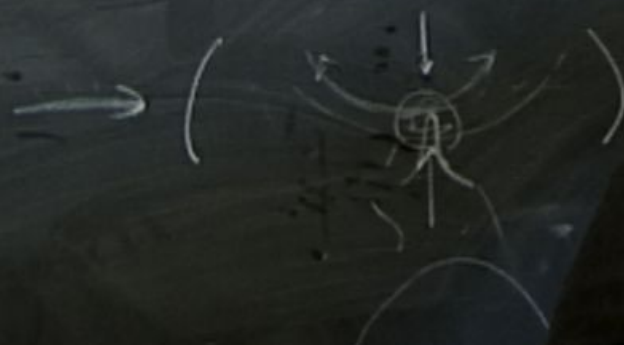
$$H = m g z$$

$$\vec{\nabla} g$$

$$10^{-11} \text{ Torr}$$

$$50 \text{ nm} \rightarrow 300 \text{ nm}$$

$$\mu\text{K}$$



$$|0\rangle \rightarrow |\alpha\rangle + |\beta\rangle$$

$$|\psi\rangle \rightarrow e^{-i m g \frac{z}{2} t} |\psi_1\rangle + e^{-i m g \frac{z}{2} t} |\psi_2\rangle$$

$$H = mgz$$

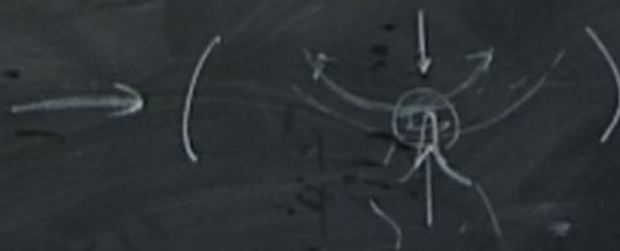
$$\vec{\nabla} g$$



$$10^{-11} \text{ Torr}$$

$$50 \text{ nm} + 300 \text{ nm}$$

$$\frac{1}{2} \mu K$$



$$m_k$$

$$|0\rangle \rightarrow |\alpha\rangle + |\beta\rangle$$

$$|4\rangle \rightarrow e^{-i\omega_1 t/2} |4_1\rangle + e^{-i\omega_2 t/2} |4_2\rangle$$

$$H = mgz$$

$$\vec{\nabla} g$$



$$10^{-11} \text{ Torr}$$

$$50 \text{ nm} + 300 \text{ nm}$$

$$3 \text{ } \mu\text{K}$$

$$\sqrt{\frac{\hbar}{1 \text{ MHz}}} = x_0$$

$$|0\rangle \rightarrow |\alpha\rangle + |\beta\rangle$$

$$10^{-12} \text{ m}$$

$$E(\sigma_1, \dots, \sigma_N) = \sum_{\langle i,j \rangle} J_{ij} \sigma_i \sigma_j$$

$$E(\sigma_1, \dots, \sigma_N) = \sum_{\langle i,j \rangle} J_{ij} \sigma_i \sigma_j$$

$$\sigma_1 = \dots$$

$$H = \sum_{\langle i,j \rangle} J_{ij} \sigma_i \cdot \sigma_j$$

$$|\psi\rangle = \sum_{\sigma_1, \dots, \sigma_N} c_{\sigma_1, \dots, \sigma_N} |\sigma_1, \dots, \sigma_N\rangle$$

$\uparrow$
 2^N

N
 $\begin{matrix} \times & \times & \times \\ \times & \times & \times \\ \times & \times & \times \end{matrix}$

$$|\psi\rangle = \sum_{\sigma_1 \sigma_N} C_{\sigma_1 \sigma_N} \sigma_1 \sigma_N$$

$$\langle \psi | A | \psi \rangle \quad 2^N$$

$$\begin{array}{c}
 N \\
 \begin{array}{ccc}
 \times & \times & \times \\
 \times & \times & \times \\
 \times & \times & \times \\
 \sum & H
 \end{array}
 \end{array}$$

$$H|\psi\rangle = E_0|\psi\rangle$$

$$\rho \sim e^{-\beta H}$$

$$|\psi\rangle = \sum_{\sigma_1 \sigma_N} C_{\sigma_1 \sigma_N} \uparrow$$

$$\langle \psi | A | \psi \rangle \quad 2^N$$

N
 $\begin{matrix} \times & \times & \times \\ \times & \times & \times \\ \times & \times & \times \end{matrix}$

$$H = \sum_{ij} h_{ij}$$

$$H|\psi\rangle = E_0|\psi\rangle$$

$$\rho \sim e^{-\beta H}$$

$$|\psi(t)\rangle = e^{-iHt} |\psi_1\rangle$$

$$|\psi\rangle = \sum_{\sigma_1 \sigma_N} c_{\sigma_1 \sigma_N} \sigma_1 \sigma_N$$

$$\langle \psi | A | \psi \rangle$$

2^N

N
 $\begin{matrix} x & x & x \\ x & x & x \\ x & x & x \end{matrix}$

$$H = \sum_{ij} \boxed{h_{ij}}$$

$$| \psi_0 \rangle = E_0 | \psi_0 \rangle \rightarrow \psi_0(H)$$

$$\rho \sim e^{-\beta H}$$

$$\psi(t) = e^{-iHt} \psi_1$$

$$|\psi\rangle = \sum_{\sigma_1 \sigma_N} c_{\sigma_1 \sigma_N} \uparrow$$

$$\langle \psi | A | \psi \rangle \quad 2^N$$

N
 $\begin{matrix} \times & \times & \times \\ \times & \times & \times \\ \times & \times & \times \end{matrix}$

$$16 N^2$$

$$H = \sum_{ij} \boxed{h_{ij}}$$

$$H|\psi_0\rangle = E_0|\psi_0\rangle \rightarrow \psi_0(N^2)$$

$$\rho \sim e^{-\beta H}$$

$$|\psi(t)\rangle = e^{-iHt} |\psi_1\rangle$$

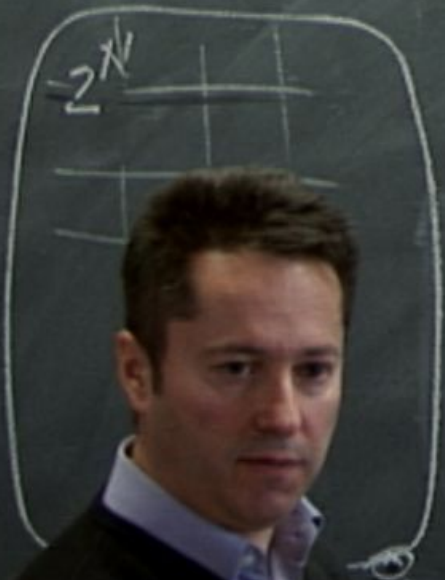
$$|\psi\rangle = \sum_{\sigma_1 \sigma_N} c_{\sigma_1 \sigma_N} \uparrow$$

$$\langle \psi | A | \psi \rangle \quad 2^N$$

$2^{X'}$

14





"PEPS"



$16 N^2$

$$H = \sum_{\langle ij \rangle} [h_{ij}]$$

$$H|\psi_0\rangle = E_0|\psi_0\rangle \rightarrow \psi_0(N,r)$$

$$P \sim e^{-\beta H}$$

$$|\psi(t)\rangle = e^{-iHt} |\psi_0\rangle$$



"PEPS"



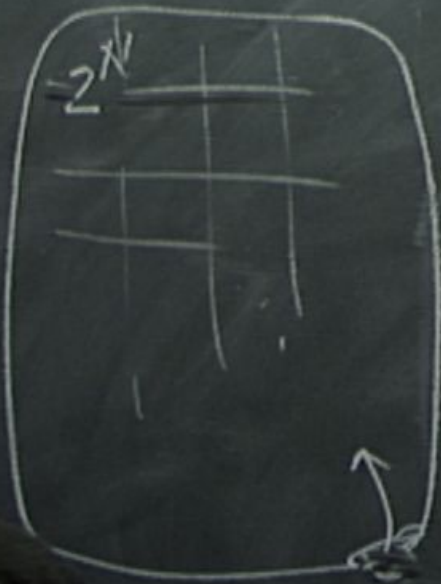
$$H = \sum_{\langle i,j \rangle} [h_{ij}]$$

$$16 N^2$$

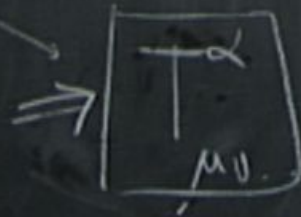
$$H|\psi_0\rangle = E_0|\psi_0\rangle \rightarrow \psi_0(N,r)$$

$$P \sim e^{-\beta H}$$

$$|\psi(t)\rangle = e^{-iHt} |\psi_0\rangle$$



"PEPS"



N

$\times \times \times$
 $\times \times \times$
 $\times \times \times$

$16 N^2$

$$H = \sum_{\langle ij \rangle} [h_{ij}]$$

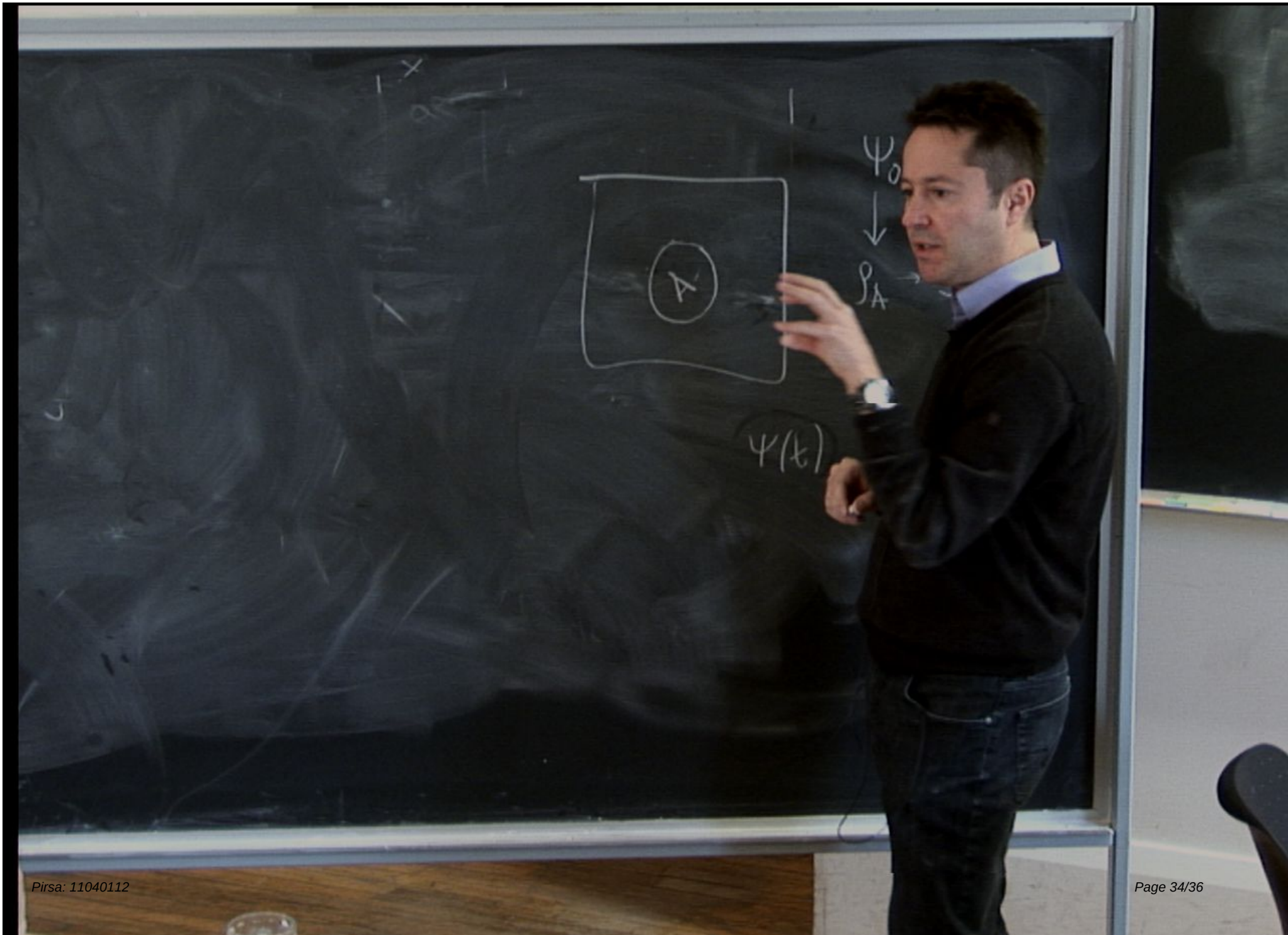
$$H|\psi_0\rangle = E_0|\psi_0\rangle \rightarrow \psi_0(Nr)$$

$$P \sim e^{-\beta H}$$

$$|\psi(t)\rangle = e^{-iHt} |\psi_0\rangle$$



$$\begin{array}{c} \psi_0 \\ \downarrow \\ \rho_A \rightarrow S \end{array}$$





$$\psi_0 \downarrow \rho_A \rightarrow S$$

$$\psi(t) \rightarrow$$



$$\psi_0 \downarrow \rho_A \rightarrow S$$

$$\psi(t) \rightarrow \rho_A$$