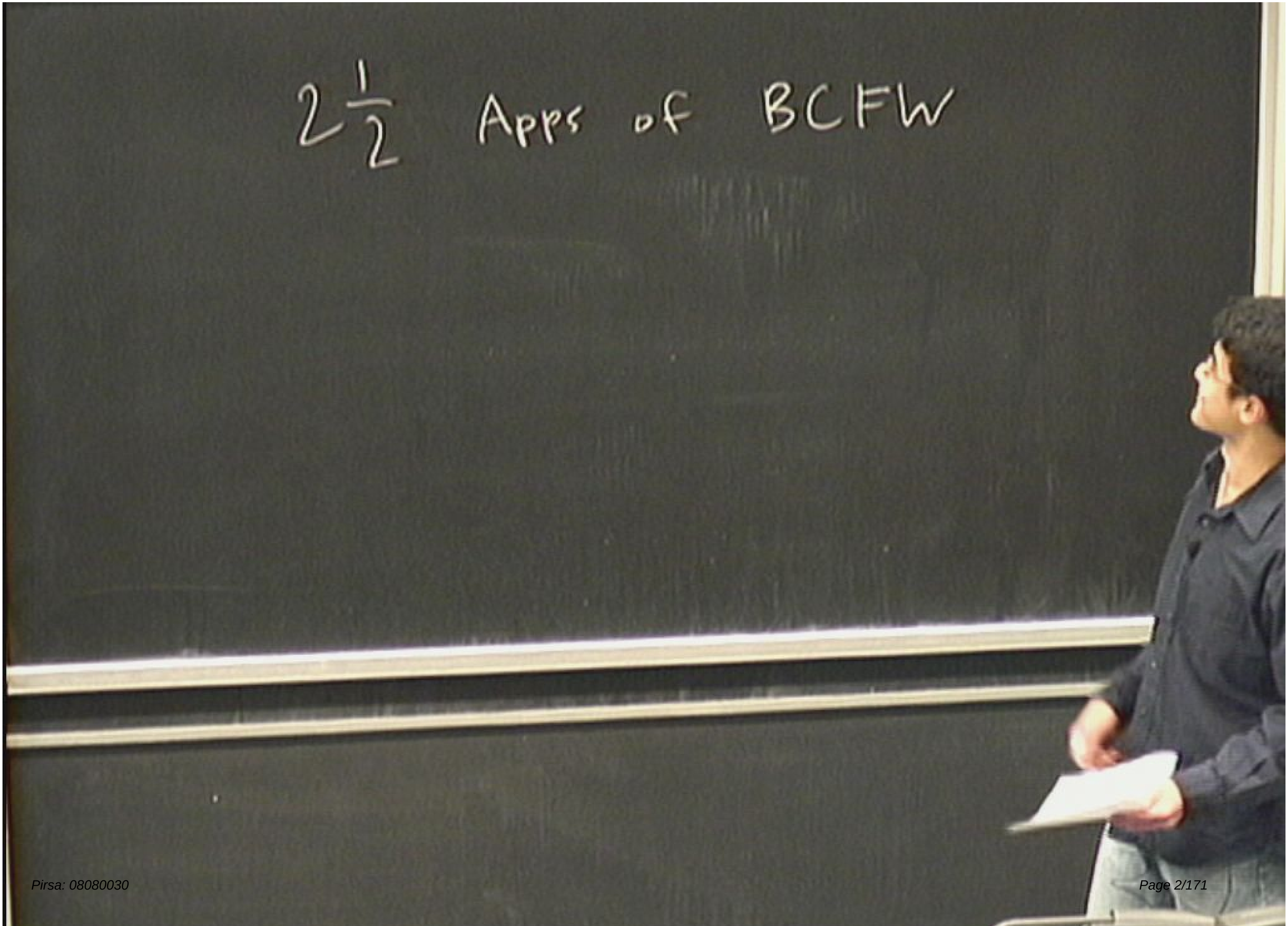
Title: Undergraduate Summer Research Project Presentations

Date: Aug 20, 2008 04:00 PM

URL: http://pirsa.org/08080030

Abstract: TBA


2 1/2 Apps of BCFW

$2\frac{1}{2}$ Apps of BCFW

$$SO(3,1) \cong SL(2,\mathbb{C}) \quad (\tfrac{1}{2},0) \quad (0,\tfrac{1}{2})$$

$$\begin{bmatrix} \cdot & \cdot \\ \cdot & \cdot \end{bmatrix}$$

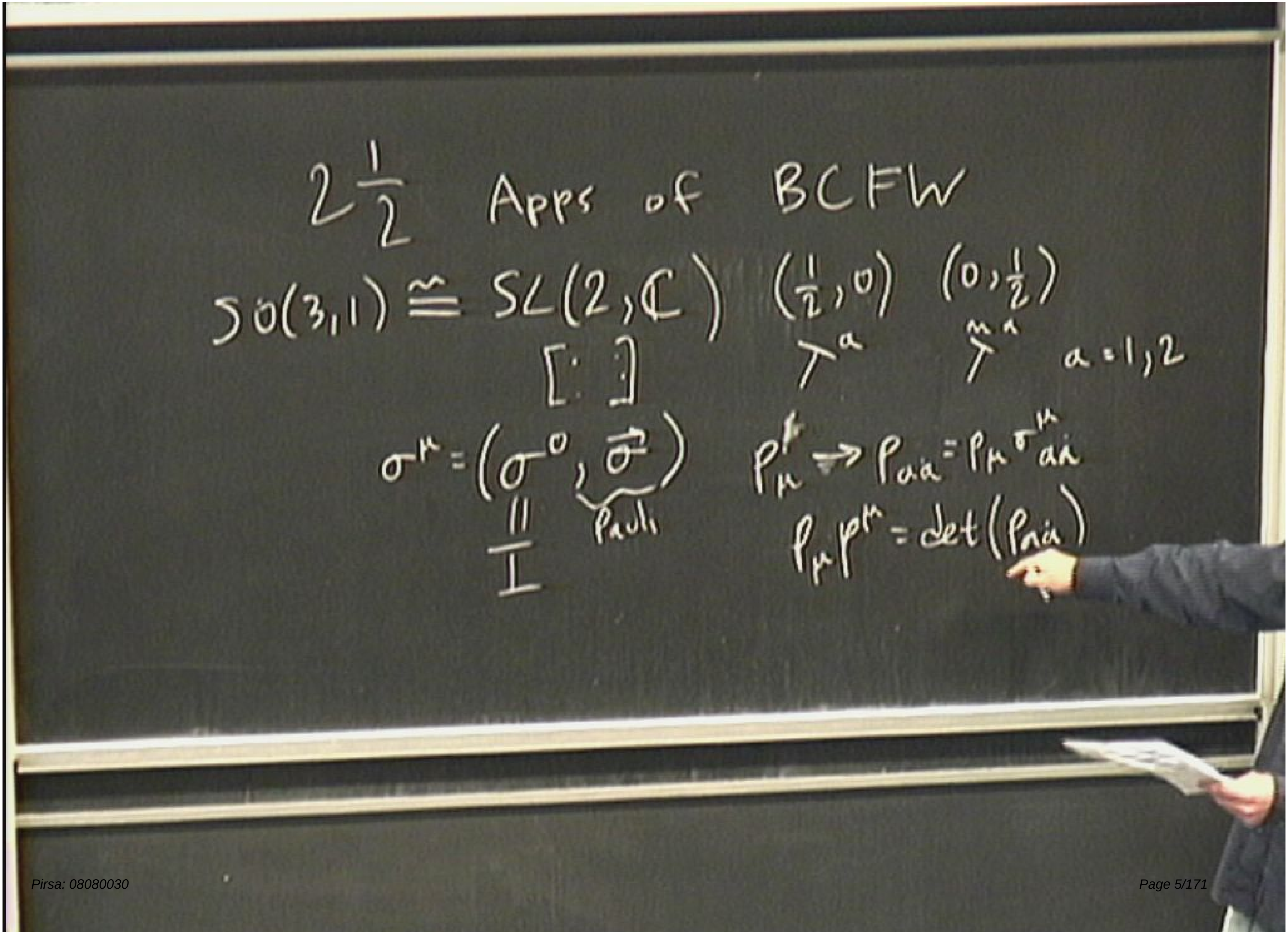
$2\frac{1}{2}$ Apps of BCFW

$$SO(3,1) \cong SL(2,\mathbb{C}) \quad (\tfrac{1}{2},0) \quad (0,\tfrac{1}{2})$$

$$[\because] \quad \lambda^{a} \quad \tilde{\lambda}^{\dot{a}} \quad a=1,2$$

$$\sigma^{\mu} = (\sigma^{0}, \underbrace{\vec{\sigma}}_{\text{Pauli}}) \quad p^{\mu}_{\mu} \Rightarrow p_{a\dot{a}} = p_{\mu}\sigma^{\mu}_{a\dot{a}}$$

$$\sigma^{0} = I$$


2 1/2 Apps of BCFW
SO(3,1) ≅ SL(2,ℂ) (1/2,0) (0,1/2)
a = 1,2
Pauli
det

$2\frac{1}{2}$ Apps of BCFW

$SO(3,1) \cong SL(2,\mathbb{C})$ $\quad (\frac{1}{2},0) \quad (0,\frac{1}{2})$

[: :] $\quad \lambda^a \quad \tilde{\lambda}^{\dot{a}} \quad a=1,2$

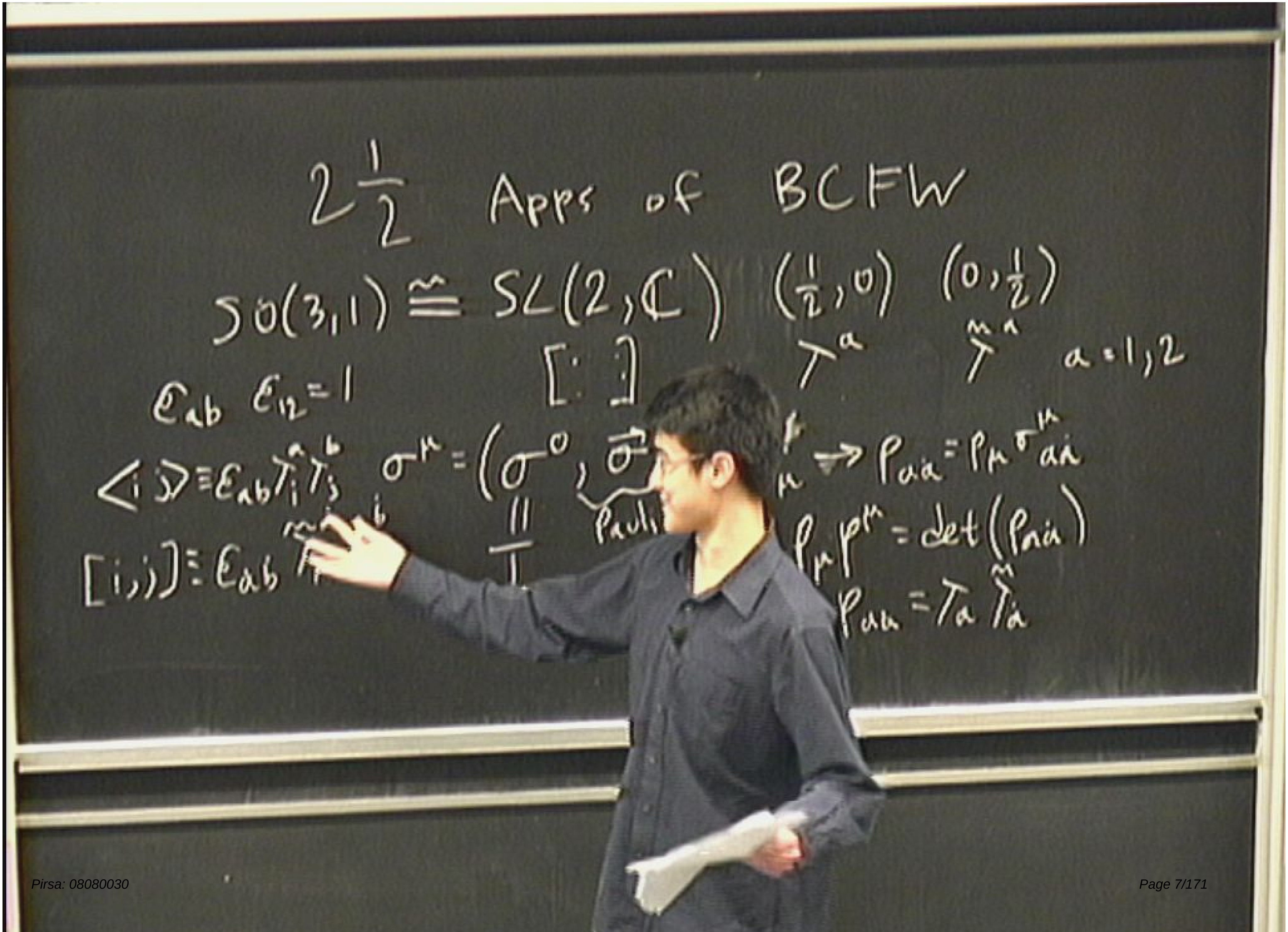
$\sigma^\mu = (\sigma^0, \vec{\sigma})$

$\sigma^0 = I$, $\vec{\sigma}$: Pauli

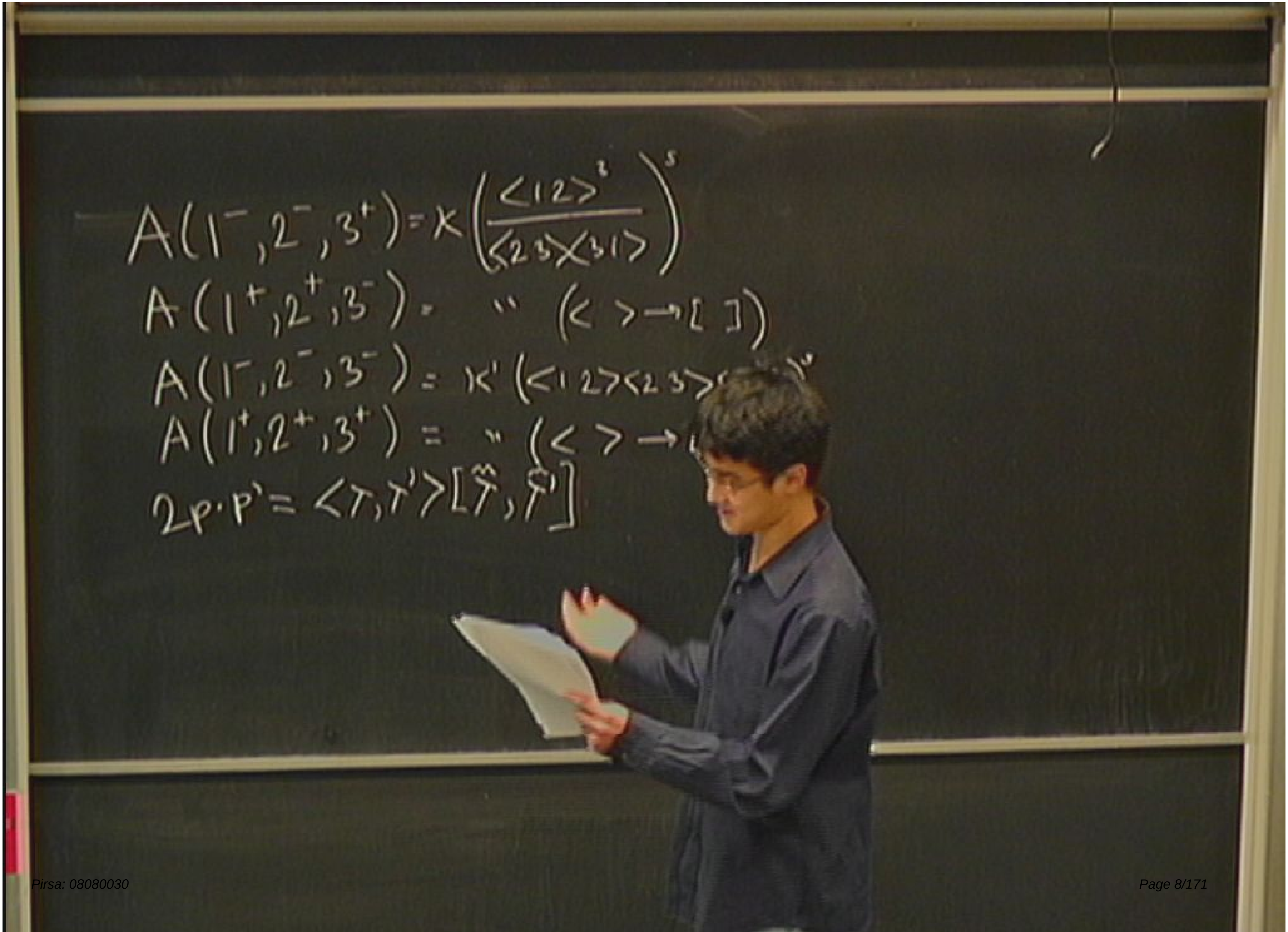
$p^\mu_\mu \to p_{a\dot{a}} = p_\mu \sigma^\mu_{a\dot{a}}$

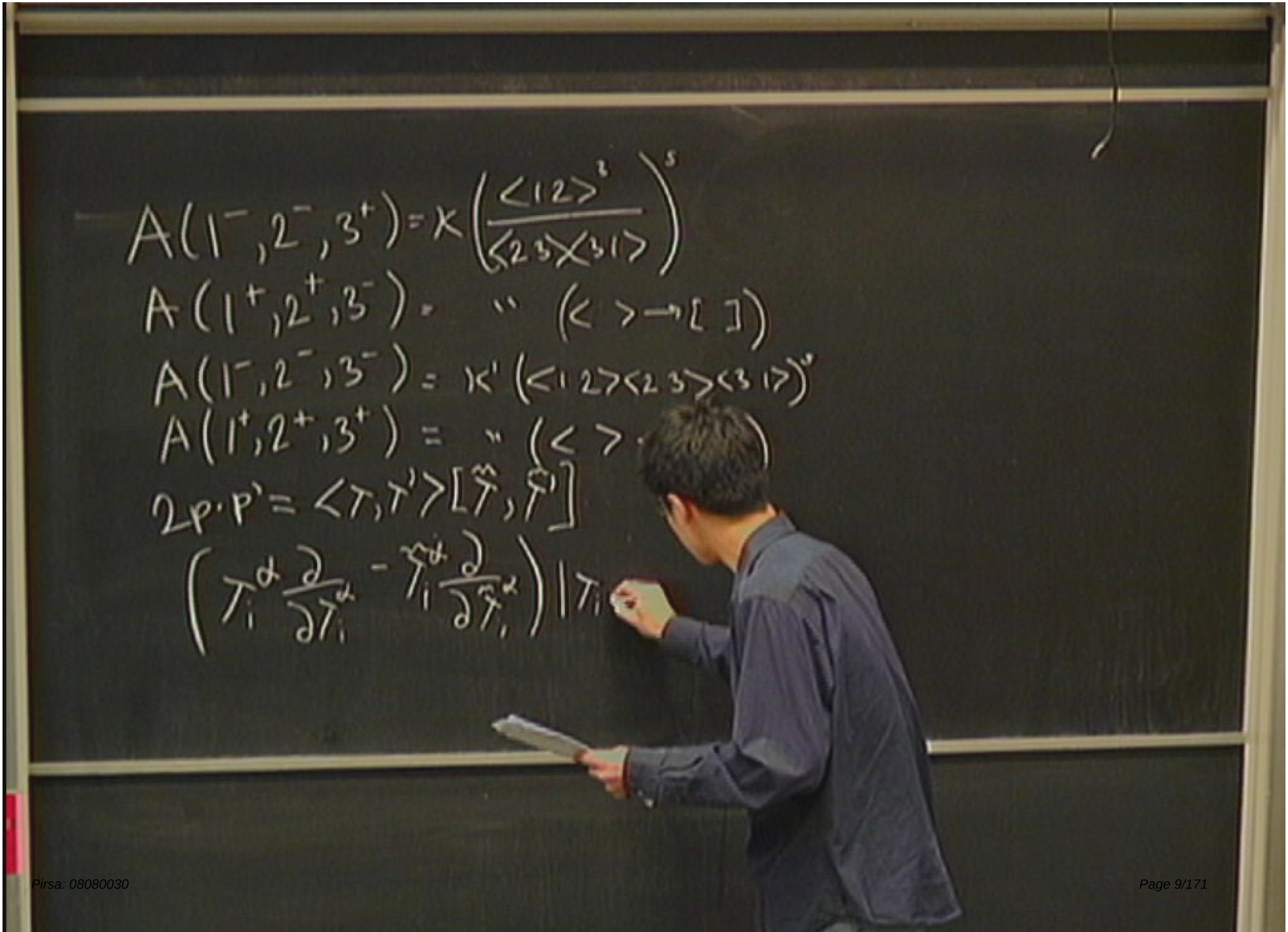
$p_\mu p^\mu = \det(p_{a\dot{a}})$

$p_{a\dot{a}} = \lambda_a \tilde{\lambda}_{\dot{a}}$

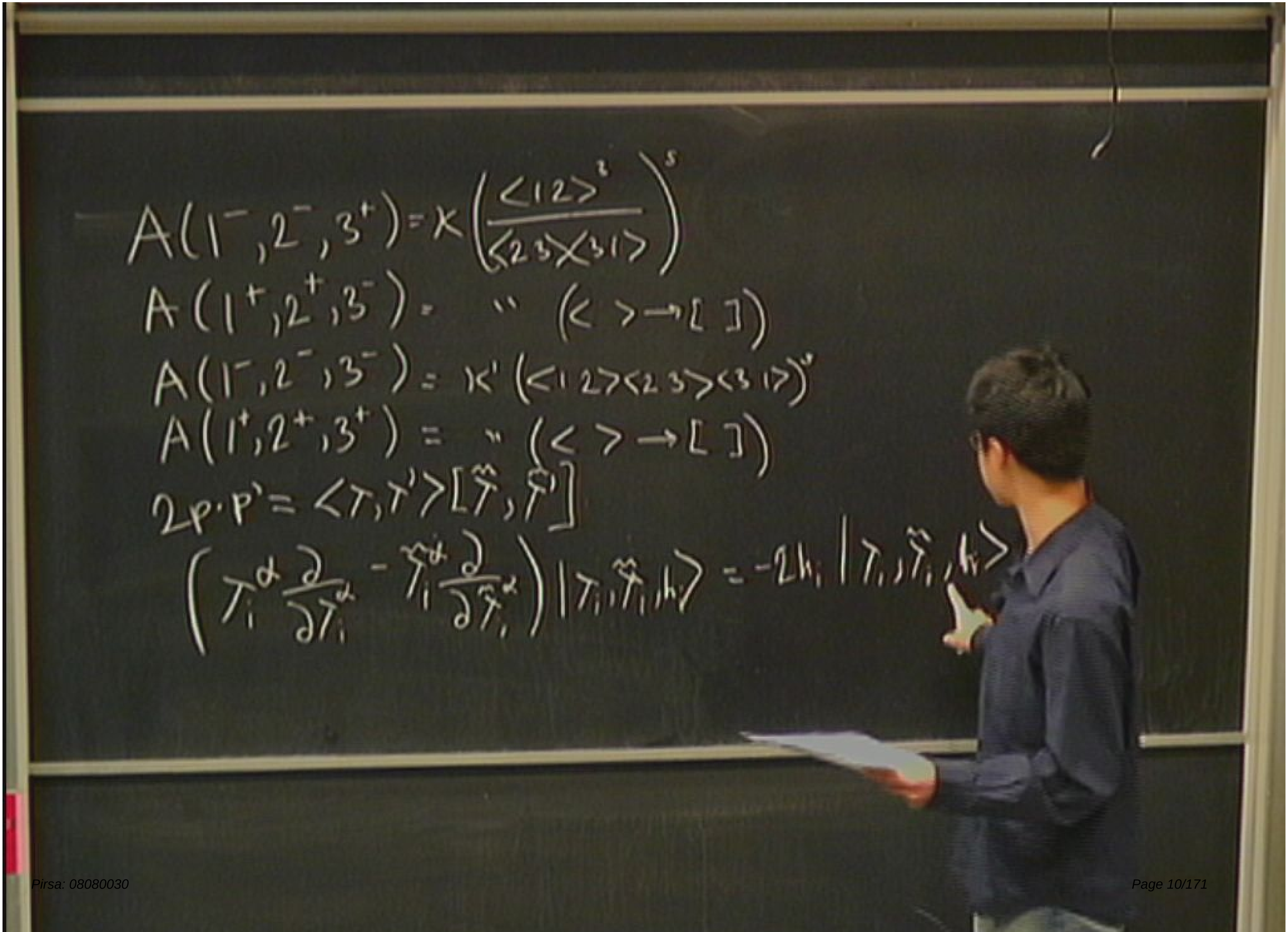


2 1/2 Apps of BCFW
SO(3,1) ≅ SL(2,ℂ) (1/2,0) (0,1/2)
[:]
λ^a λ̃^ȧ a=1,2
ε_ab ε_12=1
⟨i j⟩ ≡ ε_ab λ_i^a λ_j^b
σ^μ = (σ^0, σ⃗)
Pauli
p_μ ⇒ p_aȧ = p_μ σ^μ_aȧ
p_μ p^μ = det(p_aȧ)
p_aȧ = λ_a λ̃_ȧ
[i,j] ≡ ε_ȧḃ λ̃


$A(1^-,2^-,3^+) = \kappa\left(\frac{\langle 12\rangle^3}{\langle 23\rangle\langle 31\rangle}\right)^s$
$A(1^+,2^+,3^-) =$ " $(\langle\ \rangle \to [\ ])$
$A(1^-,2^-,3^-) = \kappa'(\langle 12\rangle\langle 23\rangle$
$A(1^+,2^+,3^+) =$ " $(\langle\ \rangle \to$
$2p\cdot p' = \langle\lambda,\lambda'\rangle[\tilde\lambda,\tilde\lambda']$



$A(1^-,2^-,3^+) = \kappa\left(\frac{\langle 12\rangle^3}{\langle 23\rangle\langle 31\rangle}\right)^s$
$A(1^+,2^+,3^-) = \text{''} \quad (\langle\ \rangle \to [\ ])$
$A(1^-,2^-,3^-) = \kappa'\left(\langle 12\rangle\langle 23\rangle\langle 31\rangle\right)^s$
$A(1^+,2^+,3^+) = \text{''} \quad (\langle\ \rangle$
$2p\cdot p' = \langle\lambda,\lambda'\rangle[\tilde\lambda,\tilde\lambda']$
$\left(\lambda_i^\alpha \frac{\partial}{\partial\lambda_i^\alpha} - \tilde\lambda_i^{\dot\alpha}\frac{\partial}{\partial\tilde\lambda_i^{\dot\alpha}}\right)|\lambda_i$


$A(1^-,2^-,3^+) = \kappa \left(\frac{\langle 12 \rangle^3}{\langle 23 \rangle \langle 31 \rangle} \right)^s$
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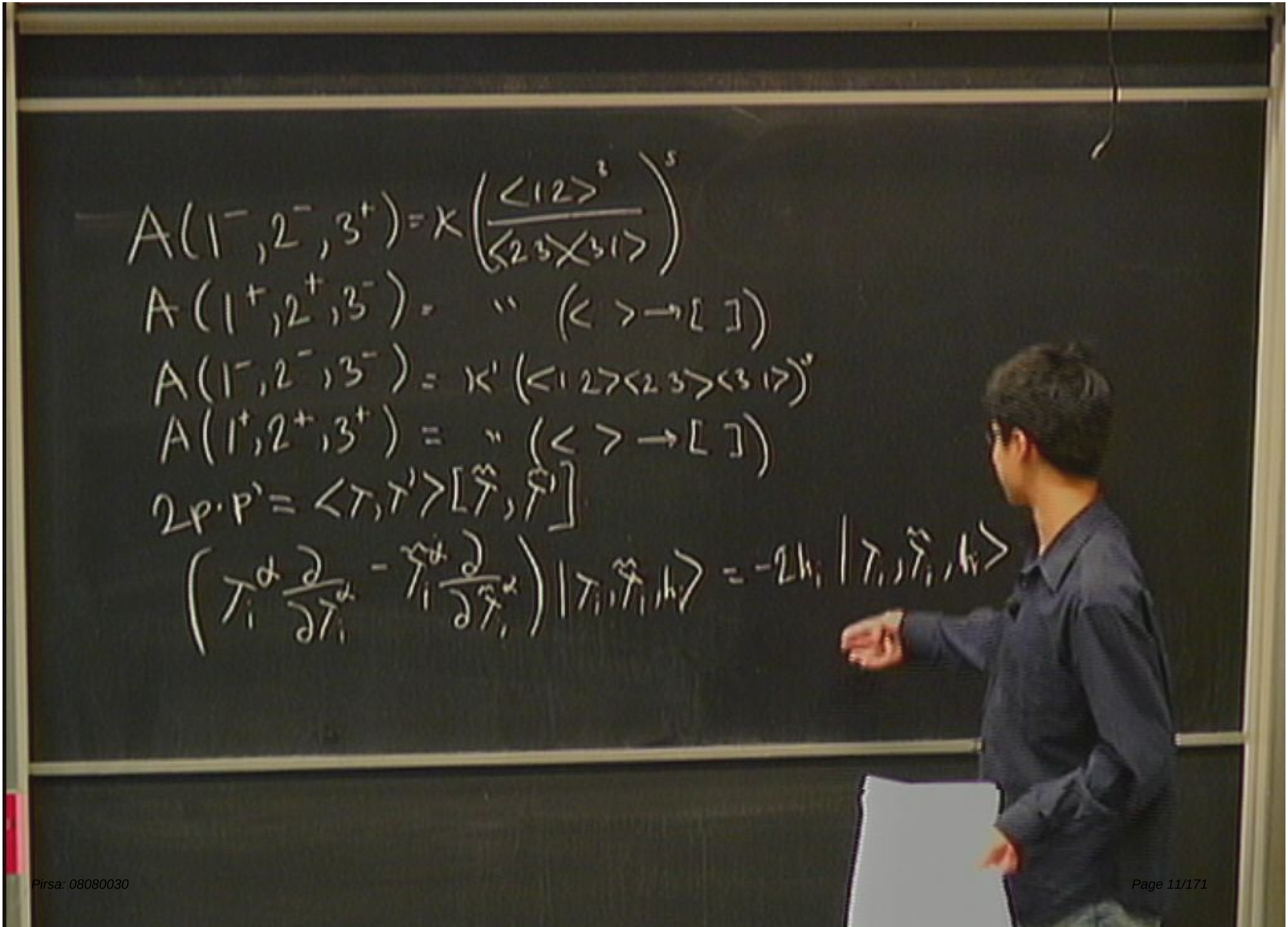
$2p \cdot p' = \langle \lambda, \lambda' \rangle [\tilde{\lambda}, \tilde{\lambda}']$
$\left(\lambda_i^\alpha \frac{\partial}{\partial \lambda_i^\alpha} - \tilde{\lambda}_i^\alpha \frac{\partial}{\partial \tilde{\lambda}_i^\alpha} \right) | \lambda_i, \tilde{\lambda}_i, h_i \rangle = -2h_i | \lambda_i, \tilde{\lambda}_i, h_i \rangle$


$A(1^-,2^-,3^+) = \kappa\left(\frac{\langle 12\rangle^3}{\langle 23\rangle\langle 31\rangle}\right)^s$
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$\left(\lambda_i^\alpha \frac{\partial}{\partial\lambda_i^\alpha} - \tilde\lambda_i^{\dot\alpha}\frac{\partial}{\partial\tilde\lambda_i^{\dot\alpha}}\right)|\lambda_i,\tilde\lambda_i,h_i\rangle = -2h_i|\lambda_i,\tilde\lambda_i,h_i\rangle$

$$A(1^-,2^-,3^+) = \kappa\left(\frac{\langle 12\rangle^3}{\langle 23\rangle\langle 31\rangle}\right)^s$$

$$A(1^+,2^+,3^-) = \text{''} \quad (\langle\ \rangle \to [\ ])$$

$$A(1^-,2^-,3^-) = \kappa'\left(\langle 12\rangle\langle 23\rangle\langle 31\rangle\right)^s$$

$$A(1^+,2^+,3^+) = \text{''} \quad (\langle\ \rangle \to [\ ])$$

$$2p\cdot p' = \langle\lambda,\lambda'\rangle[\tilde\lambda,\tilde\lambda']$$

$$\left(\lambda_i^\alpha\frac{\partial}{\partial\lambda_i^\alpha} - \tilde\lambda_i^{\dot\alpha}\frac{\partial}{\partial\tilde\lambda_i^{\dot\alpha}}\right)|\lambda_i,\tilde\lambda_i,h_i\rangle = -2h_i\,|\lambda_i,\tilde\lambda_i,h_i\rangle$$

$2\frac{1}{2}$ Apps of BCFW

$SO(3,1) \cong SL(2,\mathbb{C})$ $(\frac{1}{2},0)$ $(0,\frac{1}{2})$

ϵ_{ab} $\epsilon_{12}=1$ $[\,:\ :\,]$ λ^a $\tilde{\lambda}^{\dot a}$ $a=1,2$

$\langle i\,j\rangle \equiv \epsilon_{ab}\lambda_i^a\lambda_j^b$ $\sigma^\mu = (\sigma^0, \vec{\sigma})$ $p_{a\dot a} = p_\mu \sigma^\mu_{a\dot a}$

$[i,j] \equiv \epsilon_{\dot a\dot b}\tilde{\lambda}_i^{\dot a}\tilde{\lambda}_j^{\dot b}$ $\sigma^0 = \mathbb{I}$, $\vec{\sigma}$ = Pauli

$p^\mu ... = \det(p_{a\dot a})$

$... \tilde{\lambda}_{\dot a}$

$2\frac{1}{2}$ Apps of BCFW

$$SO(3,1) \cong SL(2,\mathbb{C}) \qquad \left(\tfrac{1}{2},0\right) \qquad \left(0,\tfrac{1}{2}\right)$$

$$\epsilon_{ab} \quad \epsilon_{12}=1 \qquad [\,:\;:\,] \qquad \lambda^{a} \qquad \tilde{\lambda}^{\dot{a}} \qquad a=1,2$$

$$\langle i\, j\rangle \equiv \epsilon_{ab}\lambda_i^{a}\lambda_j^{b} \qquad \sigma^{\mu} = \left(\sigma^{0}, \vec{\sigma}\right)$$

$$[i,j] \equiv \epsilon_{\dot{a}\dot{b}}\tilde{\lambda}_i^{\dot{a}}\tilde{\lambda}_j^{\dot{b}} \qquad \sigma^0 = I, \quad \vec{\sigma}: \text{Pauli}$$

$$p_{\mu} \Rightarrow p_{a\dot{a}} = p_{\mu}\sigma^{\mu}_{a\dot{a}}$$

$$p_{\mu}p^{\mu} = \det\left(p_{a\dot{a}}\right)$$

$$p_{a\dot{a}} = \lambda_a \tilde{\lambda}_{\dot{a}}$$

$2\frac{1}{2}$ Apps of BCFW

$$SO(3,1) \cong SL(2,\mathbb{C}) \quad (\tfrac{1}{2},0) \quad (0,\tfrac{1}{2})$$

$$[\,:\ :\,] \qquad \lambda^a \qquad \tilde{\lambda}^{\dot a} \qquad a=1,2$$

ϵ_{ab} $\quad \epsilon_{12}=1$

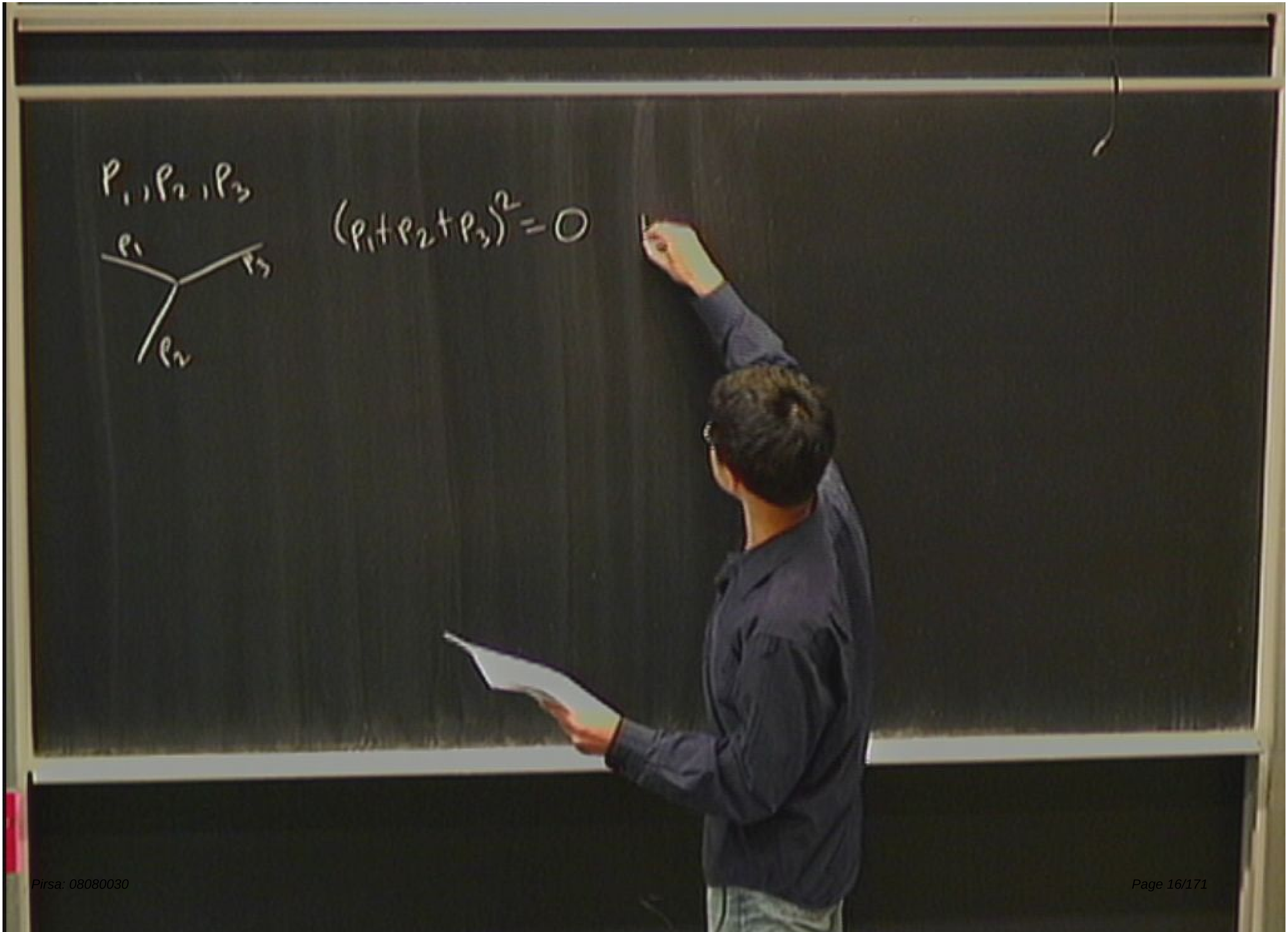
$\langle i\, j\rangle \equiv \epsilon_{ab}\lambda_i^a \lambda_j^b$ $\quad \sigma^\mu = (\sigma^0, \vec{\sigma})$ (Pauli), $\sigma^0 = \mathbb{I}$

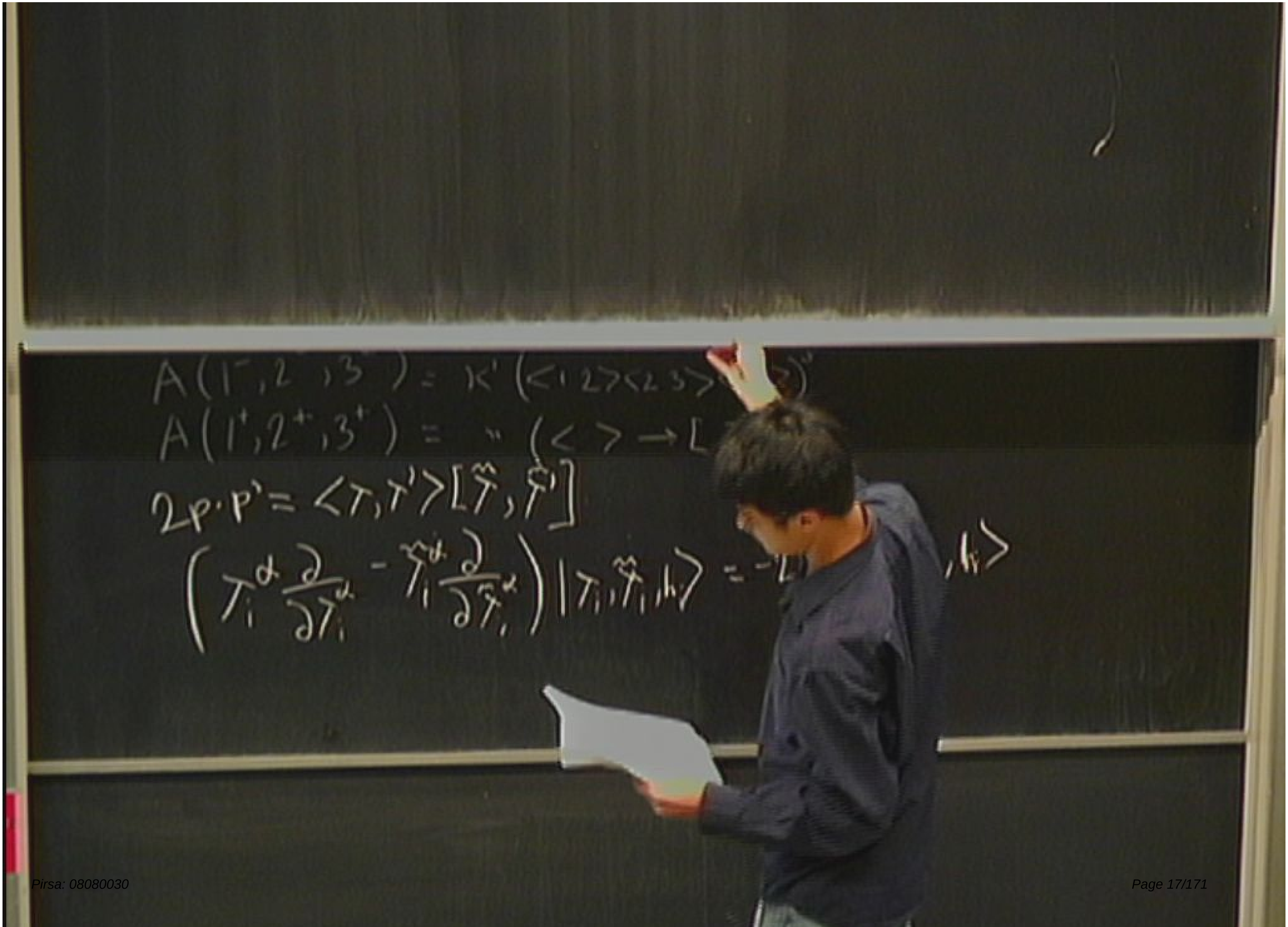
$[i,j] \equiv \epsilon_{\dot a \dot b}\tilde{\lambda}_i^{\dot a}\tilde{\lambda}_j^{\dot b}$

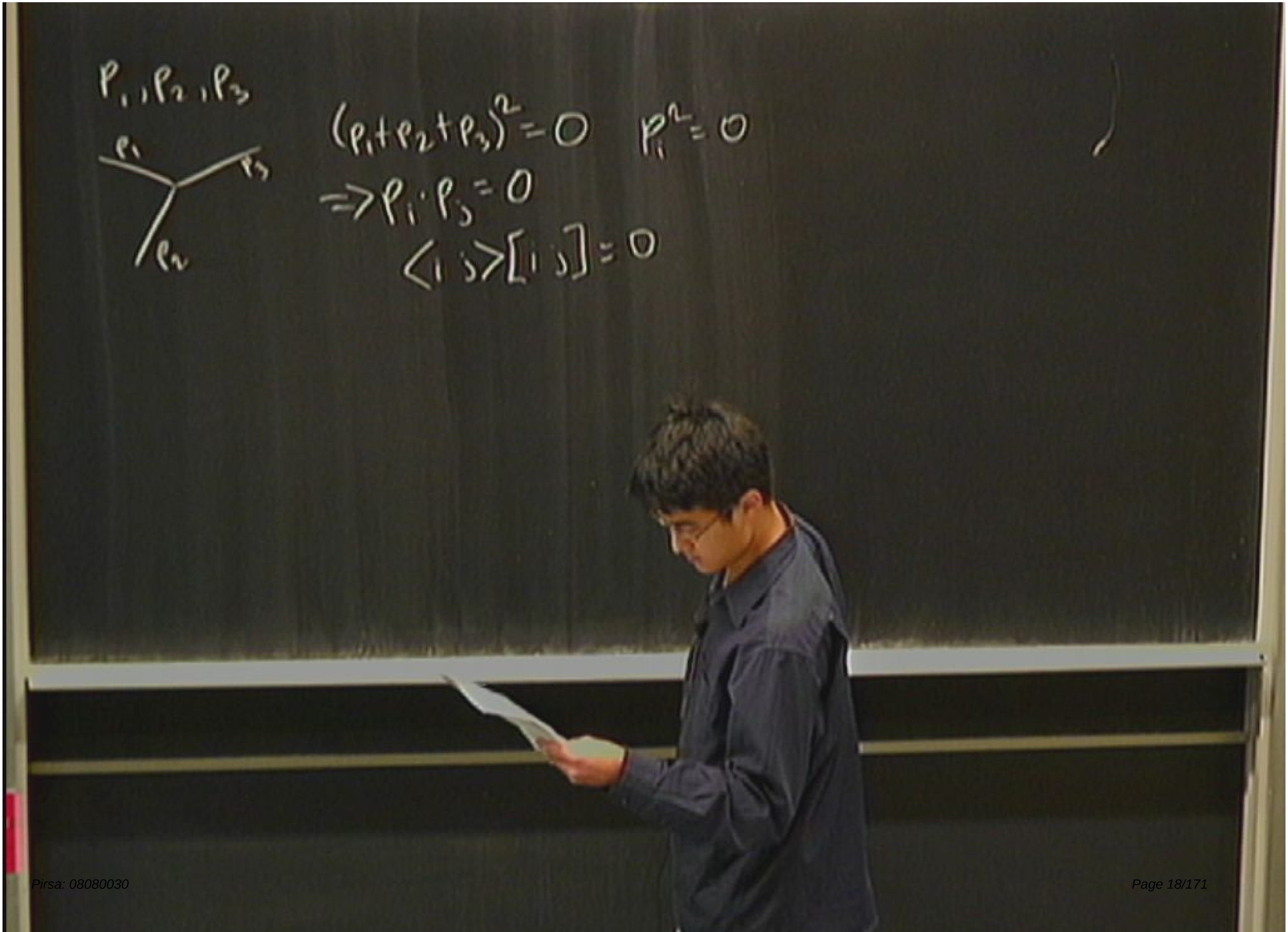
$$p^\mu \to p_{a\dot a} = p_\mu \sigma^\mu_{a\dot a}$$

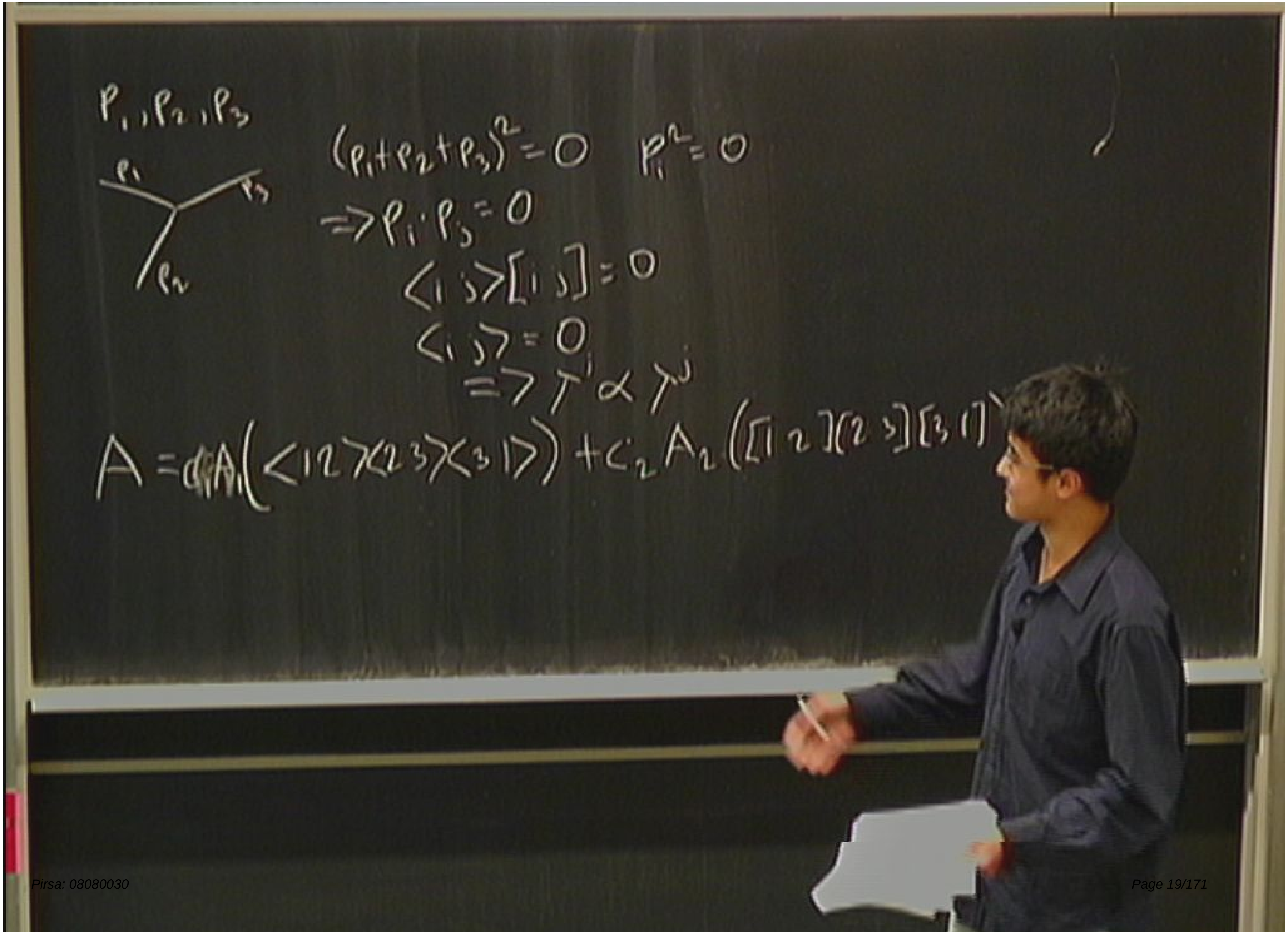
$$p_\mu p^\mu = \det(p_{a\dot a})$$

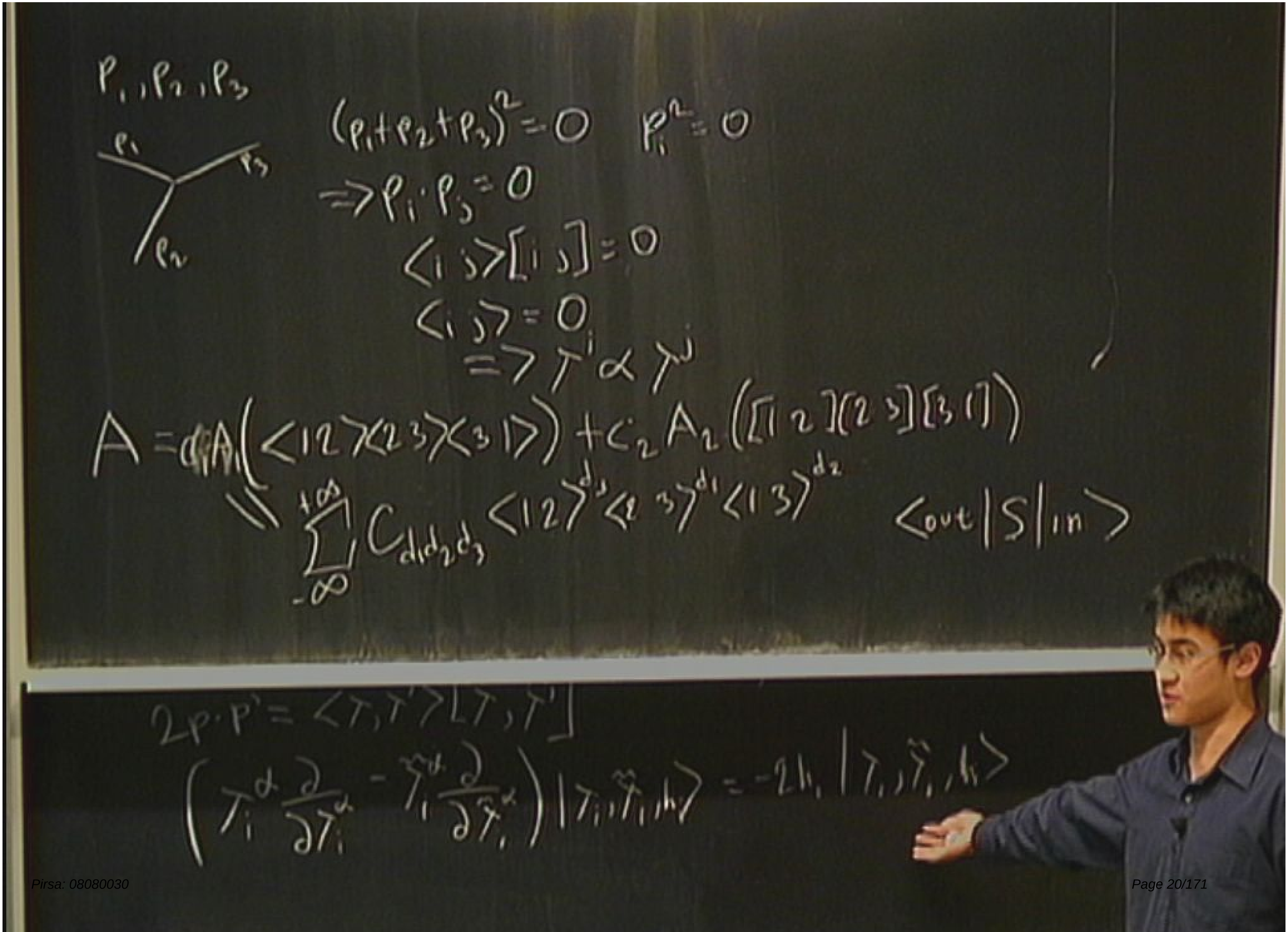
$$p_{a\dot a} = \lambda_a \tilde{\lambda}_{\dot a}$$


p_1, p_2, p_3
$(p_1+p_2+p_3)^2=0$
p_1
p_3
p_2


A(1⁻,2⁻,3⁻) = κ'(<12><23>
A(1⁺,2⁺,3⁺) = " (< > → [
2p·p' = <λ,λ'>[λ̃,λ̃']

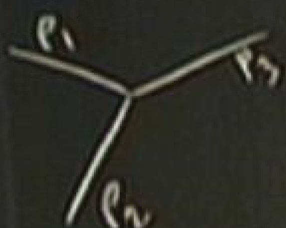

p1, p2, p3
(p1+p2+p3)^2 = 0
p1^2 = 0
p1
p2
p3
=> p1 · p3 = 0
<1 3>[1 3] = 0


p1, p2, p3
p1
p3
p2
(p1+p2+p3)^2 = 0   p_i^2 = 0
=> p_i · p_j = 0
<i j>[i j] = 0
<i j> = 0
=> λ^i ∝ λ^j
A = c1 A1(<1 2><2 3><3 1>) + c2 A2([1 2][2 3][3 1])



p_1, p_2, p_3
$(p_1+p_2+p_3)^2 = 0 \quad p_i^2 = 0$
$\Rightarrow p_i \cdot p_j = 0$
$\langle i\, j\rangle [i\, j] = 0$
$\langle i\, j\rangle = 0$
$\Rightarrow \lambda^i \propto \lambda^j$
$A = c_1 A_1(\langle 12\rangle\langle 23\rangle\langle 31\rangle) + c_2 A_2([12][23][31])$
$\sum_{-\infty}^{+\infty} C_{d_1 d_2 d_3} \langle 12\rangle^{d_3} \langle 23\rangle^{d_1} \langle 13\rangle^{d_2}$
$\langle out | S | in \rangle$
$2p \cdot p' = \langle \lambda, \lambda' \rangle [\tilde\lambda, \tilde\lambda']$
$\left(\lambda_i^\alpha \frac{\partial}{\partial \lambda_i^\alpha} - \tilde\lambda_i^{\dot\alpha} \frac{\partial}{\partial \tilde\lambda_i^{\dot\alpha}}\right) |\lambda_i, \tilde\lambda_i, h_i\rangle = -2h_i |\lambda_i, \tilde\lambda_i, h_i\rangle$

p_1, p_2, p_3



$(p_1+p_2+p_3)^2 = 0 \qquad p_i^2 = 0$

$\Rightarrow p_1 \cdot p_3 = 0$

$\langle 1\,3\rangle[1\,3] = 0$

$\langle 1\,3\rangle = 0$

$\Rightarrow \lambda^1 \propto \lambda^3$

$d_3 = h_3 - h_1 - h_2$

$d_1 = h_1 - h_3 - h_2$

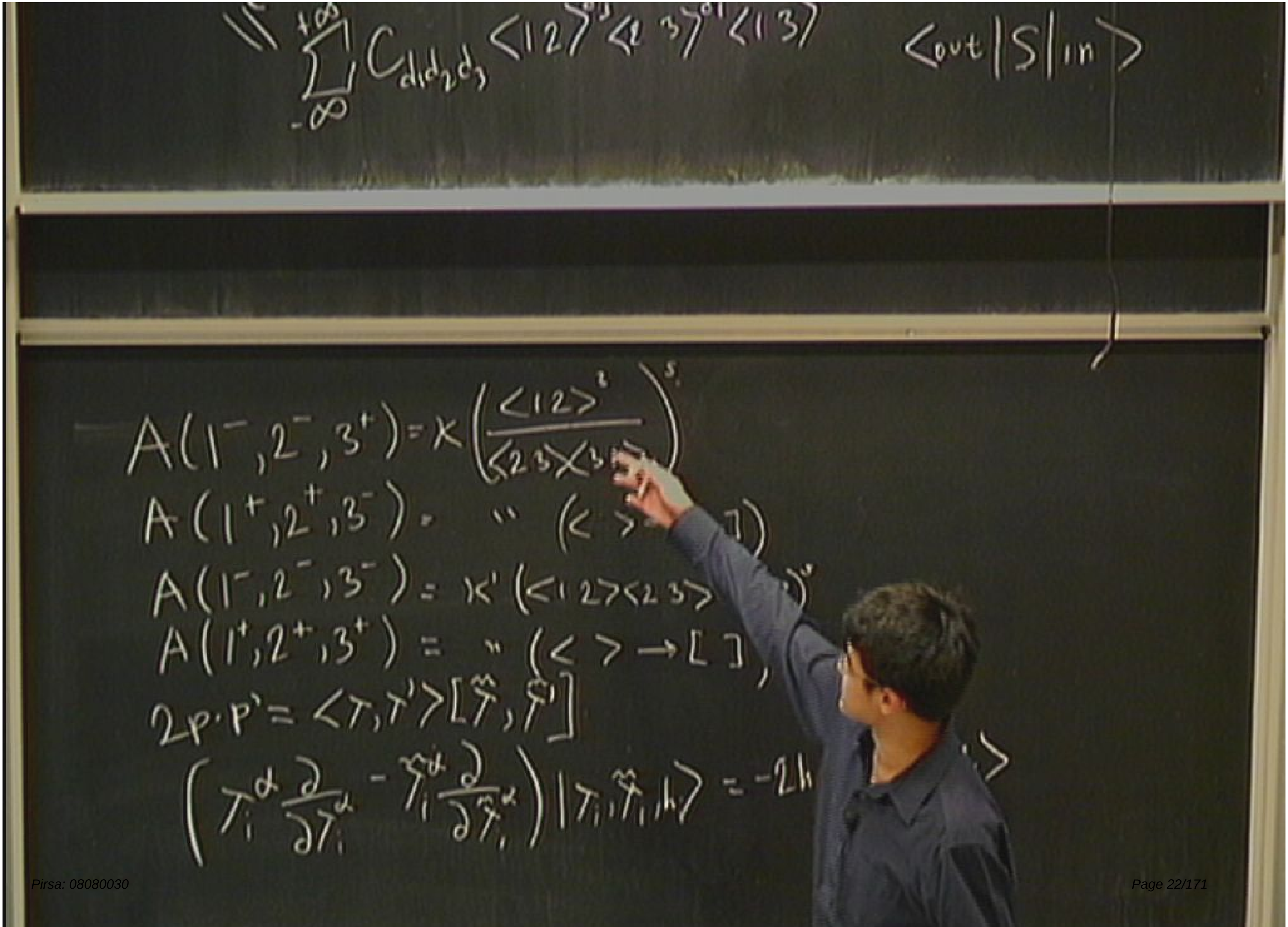
$d_2 = h_2 - h_3 - h_1$

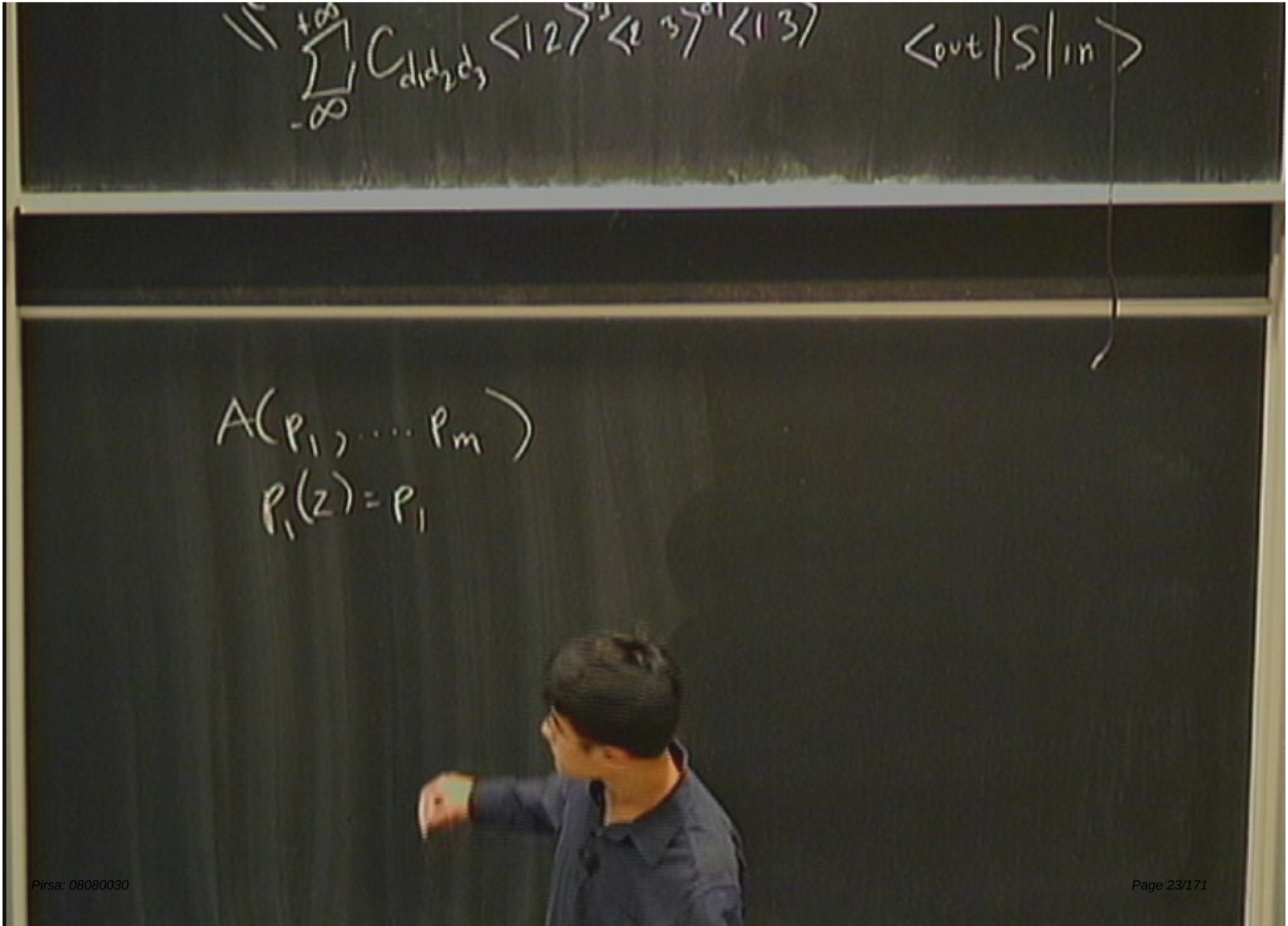
$$A = c_1 A_1(\langle 12\rangle\langle 23\rangle\langle 31\rangle) + c_2 A_2([12][23][31])$$

$$= \sum_{-\infty}^{+\infty} C_{d_1 d_2 d_3} \langle 12\rangle^{d_3}\langle 23\rangle^{d_1}\langle 13\rangle^{d_2}$$

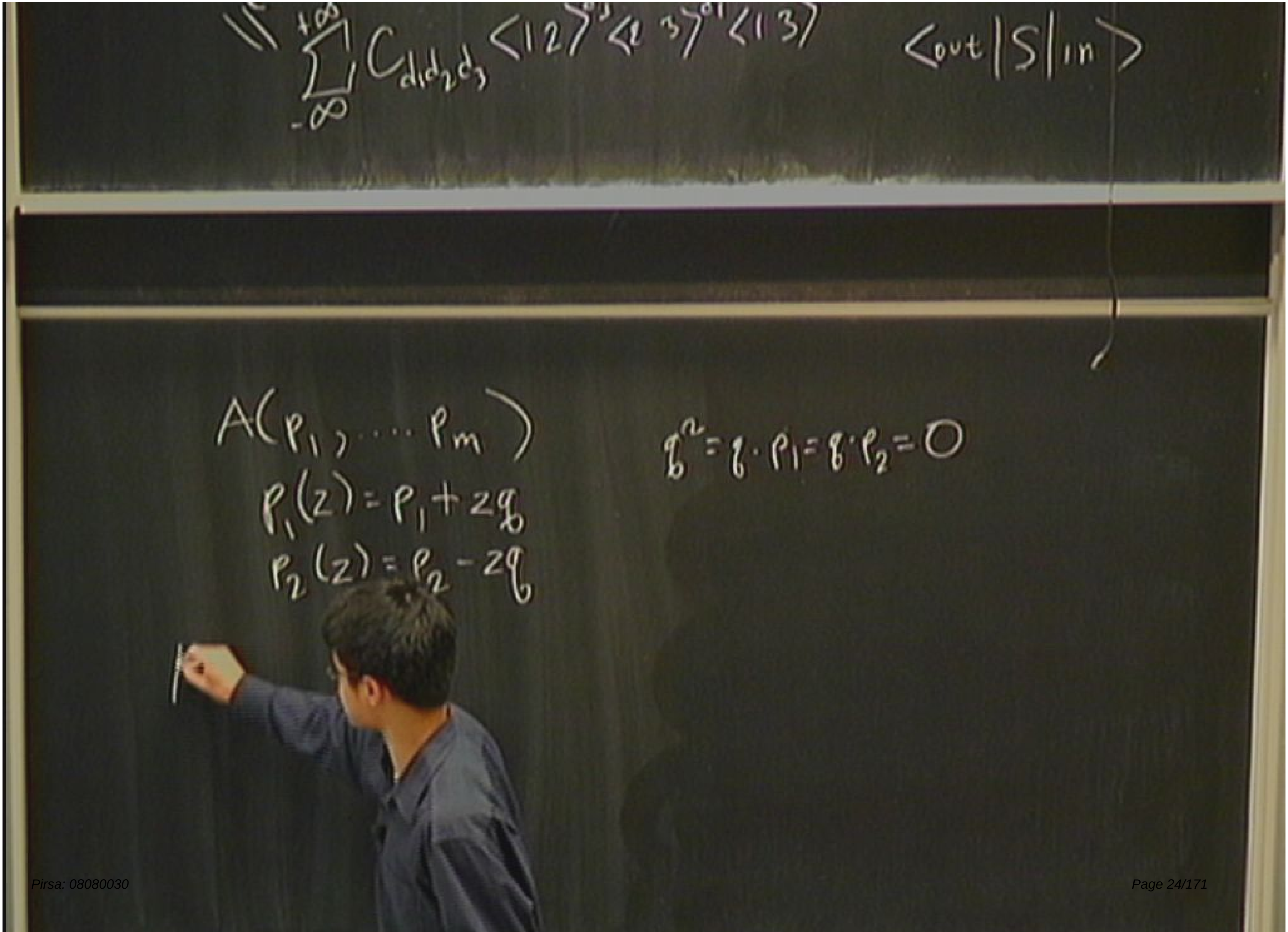
$\langle out | S | in \rangle$

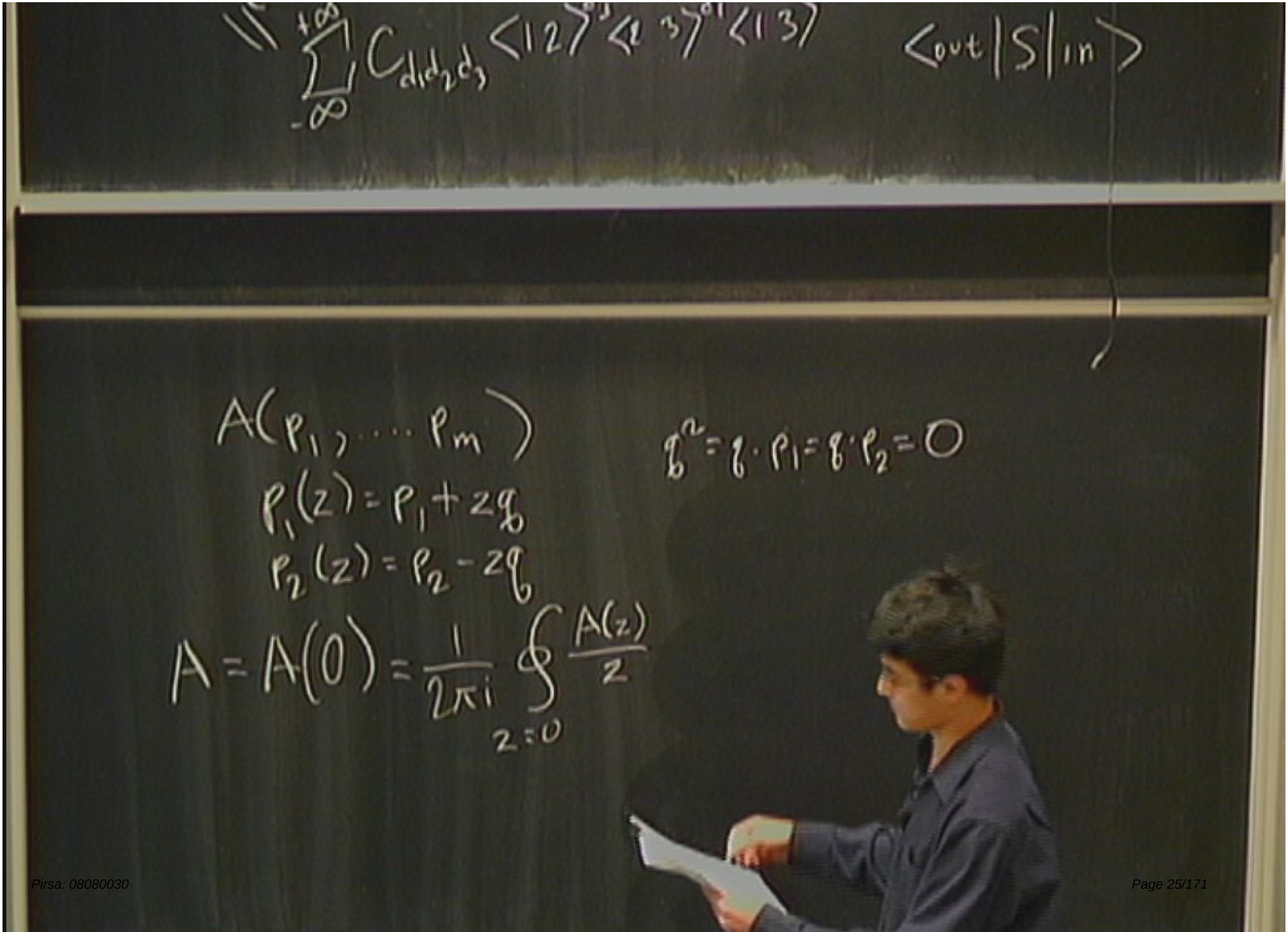
$$\left(\lambda_i^{\alpha}\frac{\partial}{\partial\lambda_i^{\alpha}} - \tilde\lambda_i^{\dot\alpha}\frac{\partial}{\partial\tilde\lambda_i^{\dot\alpha}}\right)|\lambda_i, \tilde\lambda_i, h_i\rangle = -2h_i\,|\lambda_i, \tilde\lambda_i, h_i\rangle$$

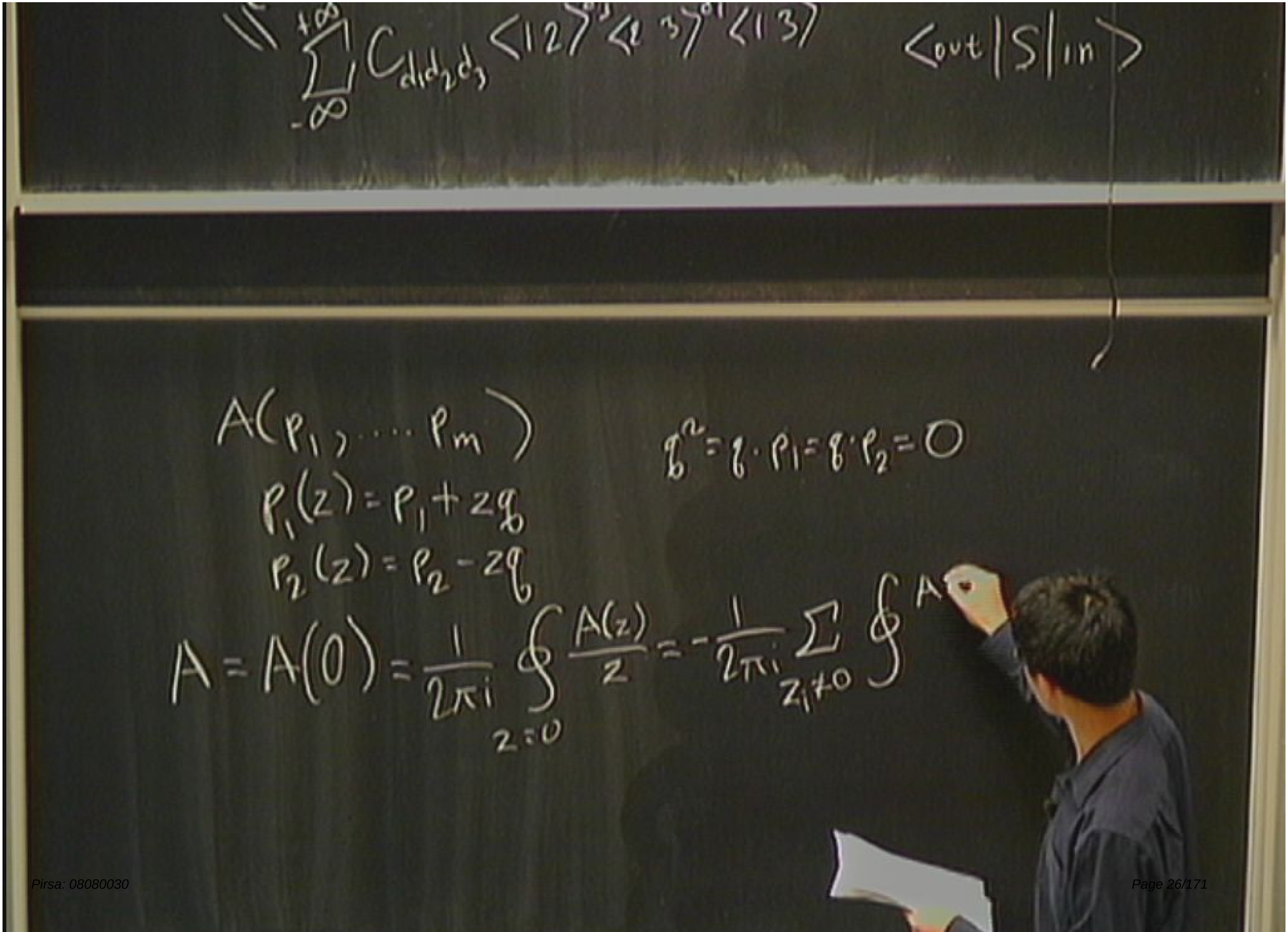

$= \sum_{-\infty}^{+\infty} C_{d_1 d_2 d_3} \langle 12\rangle \langle 23\rangle \langle 13\rangle$
$\langle out | S | in \rangle$
$A(1^-, 2^-, 3^+) = \kappa \left(\frac{\langle 12\rangle^3}{\langle 23\rangle\langle 31\rangle} \right)^{s}$
$A(1^+, 2^+, 3^-) =$ " $(\langle\ \rangle \to [\ ])$
$A(1^-, 2^-, 3^-) = \kappa' (\langle 12\rangle\langle 23\rangle$
$A(1^+, 2^+, 3^+) =$ " $(\langle\ \rangle \to [\ ])$
$2p\cdot p' = \langle \lambda, \lambda' \rangle [\tilde\lambda, \tilde\lambda']$
$\left(\lambda_i^\alpha \frac{\partial}{\partial \lambda_i^\alpha} - \tilde\lambda_i^{\dot\alpha} \frac{\partial}{\partial \tilde\lambda_i^{\dot\alpha}} \right) | \lambda_i, \tilde\lambda_i, h_i \rangle = -2h$



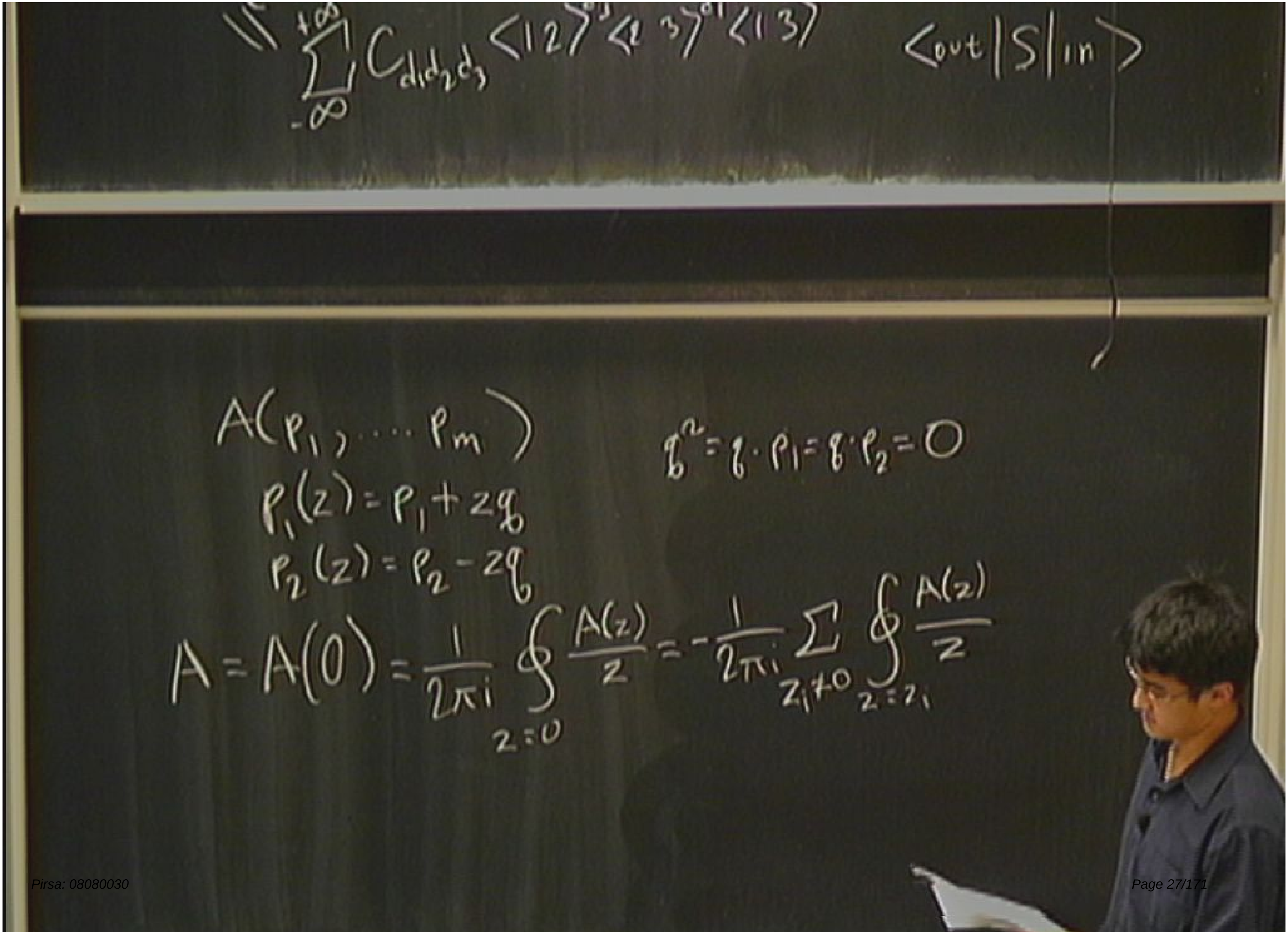
= Σ C_{d1 d2 d3} ⟨1 2⟩ ⟨2 3⟩ ⟨1 3⟩
⟨out | S | in⟩
A(p_1, ... p_m)
p_1(z) = p_1


$C_{d_1 d_2 d_3}$ ⟨1 2⟩ ⟨2 3⟩ ⟨1 3⟩
<out|S|in>
A(p1, ... pm)
p1(z) = p1 + zq
p2(z) = p2 − zq
q² = q·p1 = q·p2 = 0


$\sum_{-\infty}^{+\infty} C_{d_1 d_2 d_3} \langle 12\rangle^{d_3} \langle 23\rangle^{d_1} \langle 13\rangle$
$\langle out | S | in \rangle$
$A(p_1, \dots p_m)$
$q^2 = q \cdot p_1 = q \cdot p_2 = 0$
$p_1(z) = p_1 + zq$
$p_2(z) = p_2 - zq$
$A = A(0) = \frac{1}{2\pi i} \oint_{z=0} \frac{A(z)}{z}$



⟨out|S|in⟩
A(p1, ... pm)
p1(z) = p1 + zq
p2(z) = p2 − zq
q^2 = q·p1 = q·p2 = 0
A = A(0) = 1/2πi ∮ A(z)/z = − 1/2πi Σ ∮ A



$= \sum_{-\infty}^{+\infty} C_{d_1 d_2 d_3} \langle 12\rangle^{d_3} \langle 23\rangle^{d_1} \langle 13\rangle$
$\langle out | S | in \rangle$
$A(p_1, \cdots p_m)$
$q^2 = q \cdot p_1 = q \cdot p_2 = 0$
$p_1(z) = p_1 + zq$
$p_2(z) = p_2 - zq$
$A = A(0) = \frac{1}{2\pi i} \oint_{z=0} \frac{A(z)}{z} = -\frac{1}{2\pi i} \sum_{z_i \neq 0} \oint_{z=z_i} \frac{A(z)}{z}$

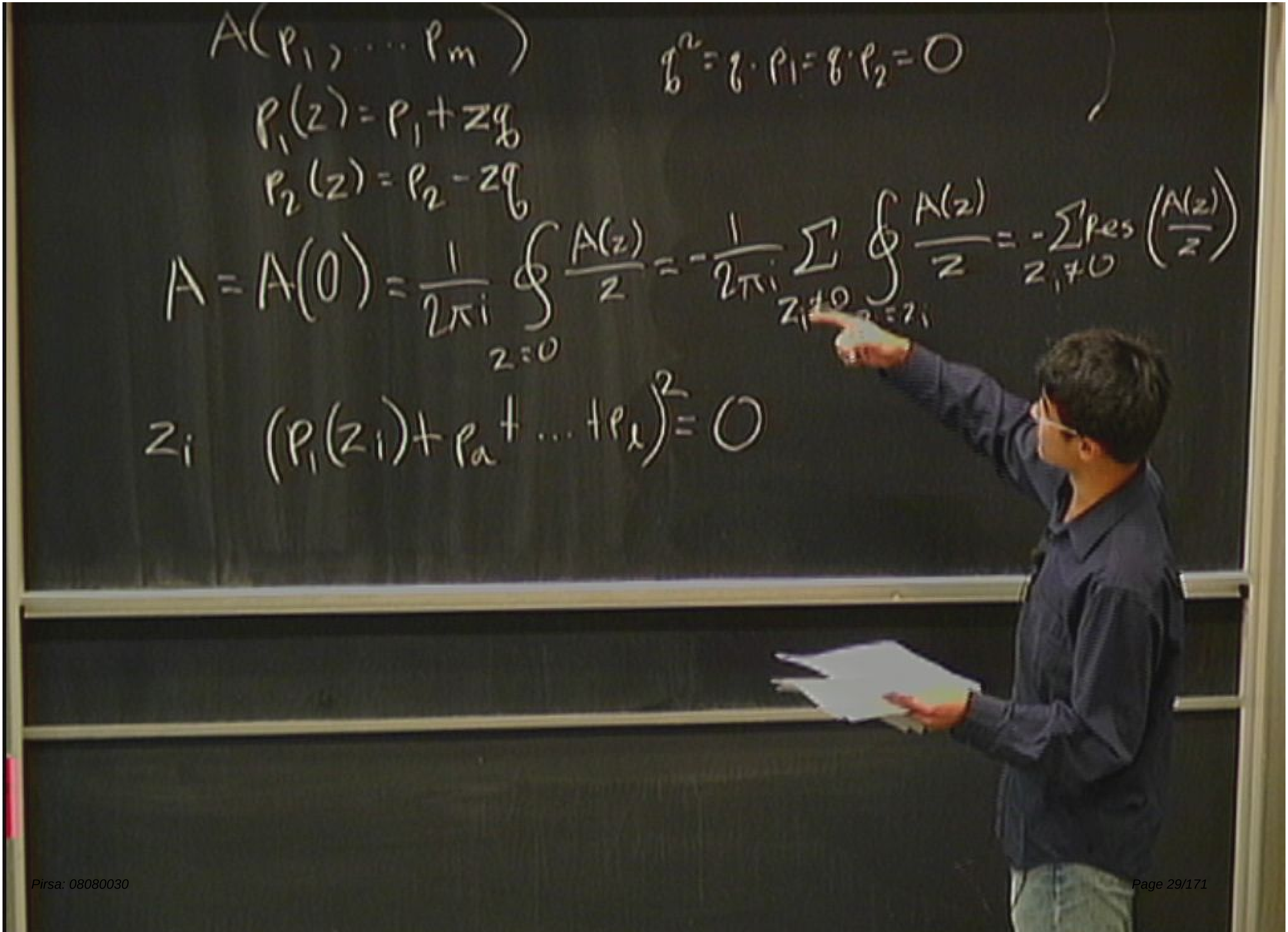
$$A(p_1, \cdots p_m)$$

$$q^2 = q \cdot p_1 = q \cdot p_2 = 0$$

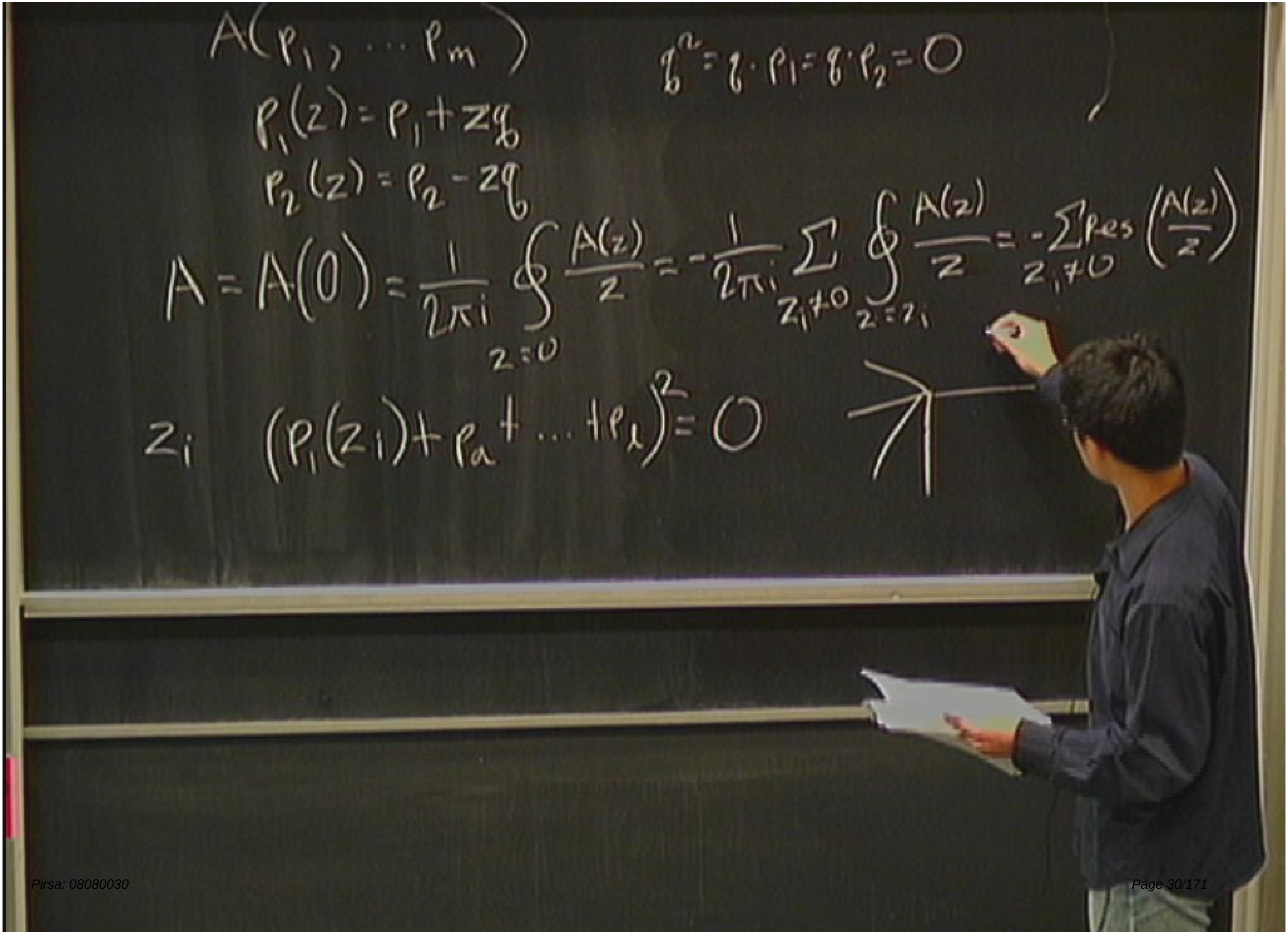
$$p_1(z) = p_1 + zq$$

$$p_2(z) = p_2 - zq$$

$$A = A(0) = \frac{1}{2\pi i} \oint_{z=0} \frac{A(z)}{z} = -\frac{1}{2\pi i} \sum_{z_i \neq 0} \oint_{z=z_i} \frac{A(z)}{z} = -\sum_{z_i \neq 0} \mathrm{Res}\left(\frac{A(z)}{z}\right)$$



$A(p_1, \dots p_m)$
$q^2 = q \cdot p_1 = q \cdot p_2 = 0$
$p_1(z) = p_1 + zq$
$p_2(z) = p_2 - zq$
$A = A(0) = \frac{1}{2\pi i} \oint_{z=0} \frac{A(z)}{z} = -\frac{1}{2\pi i} \sum_{z_i \neq 0} \oint_{z=z_i} \frac{A(z)}{z} = -\sum_{z_i \neq 0} \text{Res}\left(\frac{A(z)}{z}\right)$
$z_i \quad (p_1(z_i) + p_a + \dots + p_l)^2 = 0$


$A(p_1, \dots p_m)$
$q^2 = q \cdot p_1 = q \cdot p_2 = 0$
$p_1(z) = p_1 + zq$
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$z_i \quad (p_1(z_i) + p_a + \dots + p_l)^2 = 0$

$$A(p_1, \dots p_m)$$

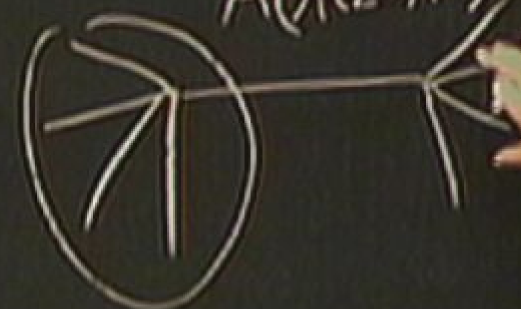
$$q^2 = q \cdot p_1 = q \cdot p_2 = 0$$

$$p_1(z) = p_1 + zq$$

$$p_2(z) = p_2 - zq$$

$$A = A(0) = \frac{1}{2\pi i} \oint_{z=0} \frac{A(z)}{z} = -\frac{1}{2\pi i} \sum_{z_i \neq 0} \oint_{z=z_i} \frac{A(z)}{z} = -\sum_{z_i \neq 0} \mathrm{Res}\left(\frac{A(z)}{z}\right)$$

$$A(S_1(z), P^h)\,A(S_2(z), P^+)$$



$$z_i \qquad (p_1(z_i) + p_a + \dots + p_l)^2 = 0$$

$$q^2 = q\cdot p_1 = q\cdot p_2 = 0$$

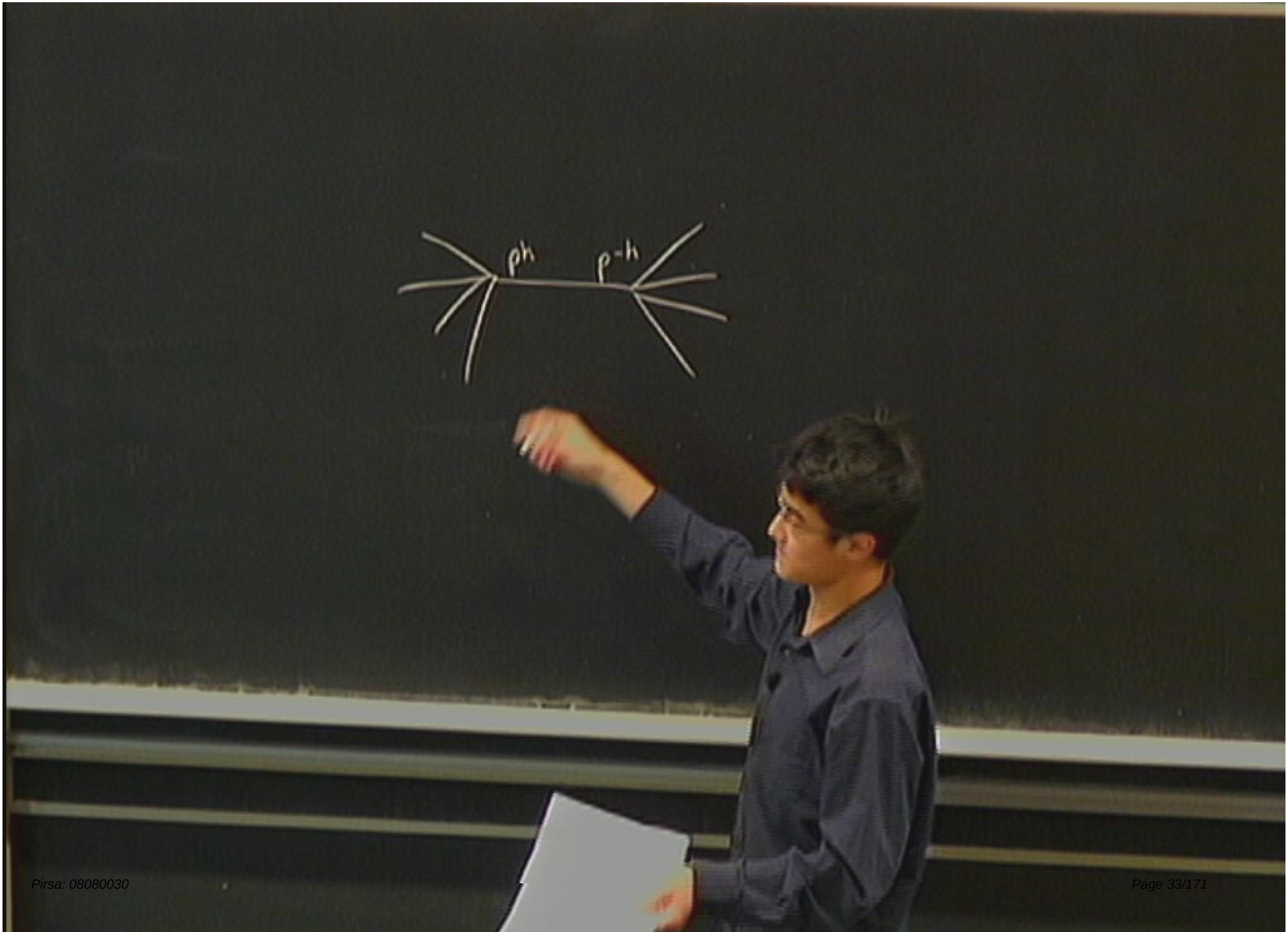
$$p_1(z) = p_1 + zq$$

$$p_2(z) = p_2 - zq$$

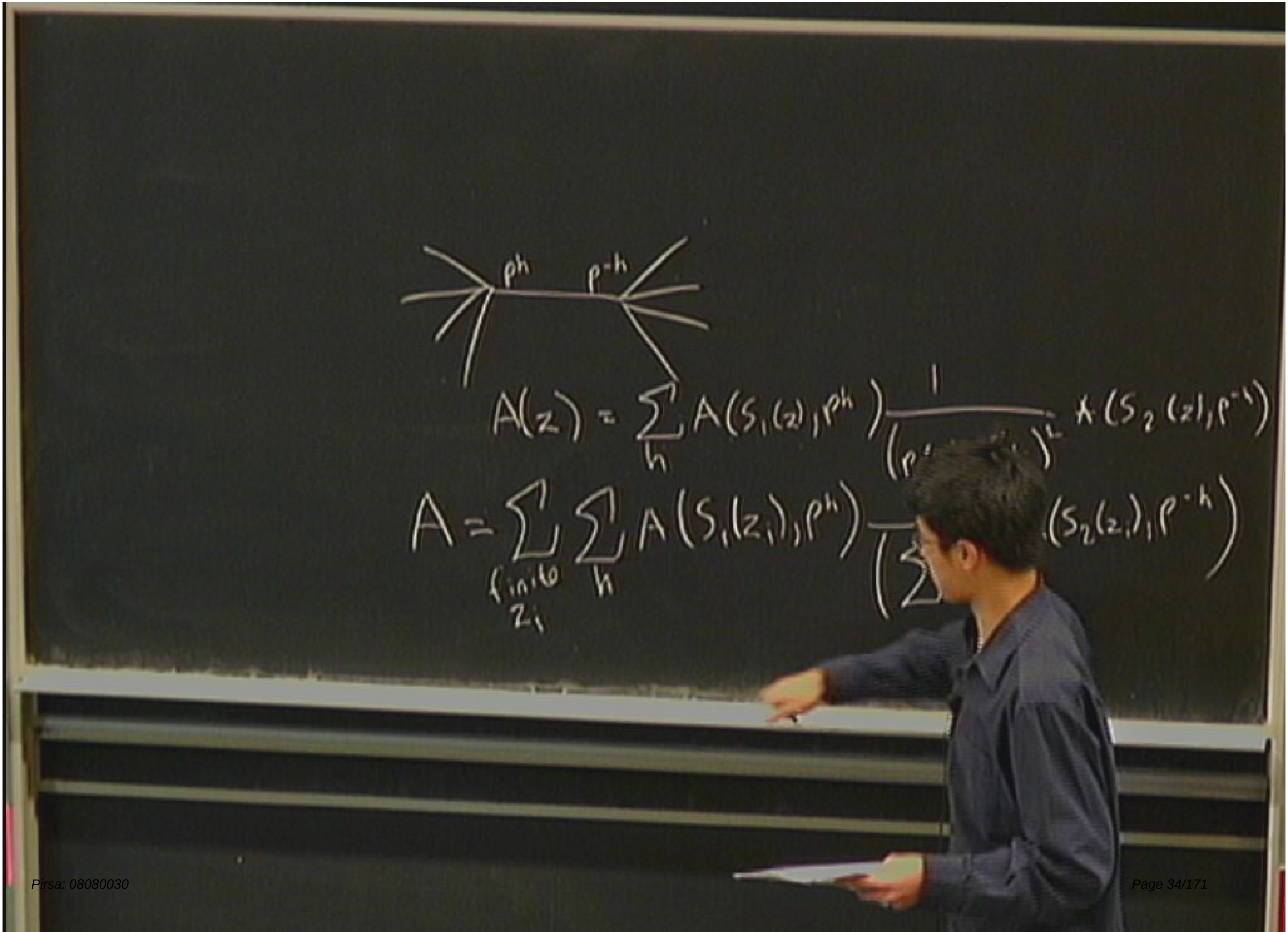
$$A = A(0) = \frac{1}{2\pi i}\oint_{z=0}\frac{A(z)}{z} = -\frac{1}{2\pi i}\sum_{z_i\neq 0}\oint_{z=z_i}\frac{A(z)}{z} = -\sum_{z_i\neq 0}\mathrm{Res}\left(\frac{A(z)}{z}\right)$$

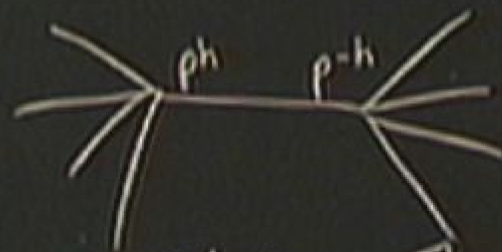
$$A(S_1(z_i), p^h)\,A(S_2(z_i), p^{-h})$$

$$z_i \qquad (p_1(z_i) + p_a + \dots + p_l)^2 = 0$$



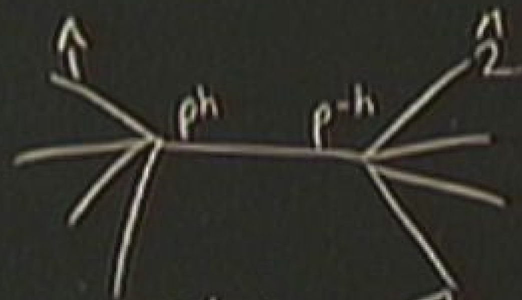
p^{h}
p^{-h}


p^h
p^{-h}
$A(z) = \sum_h A(S_1(z), p^h) \frac{1}{(p \ldots)^2} A(S_2(z), p^{-h})$
$A = \sum_{\text{finite } z_i} \sum_h A(S_1(z_i), p^h) \ldots (S_2(z_i), p^{-h})$



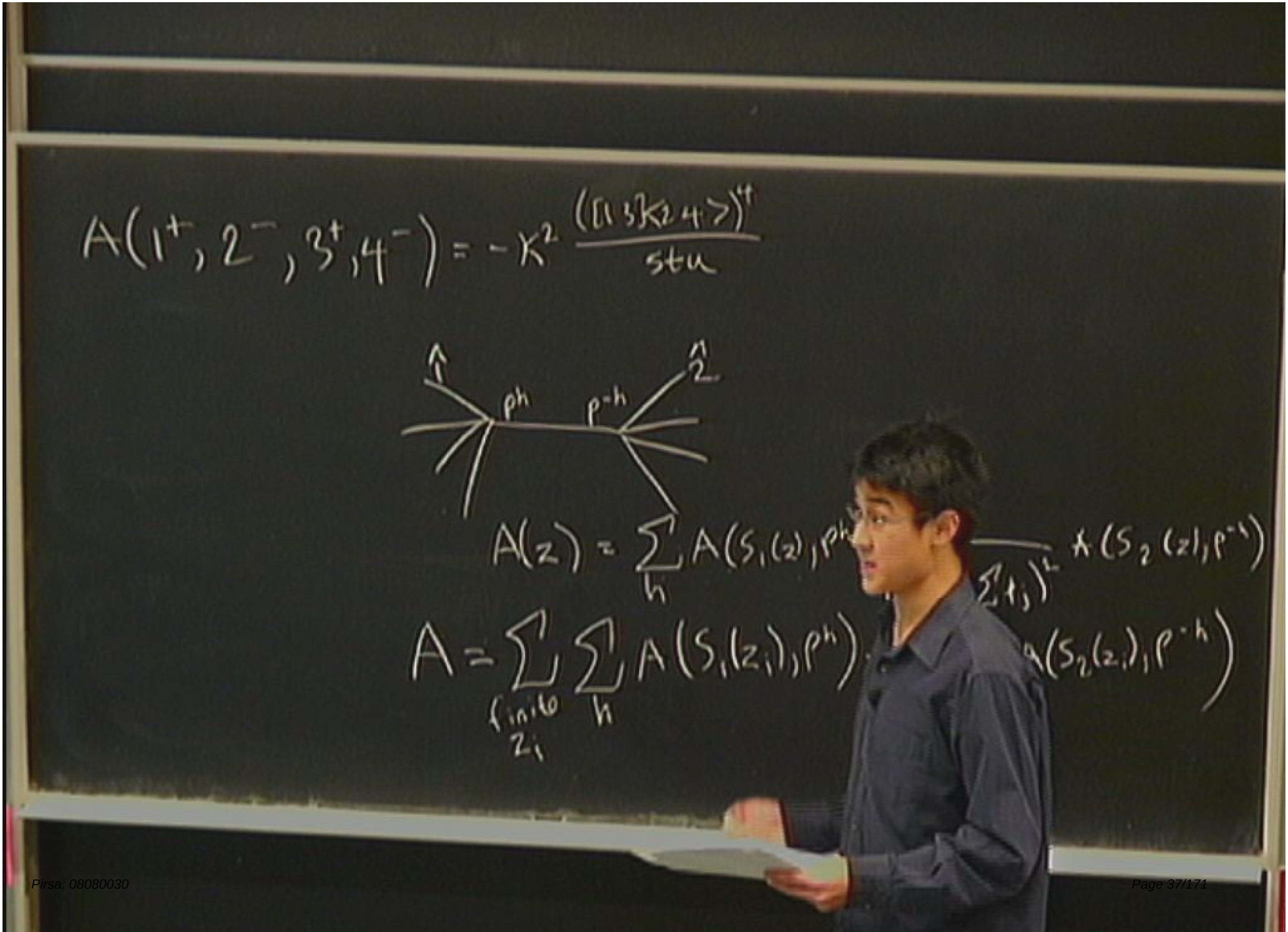
$$A(z) = \sum_h A(S_1(z), p^h) \frac{1}{\left(p_1(z) + \sum t_j\right)^2} A(S_2(z), p^{-h})$$

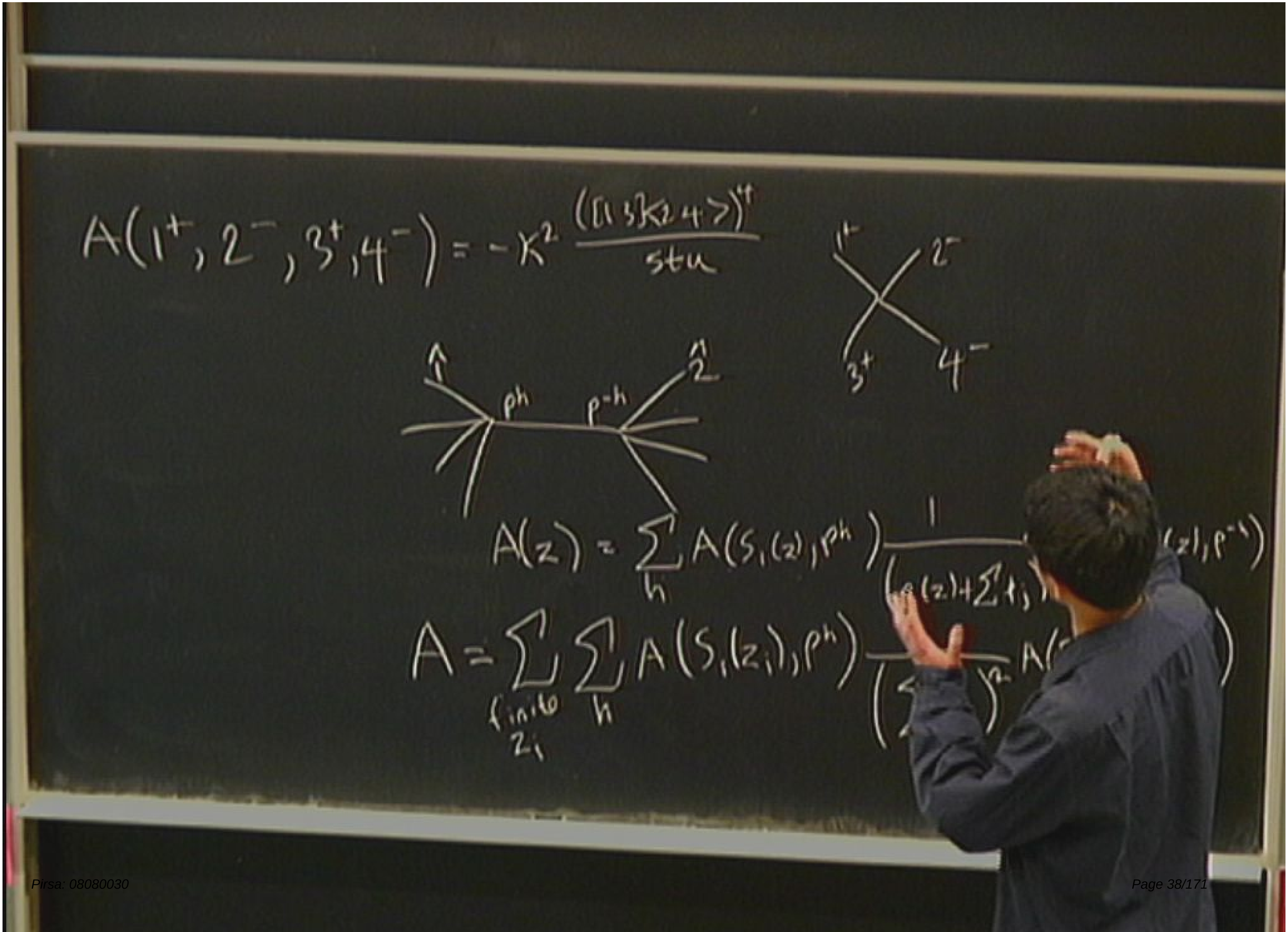
$$A = \sum_{\substack{\text{finite} \\ z_i}} \sum_h A(S_1(z_i), p^h) \frac{1}{\left(\sum p_j\right)^2} A(S_2(z_i), p^{-h})$$



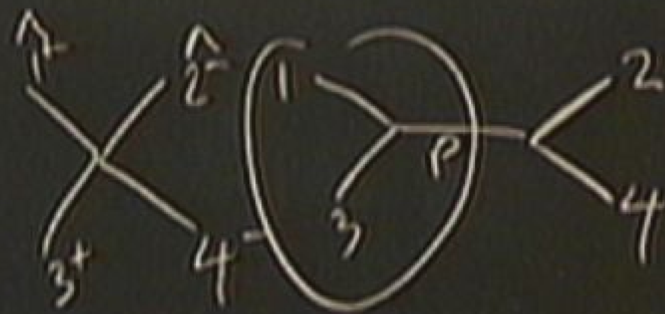
$$A(z) = \sum_h A(S_1(z), P^h) \frac{1}{\left(P_1(z) + \sum t_j\right)^2} A(S_2(z), P^{-h})$$

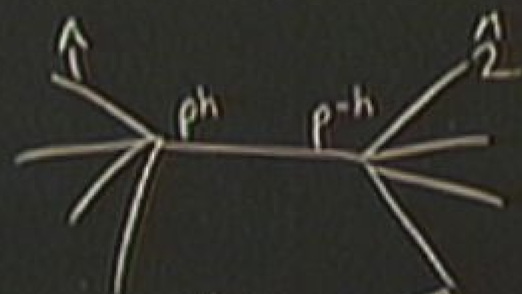
$$A = \sum_{\substack{\text{finite} \\ z_i}} \sum_h A(S_1(z_i), P^h) \frac{1}{\left(\sum P_j\right)^2} A(S_2(z_i), P^{-h})$$


A(1+, 2−, 3+, 4−) = −κ² ([1 3]⟨2 4⟩)⁴ / stu
1̂
2̂
P^h
P^−h
A(z) = Σ_h A(S₁(z), P^h)
A(S₂(z), P^−h)
A = Σ_{finite z_i} Σ_h A(S₁(z_i), P^h)
A(S₂(z_i), P^−h)


A(1+, 2−, 3+, 4−) = −κ² ([1 3]⟨2 4⟩)⁴ / stu
1+
2−
3+
4−
1̂
2̂
P^h
P^-h
A(z) = Σ_h A(S_1(z), P^h)
A = Σ_{finite z_i} Σ_h A(S_1(z_i), P^h)

$$A(1^+, 2^-, 3^+, 4^-) = -\kappa^2 \frac{([13]\langle 24\rangle)^4}{stu}$$





$$A(z) = \sum_h A(S_1(z), P^h) \frac{1}{(P_1(z) + \sum k_j)^2} A(S_2(z), P^{-h})$$

$$A = \sum_{\substack{\text{finite} \\ z_i}} \sum_h A(S_1(z_i), P^h) \frac{1}{(\sum P_j)^2} A(S_2(z_i), P^{-h})$$

$$A(1^-,2^-,3^+) = \kappa\left(\frac{\langle 12\rangle^3}{\langle 23\rangle\langle 31\rangle}\right)^{s}$$

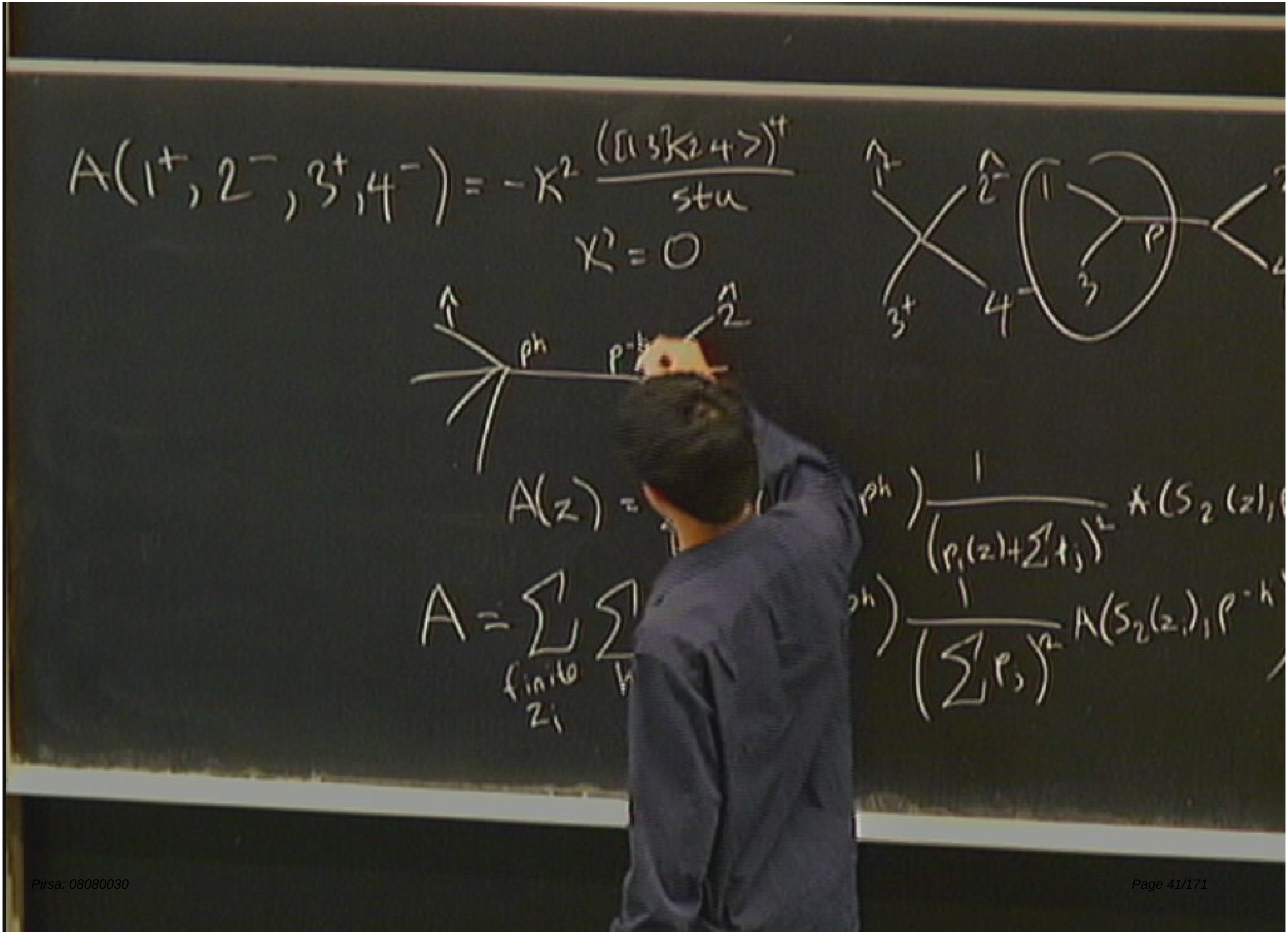
$$A(1^+,2^+,3^-) = \text{''} \quad (\langle\,\rangle \to [\,])$$

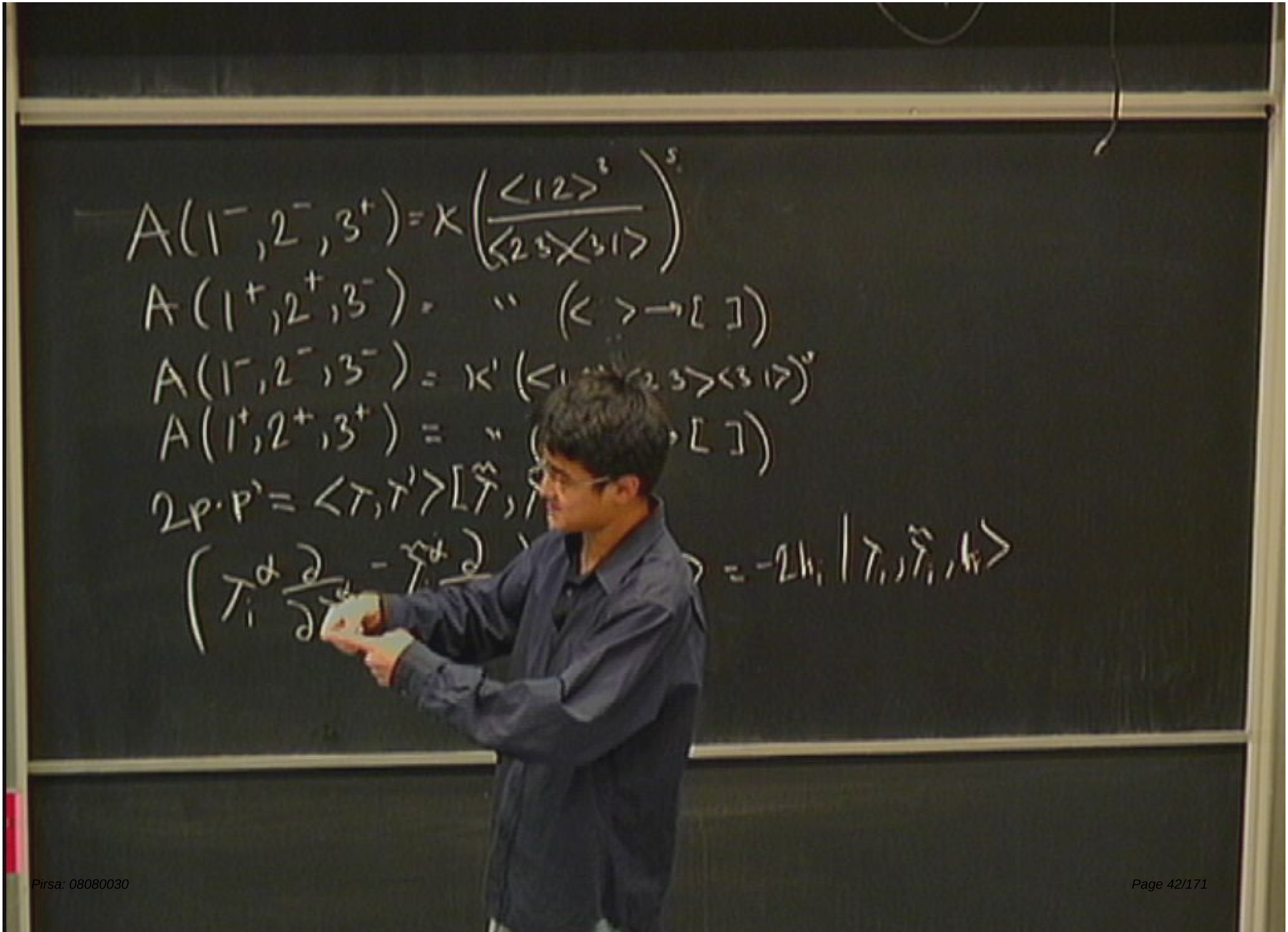
$$A(1^-,2^-,3^-) = \kappa'\left(\langle 12\rangle\langle 23\rangle\langle 31\rangle\right)^{s}$$

$$A(1^+,2^+,3^+) = \text{''} \quad (\langle\,\rangle \to [\,])$$

$$2p\cdot p' = \langle \lambda, \lambda'\rangle[\tilde\lambda, \tilde\lambda']$$

$$\left(\lambda_i^\alpha \frac{\partial}{\partial \lambda_i^\alpha} - \tilde\lambda_i^{\dot\alpha}\frac{\partial}{\partial \tilde\lambda_i^{\dot\alpha}}\right)|\lambda_i,\tilde\lambda_i,h_i\rangle = -2h_i\,|\lambda_i,\tilde\lambda_i,h_i\rangle$$


A(1+, 2−, 3+, 4−) = −K² ([13][24])⁴ / stu
K² = 0
ph
A(z)
A = Σ Σ
finite z_i
(p_1(z) + Σ p_j)²
A(S_2(z_i), P^−h


A(1⁻, 2⁻, 3⁺) = κ (<12>³ / <23><31>)^s
A(1⁺, 2⁺, 3⁻) = " (< > → [ ])
A(1⁻, 2⁻, 3⁻) = κ' (<12><23><31>)^s
A(1⁺, 2⁺, 3⁺) = " (→ [ ])
2p·p' = <λ, λ'>[λ̃, λ̃']
= −2h_i |λ_i, λ̃_i, h_i>

$$A(1^-,2^-,3^+) = \kappa\left(\frac{\langle 12\rangle^3}{\langle 23\rangle\langle 31\rangle}\right)^s$$

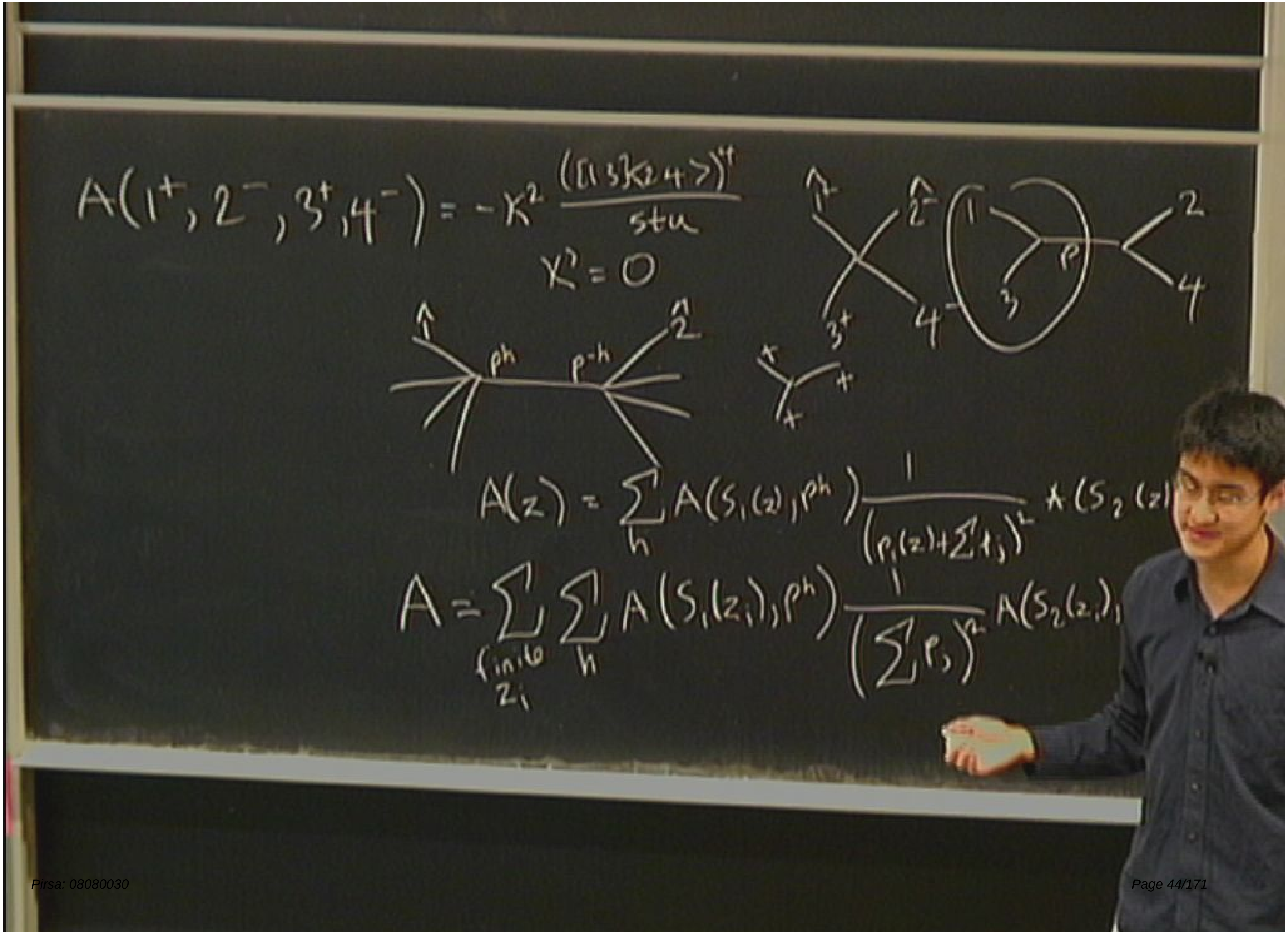
$$A(1^+,2^+,3^-) = \text{''} \quad (\langle\ \rangle \to [\ ])$$

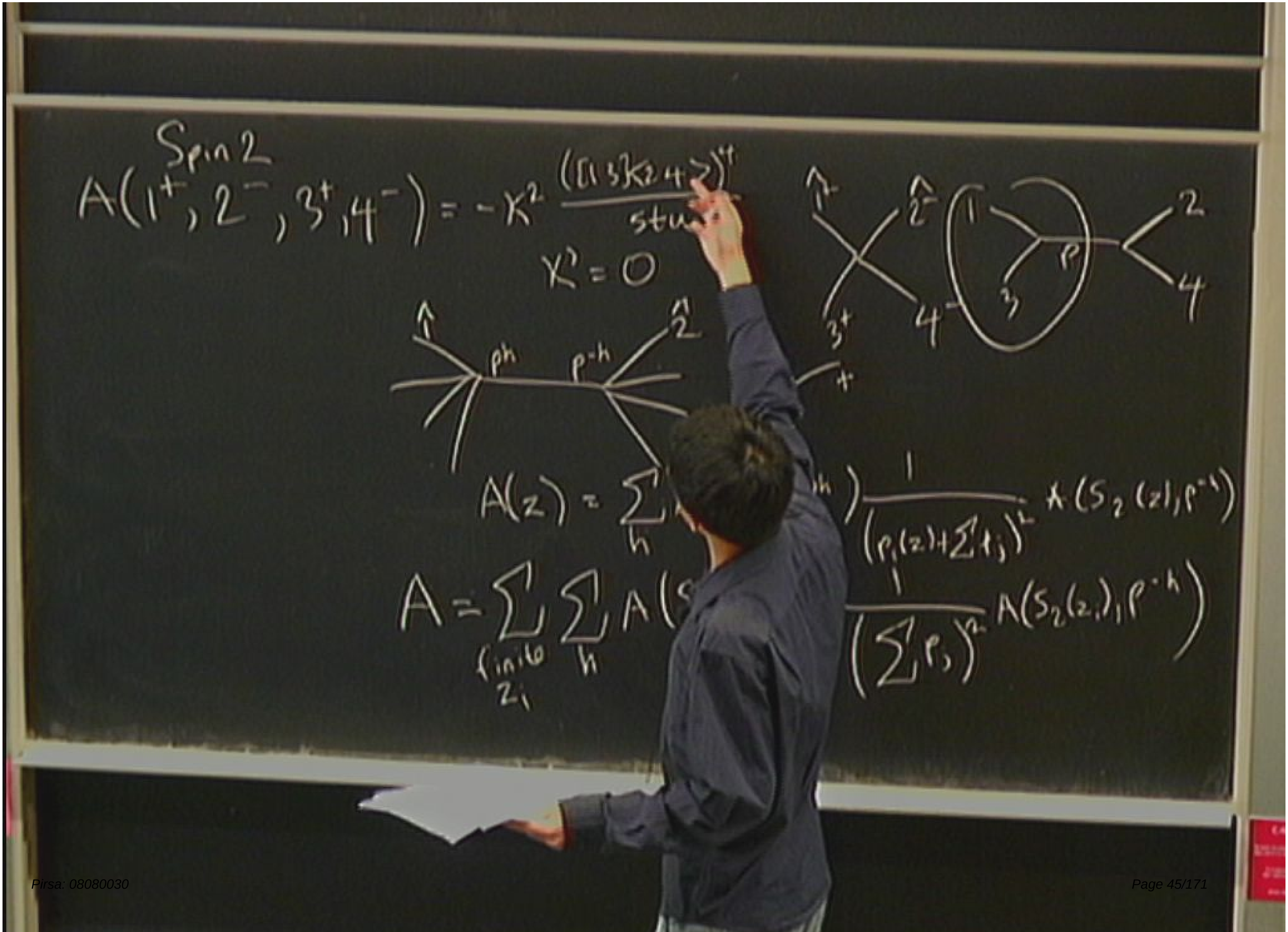
$$A(1^-,2^-,3^-) = \kappa'\left(\langle 12\rangle\langle 23\rangle\langle 31\rangle\right)^s$$

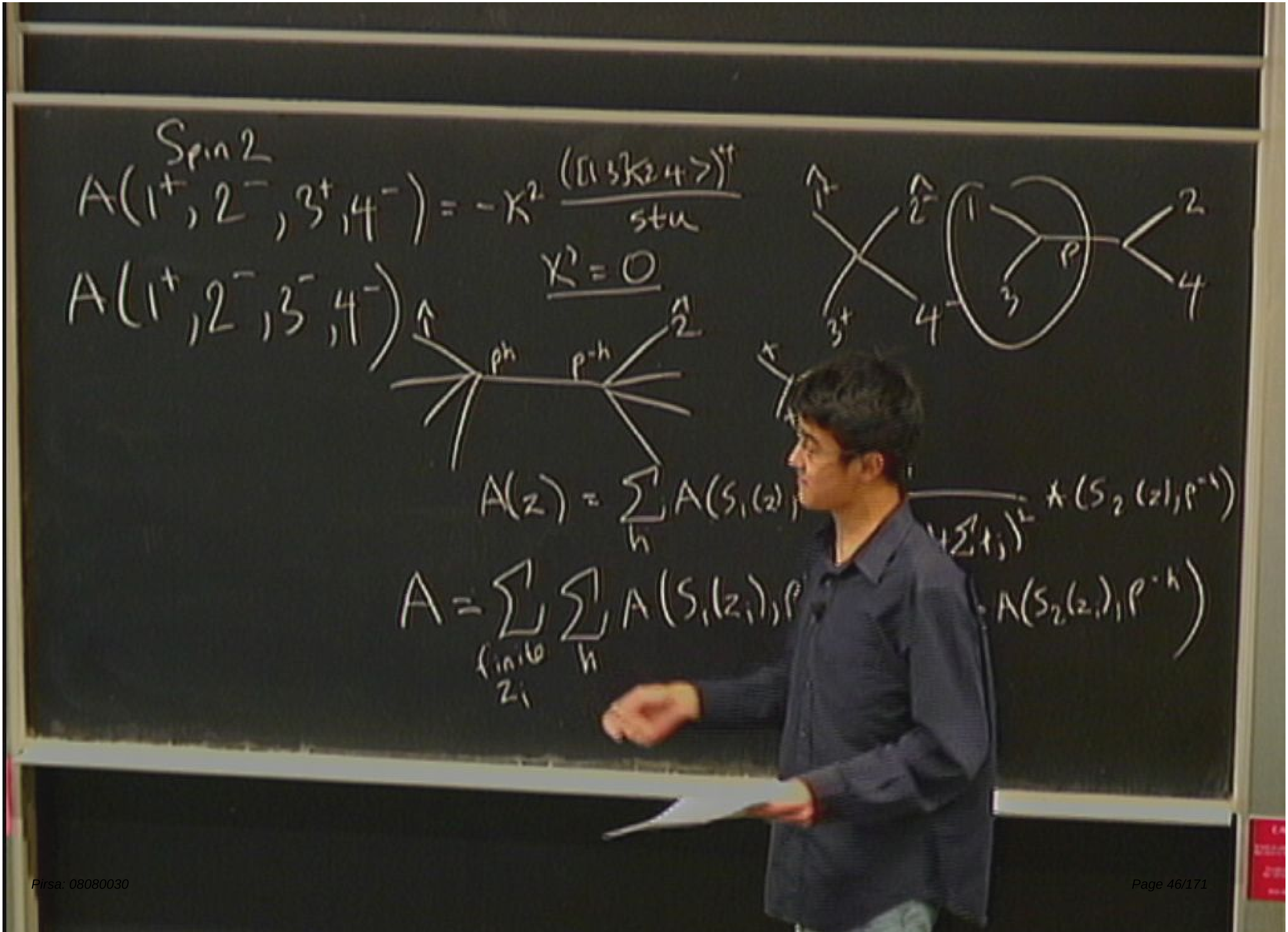
$$A(1^+,2^+,3^+) = \text{''} \quad (\langle\ \rangle \to [\ ])$$

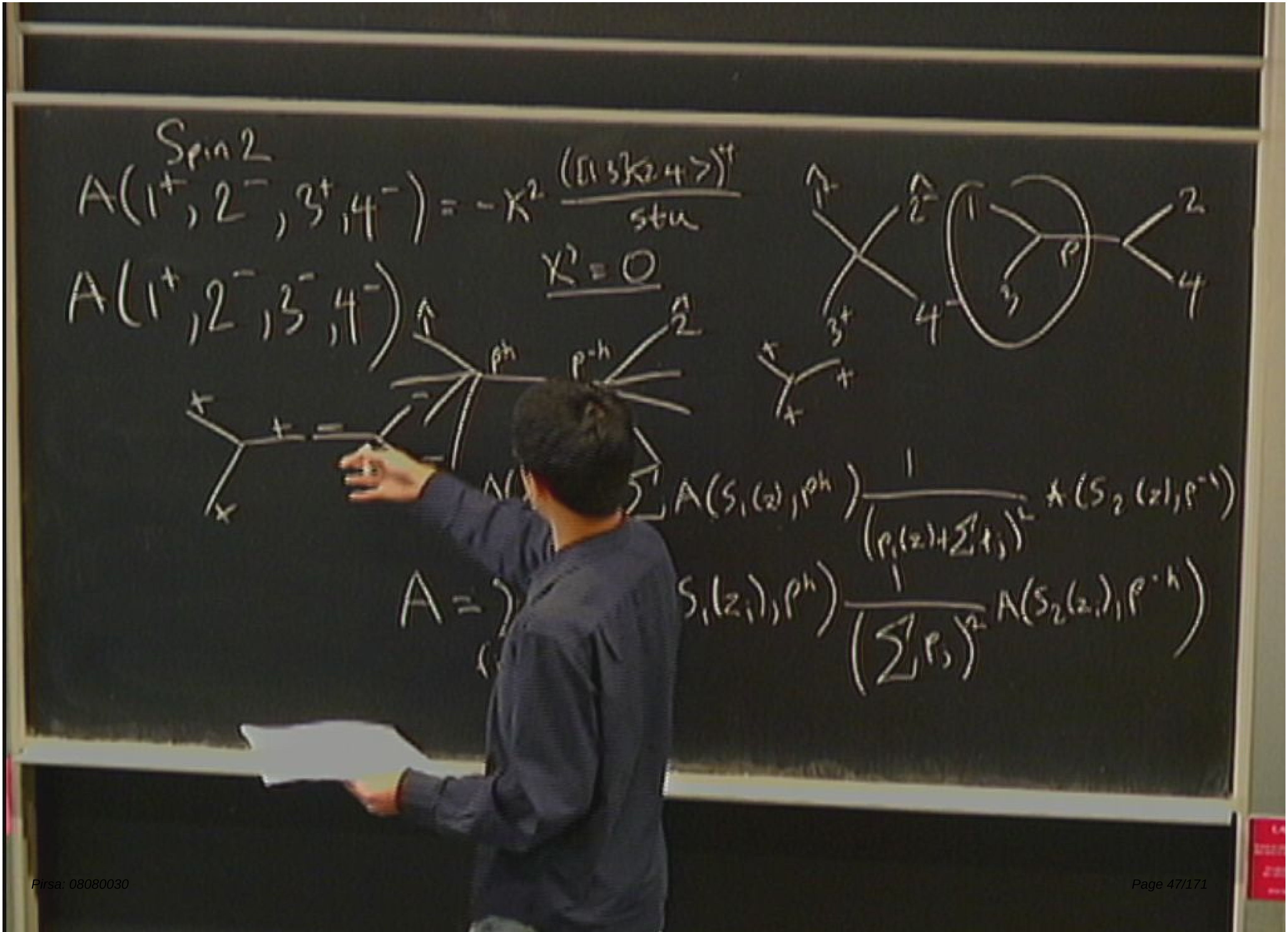
$$2p\cdot p' = \langle \lambda,\lambda'\rangle[\tilde\lambda,\tilde\lambda']$$

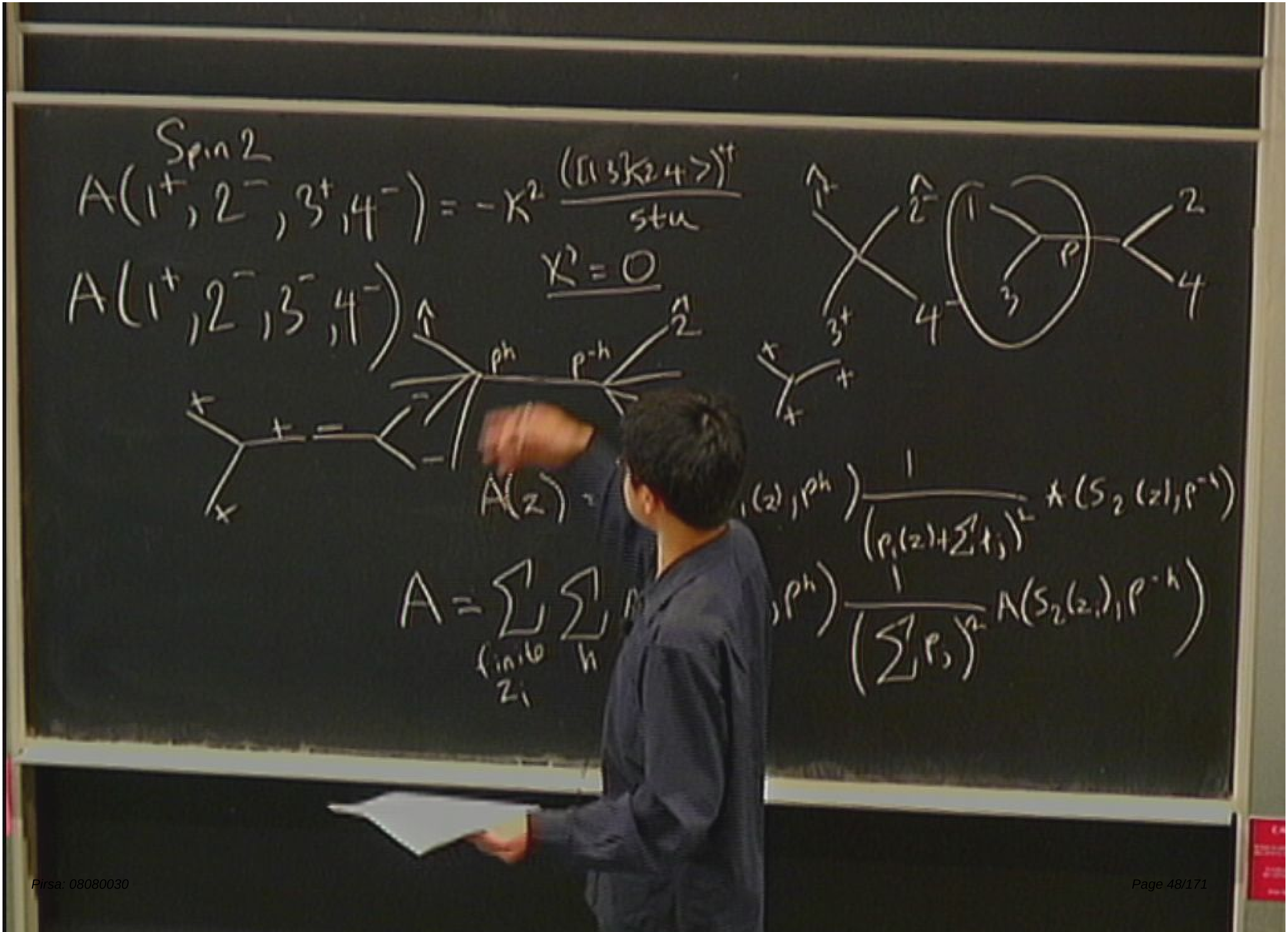
$$\left(\lambda_i^\alpha \frac{\partial}{\partial \lambda_i^\alpha} - \tilde\lambda_i^{\dot\alpha}\frac{\partial}{\partial \tilde\lambda_i^{\dot\alpha}}\right)|\lambda_i,\tilde\lambda_i,h_i\rangle = -2h_i\,|\lambda_i,\tilde\lambda_i,h_i\rangle$$


A(1+, 2−, 3+, 4−) = −κ² ([1 3]⟨2 4⟩)⁴ / stu
κ² = 0
p^h
p^−h
A(z) = Σ_h A(S_1(z), p^h) 1/(P_1(z) + Σ P_i)² A(S_2(z)
A = Σ_{finite z_i} Σ_h A(S_1(z_i), p^h) 1/(Σ P_i)² A(S_2(z_i),


Spin 2
A(1+, 2−, 3+, 4−) = −K² ([1|3|2|4⟩)⁴ / stu
K² = 0
A(z) = Σ h
A = Σ finite zi Σ h A(S
A(S2(zi), P−h)


Spin 2
A(1+, 2−, 3+, 4−) = −K² ([13]⟨24⟩)⁴ / stu
A(1+, 2−, 3−, 4−)
K² = 0
finite
zᵢ


Spin 2
A(1+, 2−, 3+, 4−) = −κ² ([1|3|2, 4>)⁴ / stu
A(1+, 2−, 3−, 4−)
κ² = 0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A(1+, 2−, 3+, 4−) = −K² ([1 3]⟨2 4⟩)⁴ / stu
K² = 0
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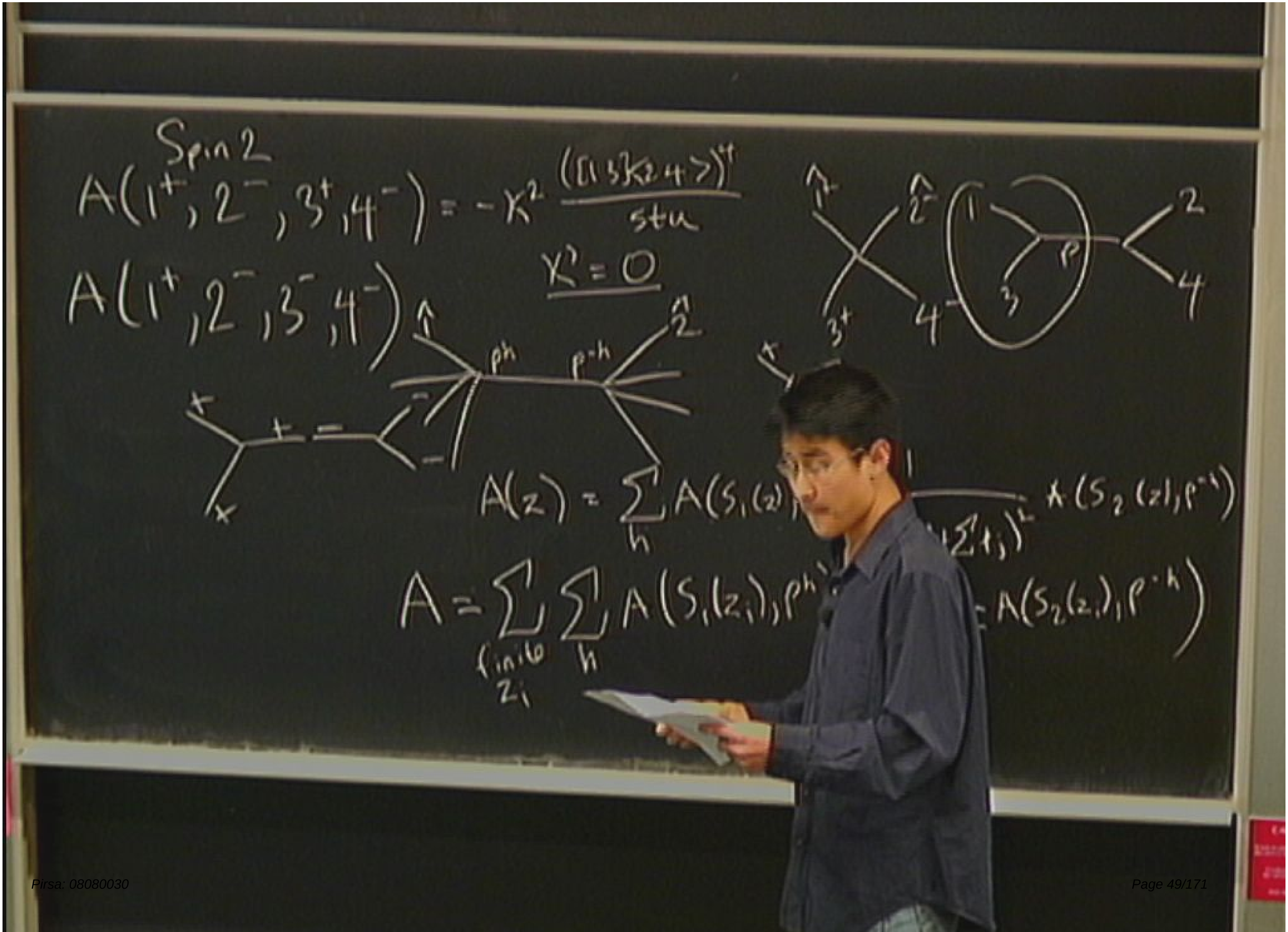
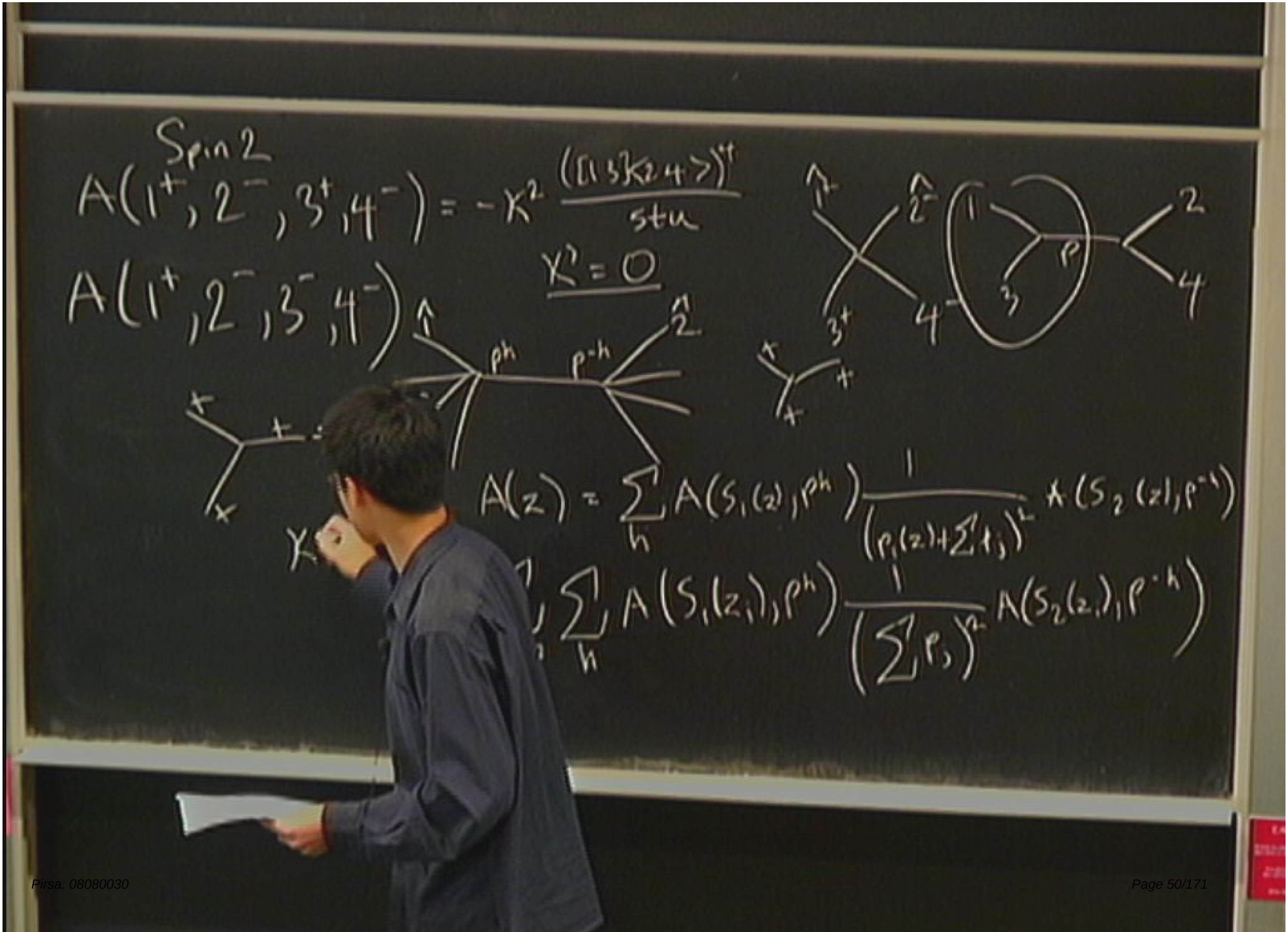
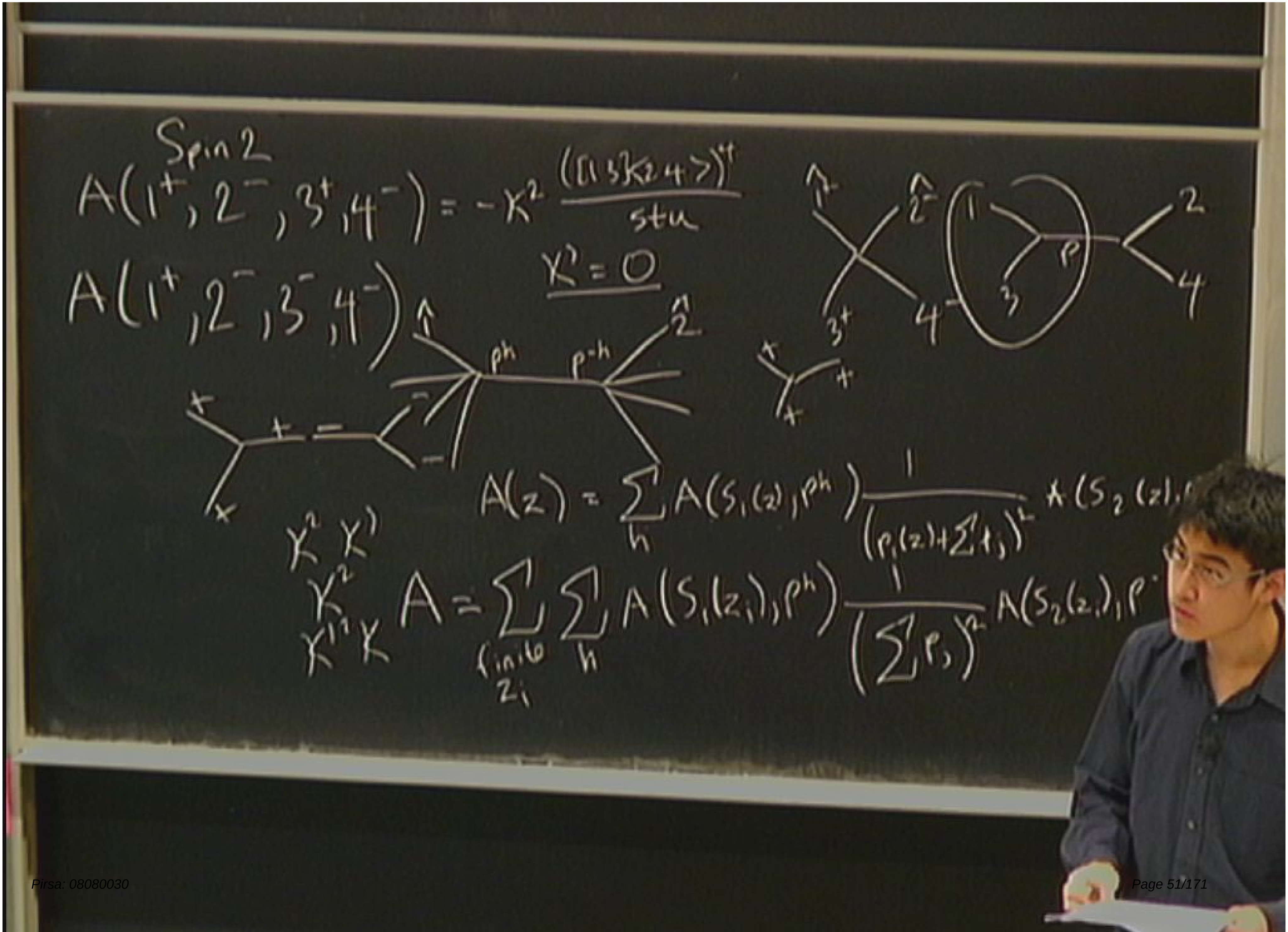
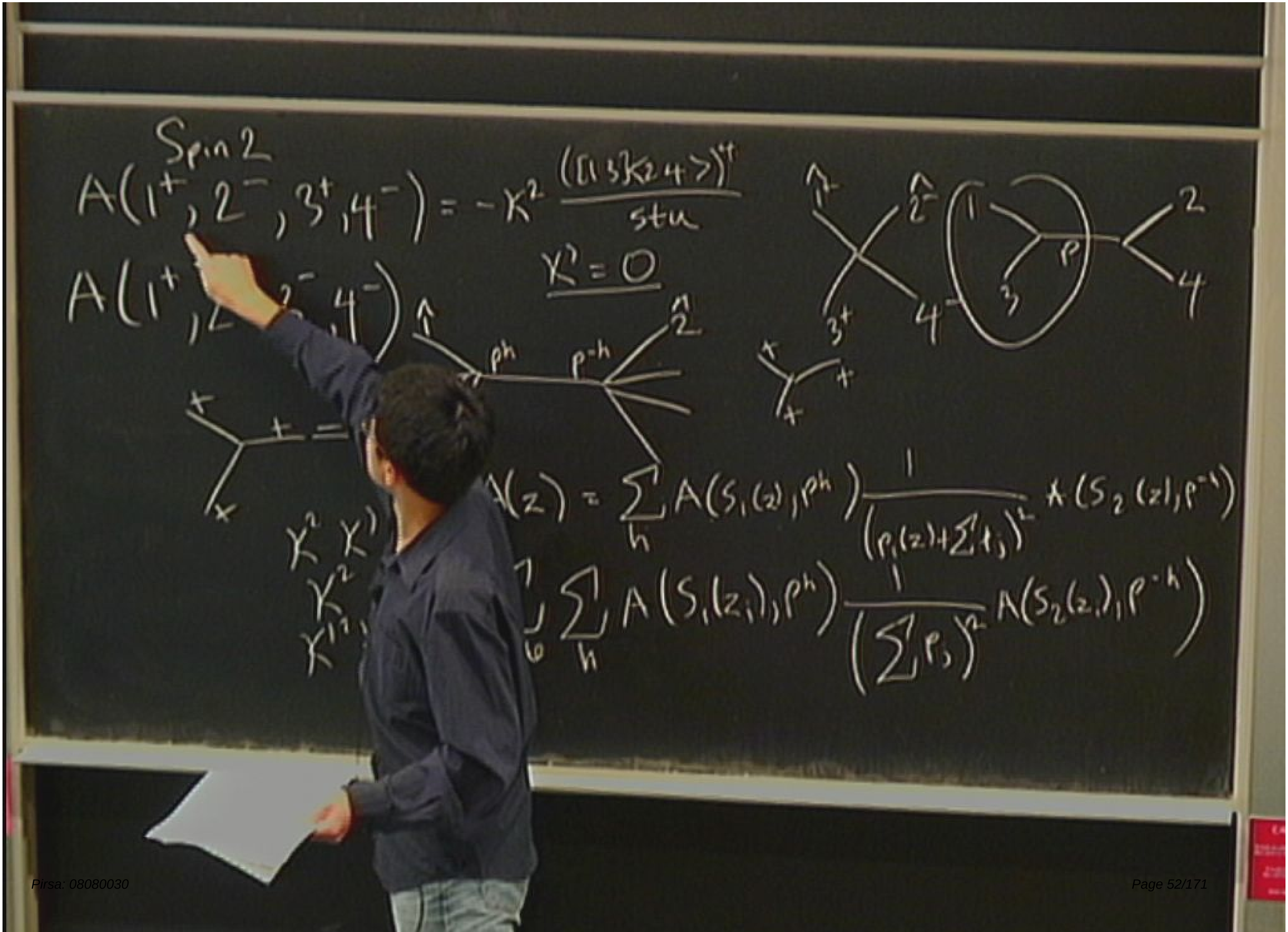
p^h p^−h
A = Σ Σ
finite z_i
h


Spin 2
A(1+, 2−, 3+, 4−) = −κ² ([13]⟨24⟩)⁴ / stu
κ² = 0
A(1+, 2−, 3−, 4−)
A(z) = Σ_h A(S₁(z), p^h)
A = Σ_{finite z_i} Σ_h A(S₁(z_i), p^h)
A(S₂(z_i), p^{−h})

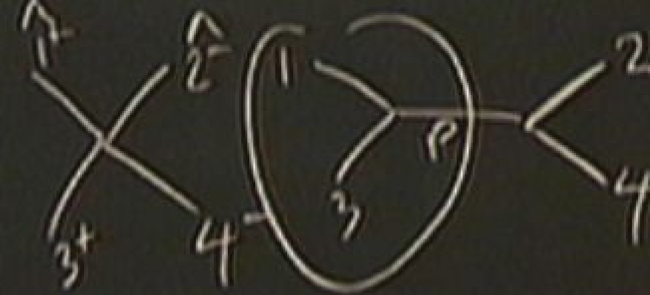

Spin 2
A(1+, 2−, 3+, 4−) = −K² ([13]⟨24⟩)⁴ / stu
A(1+, 2−, 3−, 4−)
K² = 0
A(z) = Σ_h A(S₁(z), p^h) 1/(p₁(z)+Σ k_i)² A(S₂(z), p^−h)
Σ_h A(S₁(z_i), p^h) 1/(Σ p_i)² A(S₂(z_i), p^−h)


Spin 2
A(1+, 2−, 3+, 4−) = −κ² ([13]⟨24⟩)⁴ / stu
κ² = 0
A(1+, 2−, 3−, 4−)
A(z) = Σ_h A(S₁(z), p^h) 1/(p₁(z)+Σ k_j)² A(S₂(z), p^−h)
A = Σ_{finite z_i} Σ_h A(S₁(z_i), p^h) 1/(Σ p_i)² A(S₂(z_i), p^−h)


Spin 2
A(1+, 2−, 3+, 4−) = −κ² ([13]⟨24⟩)⁴ / stu
κ² = 0

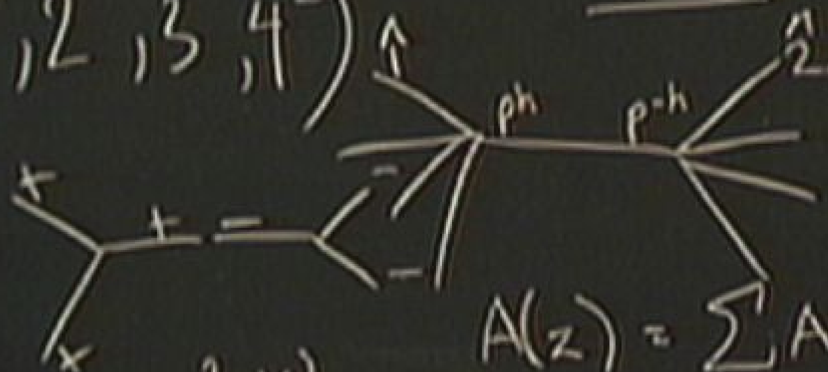
Spin 2

$$A(1^+,2^-,3^+,4^-) = -\kappa^2 \frac{([1|3|2\,4\rangle)^4}{stu}$$



$$A(1^+,2^-,3^-,4^-)$$

$$\underline{\kappa^2 = 0}$$



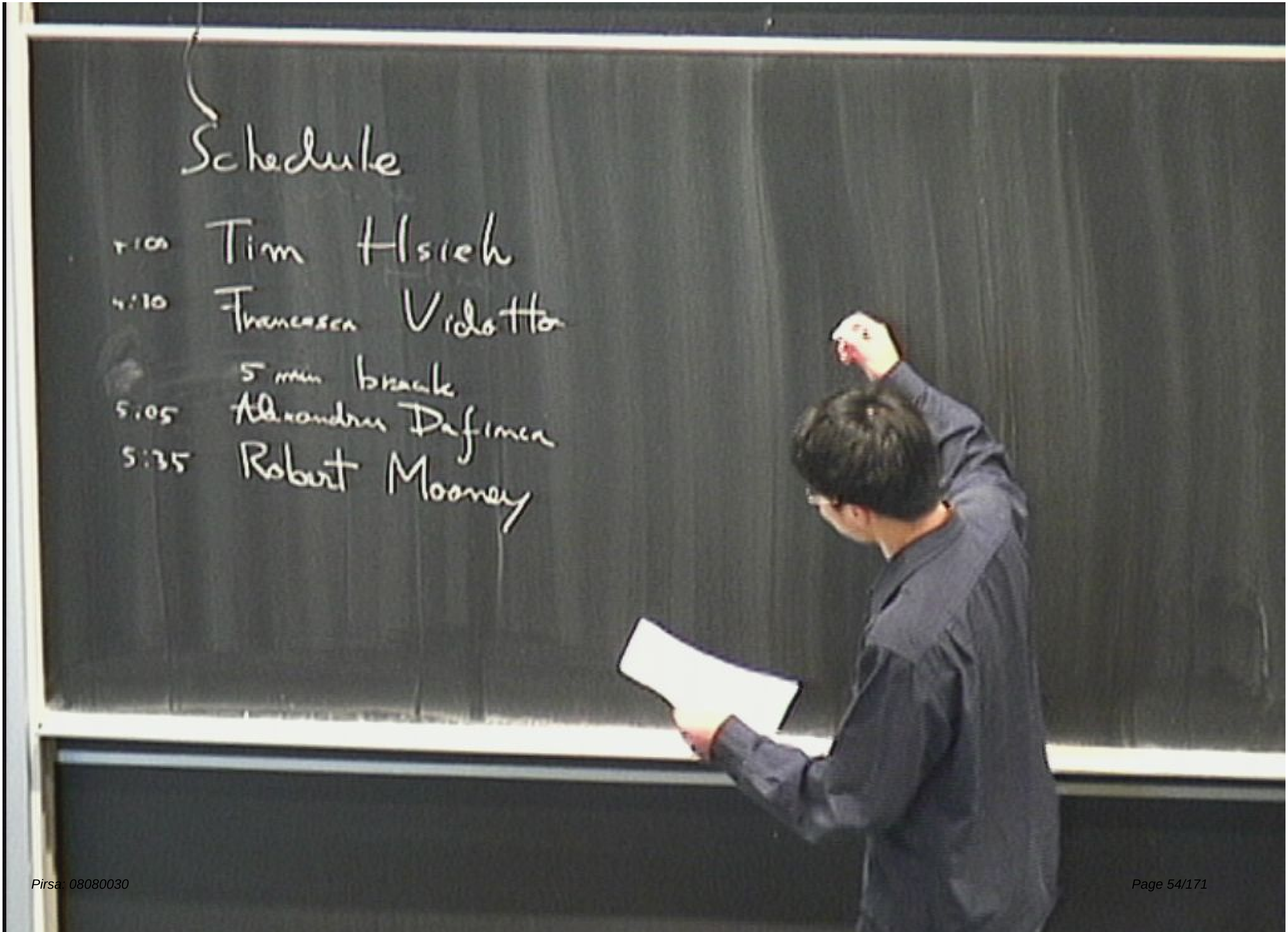
$$A(z) = \sum_h A(S_1(z), p^h) \frac{1}{(p_1(z)+\sum k_j)^2} A(S_2(z), p^{-h})$$

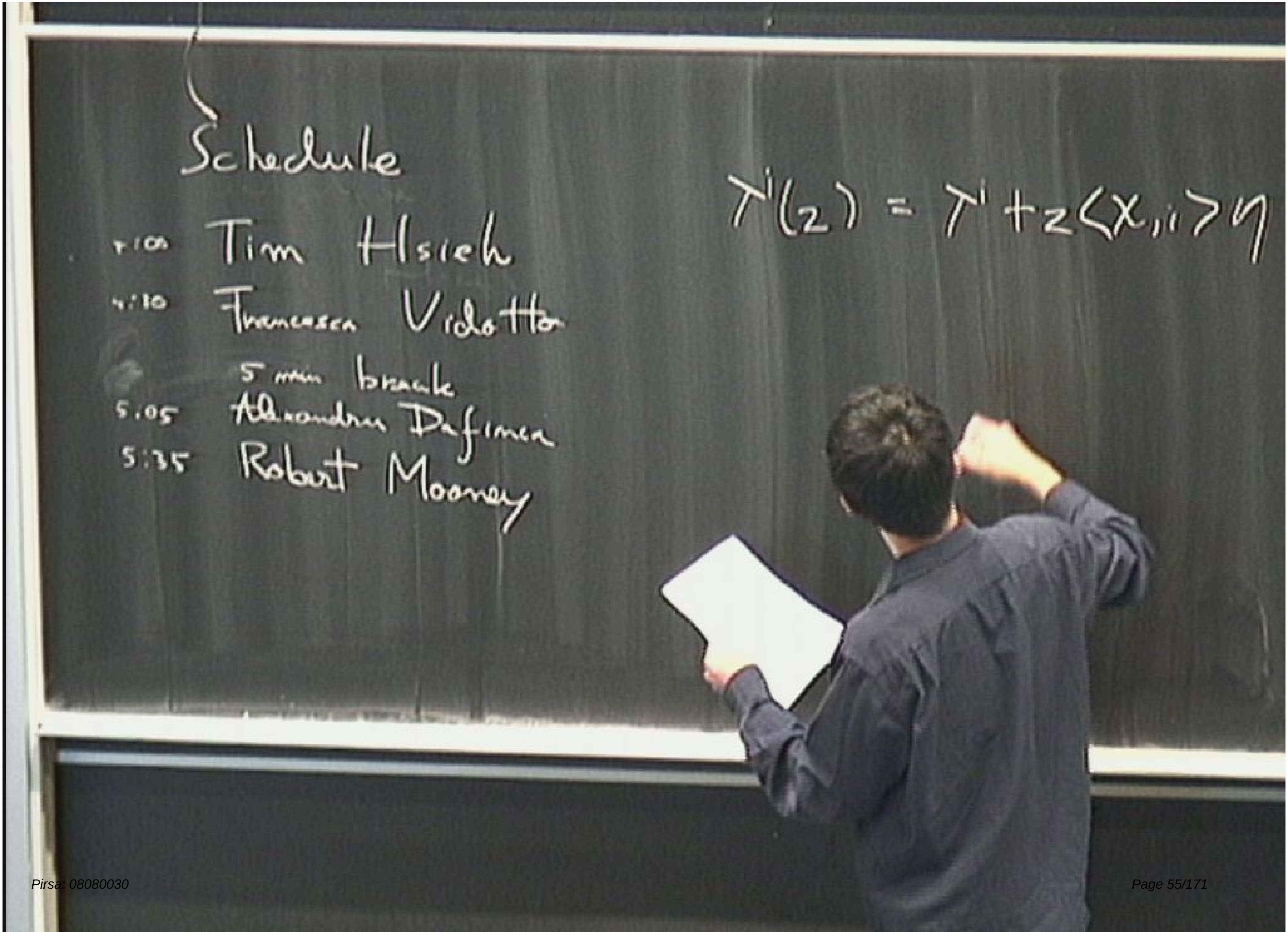
$\kappa^2\ \kappa^2$

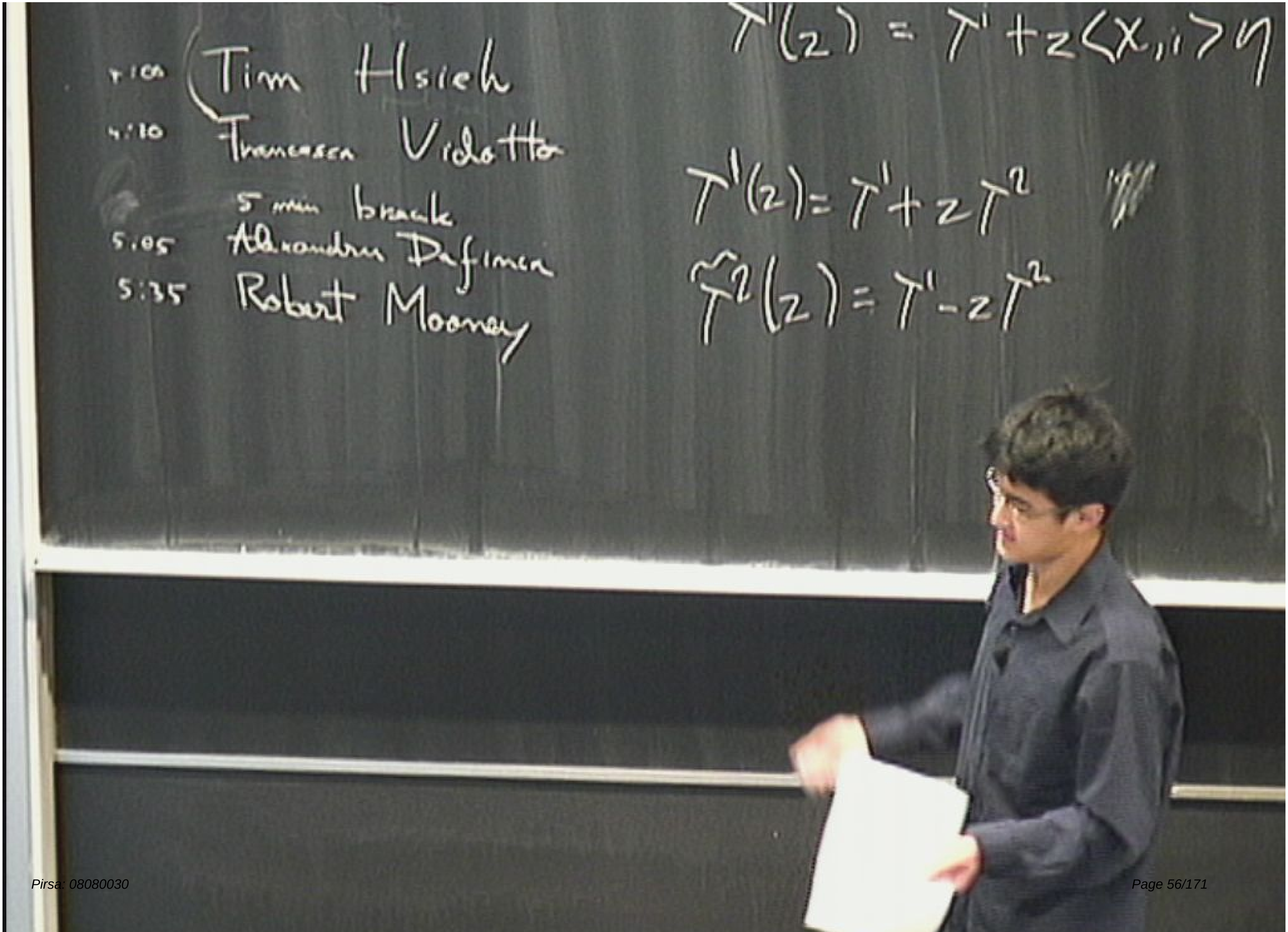
κ^2

$\kappa'^2\ \kappa$

$$A = \sum_{\text{finite } z_i} \sum_h A(S_1(z_i), p^h) \frac{1}{(\sum p_j)^2} A(S_2(z_i), p^{-h})$$


Schedule
Tim Hsieh
4:10 Francesca Vidotto
5 min break
5:05
5:35 Robert Mooney


Schedule
4:00 Tim Hsieh
4:30 Francesca Vidotto
5 min break
5:05 Alexandru Dafinca
5:35 Robert Mooney
γ'(z) = γ' + z⟨X,i⟩η



Tim Hsieh
4:30 Francesca Vidotto
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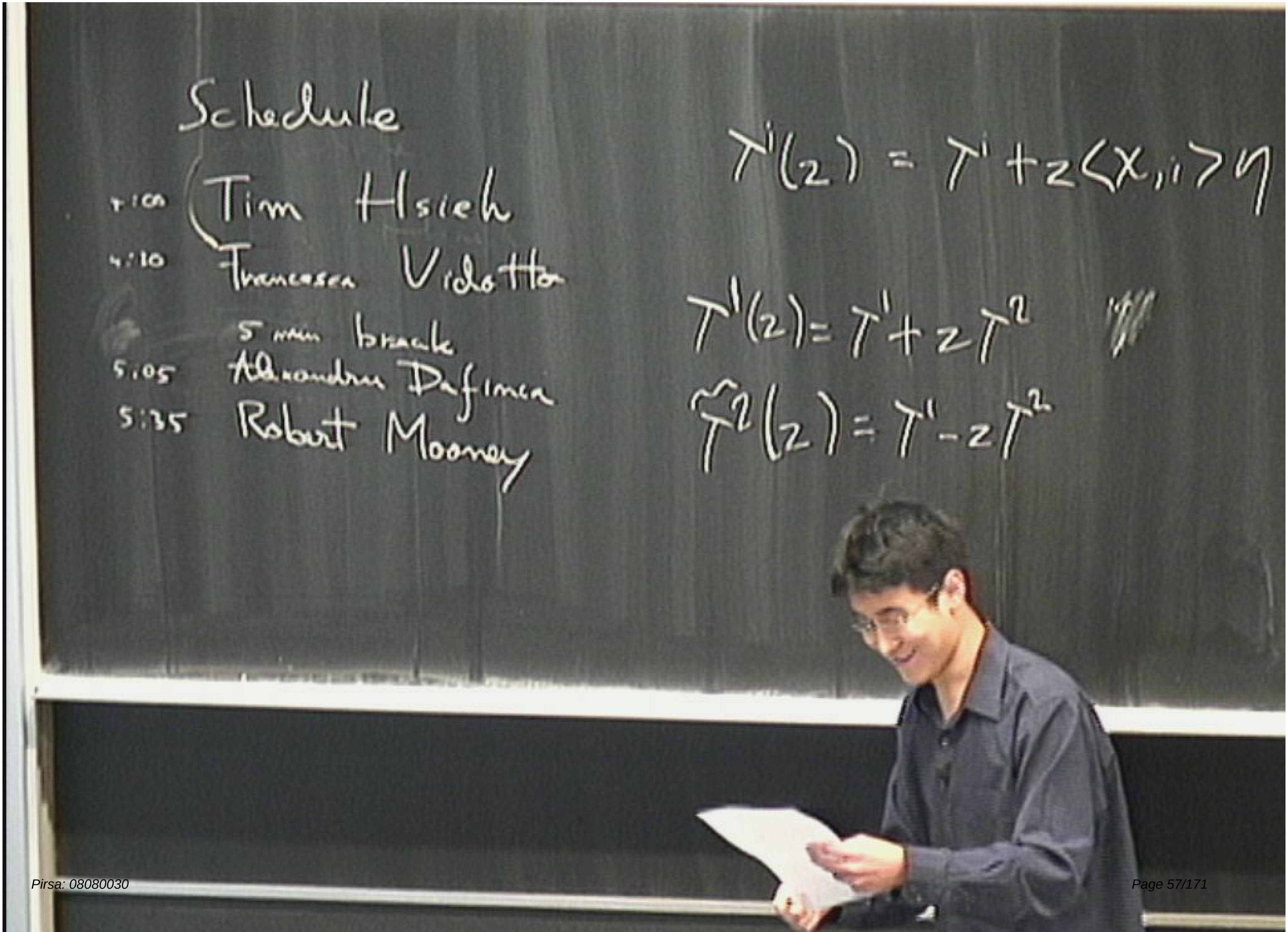
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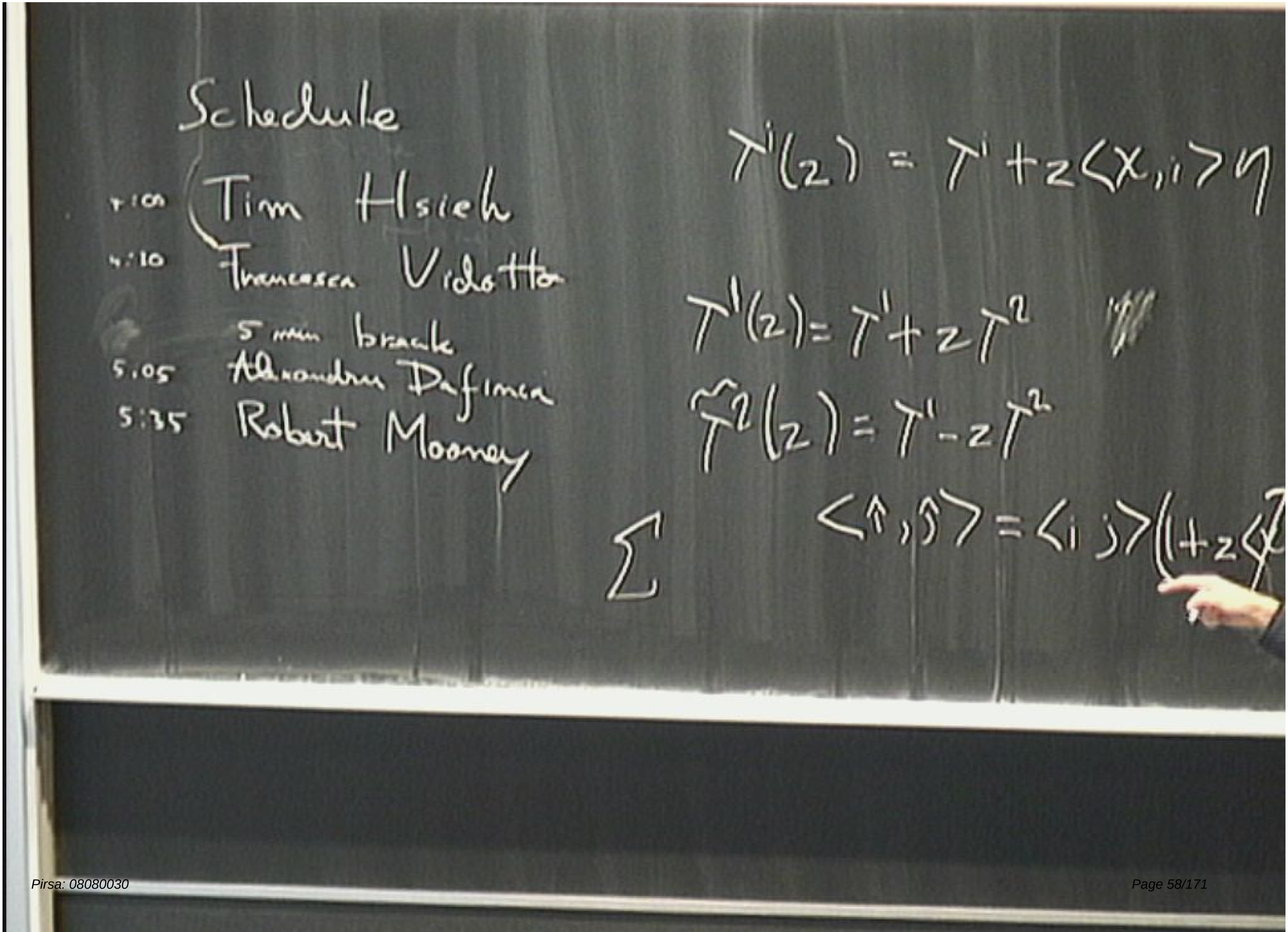
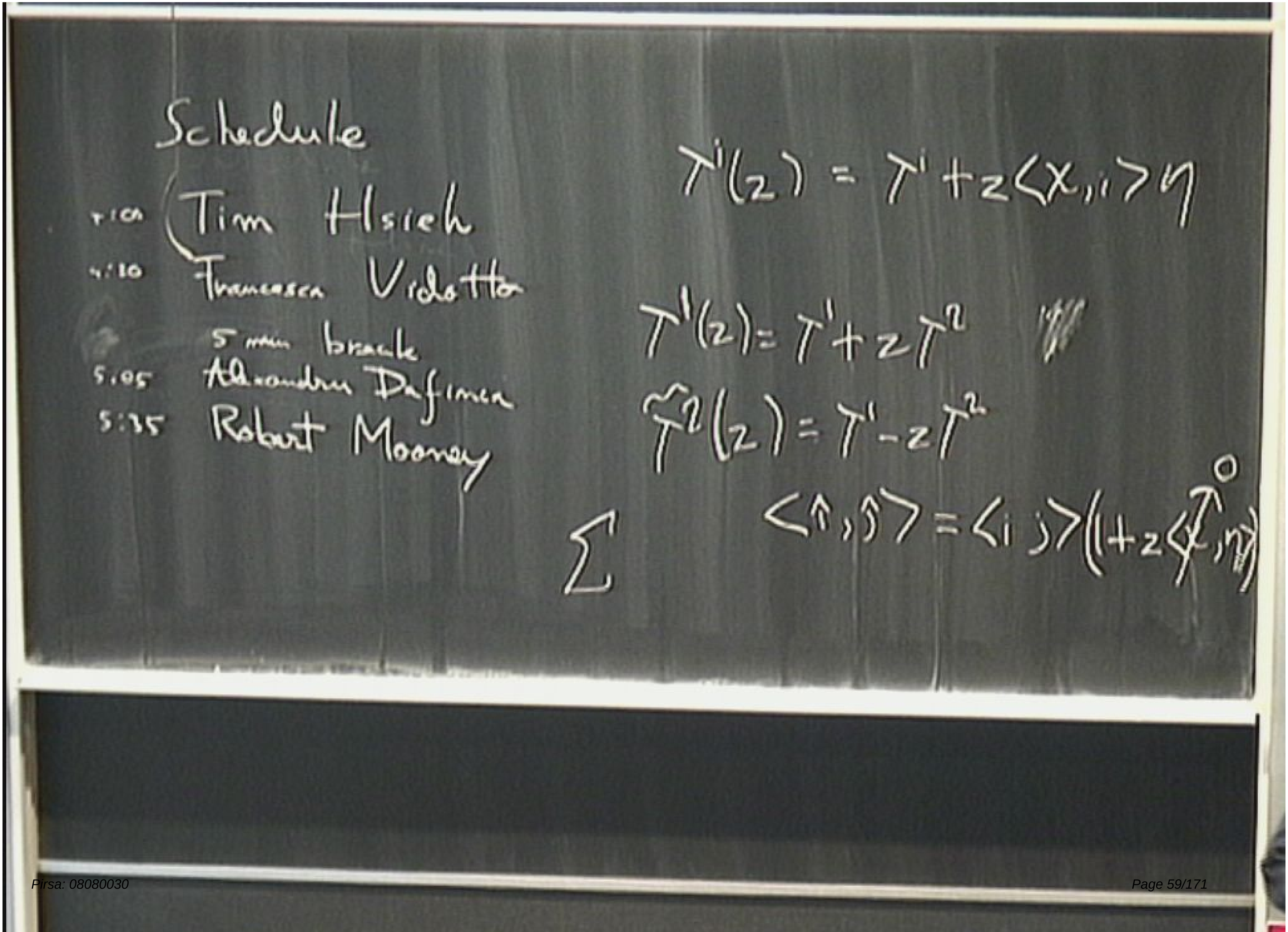
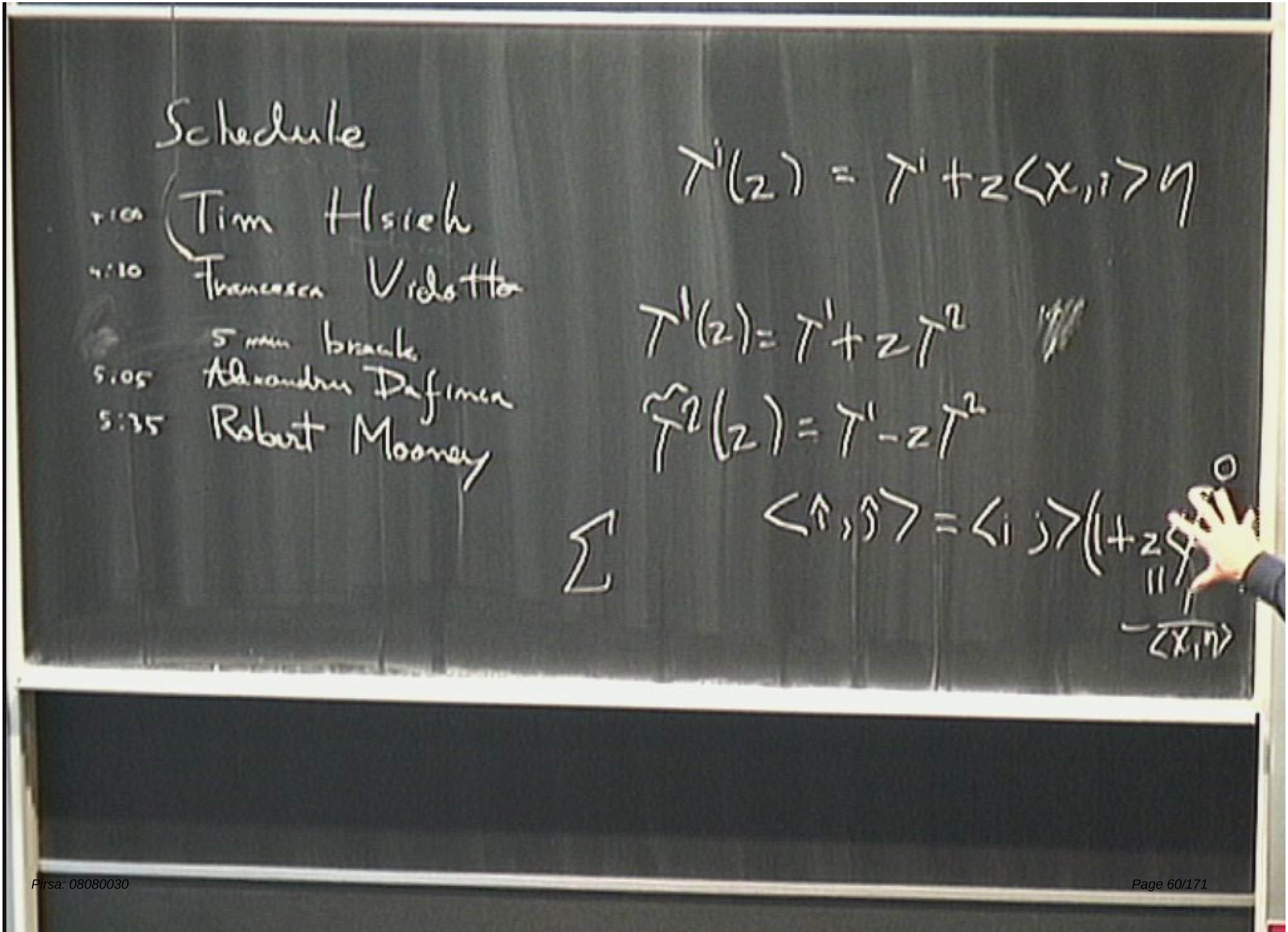

Schedule
4:00 Tim Hsieh
4:10 Francesca Vidotto
5 min break
5:05 Alexandru Dafinca
5:35 Robert Mooney
T'(z) = T' + z<X, i> η
T'(z) = T' + zT²
T²(z) = T' - zT²
<î, ĵ> = <i j>(1 + z



Schedule
?:00 Tim Hsieh
4:10 Francesca Vidotto
5 min break
5:05 Alexandru Dafinca
5:35 Robert Mooney
$\gamma^1(z) = \gamma^1 + z\langle ?, i\rangle \eta$
$\gamma^1(z) = \gamma^1 + z\gamma^2$
$\gamma^2(z) = \gamma^1 - z\gamma^2$
$\langle \hat{i}, \hat{j}\rangle = \langle i\, j\rangle(1 + z\langle \mathring{\gamma}, \eta\rangle)$


Schedule
4:00 Tim Hsieh
4:10 Francesca Vidotto
5 min break
5:05 Alexandru Dafimca
5:35 Robert Mooney
$T^1(z) = T^1 + z\langle X, i\rangle \eta$
$T^1(z) = T^1 + zT^2$
$\tilde{T}^2(z) = T^1 - zT^2$
$\langle \hat{i}, \hat{j}\rangle = \langle i\, j\rangle(1 + z$
$\langle X, \eta\rangle$
Σ

Schedule

4:00 Tim Hsieh

4:10 Francesca Vidotto

5 min break

5:05 Alexandru Dafinca

5:35 Robert Mooney

$$\lambda^i(z) = \lambda^i + z\langle X, i\rangle \eta$$

$$\lambda^1(z) = \lambda^1 + z\lambda^2$$

$$\tilde{\lambda}^2(z) = \lambda^1 - z\lambda^2$$

$$\sum$$

$$\langle \hat{i}, \hat{j}\rangle = \langle i\, j\rangle\left(1 + z\langle \lambda^0, \eta\rangle\right), \quad \langle \lambda^0, \eta\rangle = -\langle X, \eta\rangle$$

Loop Quantum Cosmology

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supervisor: Parampreet Singh

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Perimeter Institute, Summer Student Research Project 2008

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Plan of the talk

Loop Quantum Cosmology

Isotropic Flat Model

The Friendmann-Raichauduri equation

Isotropic Curved Models
- to conclude...

Introduction
- Motivations
- Loop Quantum Gravity

Loop Quantum Cosmology

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LQC: Homogeneous and Isotropic setting

Spatial homogeneity and isotropy: fix a fiducial triad ${}^{o}e^{a}_{i}$ and co-triad ${}^{o}\omega^{i}_{a}$.

Symmetries $\Rightarrow A^{i}_{a} = cV_{0}^{-\frac{1}{3}}\,{}^{o}\omega^{i}_{a}\,,\; E^{a}_{i} = pV_{o} - \frac{2}{3}(\det{}^{o}\omega)\,{}^{o}e^{a}_{i}$
where c and p satisfy $\{c, p\} = \frac{8}{3}\pi G\gamma$.

Elementary variables:
Holonomies: $h_{k}(\mu) = \cos(\mu\frac{c}{2})\mathbb{I} + 2sin(\mu\frac{c}{2})\tau_{k}\,,\; \mu \in (-\infty, \infty)$.
Elements of form $\exp(i\mu\frac{c}{2})$ generate algebra of almost periodic functions.
Hilbert space: $\mathcal{H}_{kin} = L^{2}(\mathbb{R}, d\mu)$
Orthonormal basis: $N(\mu) = \exp(i\mu\frac{c}{2})$; $\langle N|(\mu)|N(\mu')| =\rangle \delta_{?,?'}$

Hamiltonian Constraint $C_{\rm grav} = \int_{\mathcal{V}} \mathrm{d}^{3}x\, \epsilon^{ijk}\, F^{i}_{ab}\, \frac{E^{aj}E^{bk}}{\sqrt{\det E}}$
Procedure:

- Express $C_{\rm grav}$ in terms of elementary variables and their Poisson brackets
- Classical identity of the phase space:

$$\epsilon^{ijk}\,\frac{E^{aj}E^{bk}}{\sqrt{\det E}} \longrightarrow Tr(h^{k}(\mu)\{h^{k}(\mu)^{-1}, V\})$$

- Express field strength in terms of holonomies

Flat Theory

FRW with $k = 0$ is instructive because every classical solution is singular and provides a foundation for more complicated models.
Consider the conjugate variables (c, p) related to scale factor such that:
$p = a^2$ (with two possible orientations for the triad)
$c = \gamma \dot{a}$ (on the space of solutions of GR). where volume and laps are normalized to 1.
The fundamental Poisson bracket is given by:

$$\{c, p\} = \frac{8}{3}\pi G\gamma \quad (1)$$

where γ is the Barbero-Immirzi parameter. It's defined a *minial area gap* so that $\bar{\mu}^2|p| = 2\sqrt{3}\pi G\hbar\gamma$. The effective Hamiltonian turns out to be

$$\mathcal{H}_{\text{eff}} = -\frac{3}{8\pi G\gamma^2}\frac{|p|^{\frac{1}{2}}}{\bar{\mu}^2}\sin^2(\bar{\mu}c) + \mathcal{H}_m \quad (2)$$

The classical equations

Classically we have the well known equations:

$$\text{Friendmann eq.} \quad H^2 = \left(\frac{\dot{a}}{a}\right)^2 = \frac{8}{3}\pi G\rho \tag{3}$$

which is derived from the 00 component of Einstein field equations;

$$\text{Conservation law} \quad \dot{\rho} + 3H(\rho + p) = 0 \tag{4}$$

$$\text{Raichauduri eq.} \quad \frac{\ddot{a}}{a} = \dot{H} + H^2 = -\frac{4}{3}\pi G(\rho + 3p) \tag{5}$$

which is derived from the trace of Einstein's field equations, and can be easily be computed putting together 3 and 4.

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- Express field strength in terms of holonomies

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FRW with $k = 0$ is instructive because every classical solution is singular and provides a foundation for more complicated models.
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$$\dot{p}\ \{p, H_{eff}\} = -\{q, p\}\frac{\partial H_{eff}}{\partial c}$$

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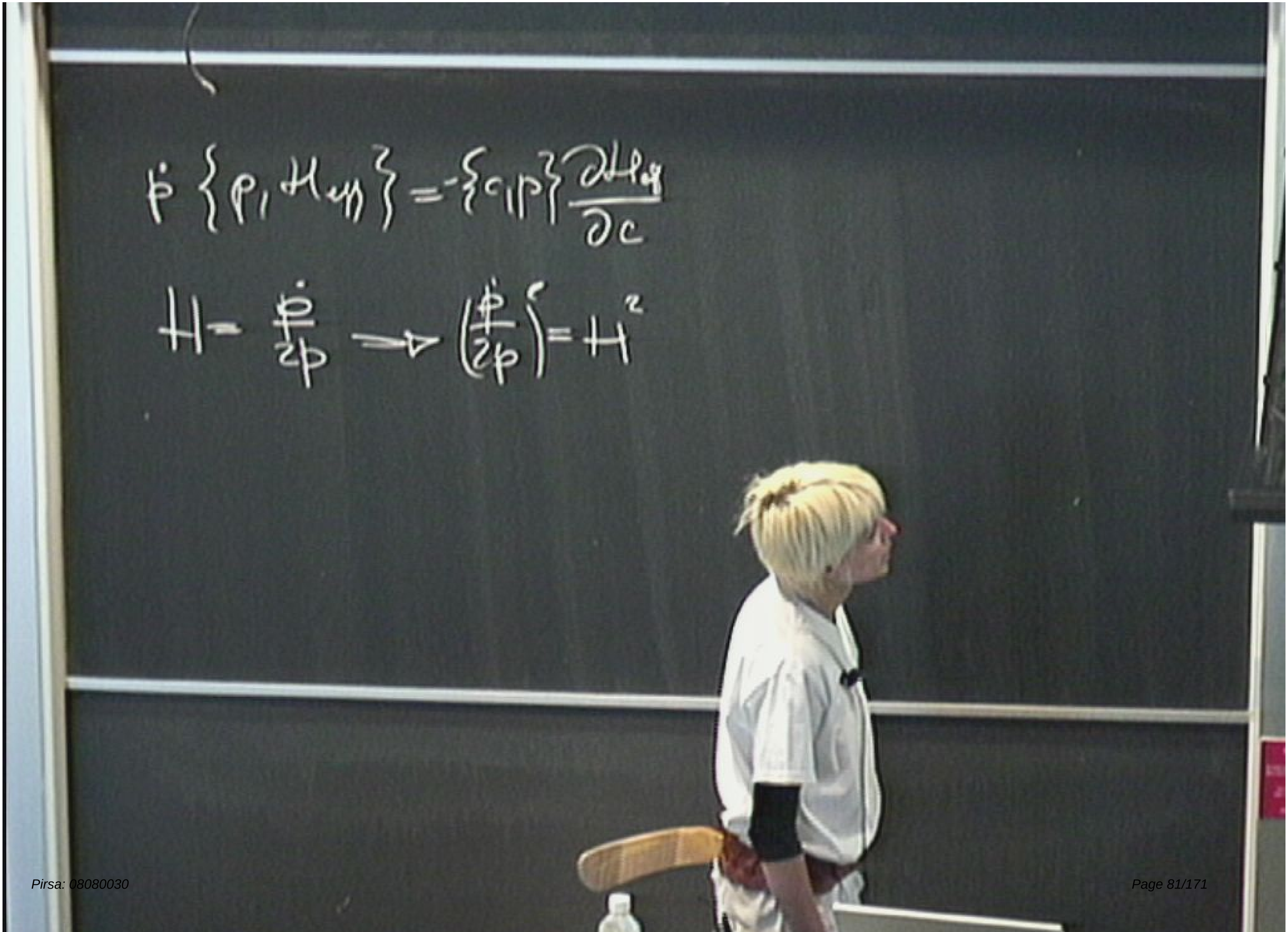
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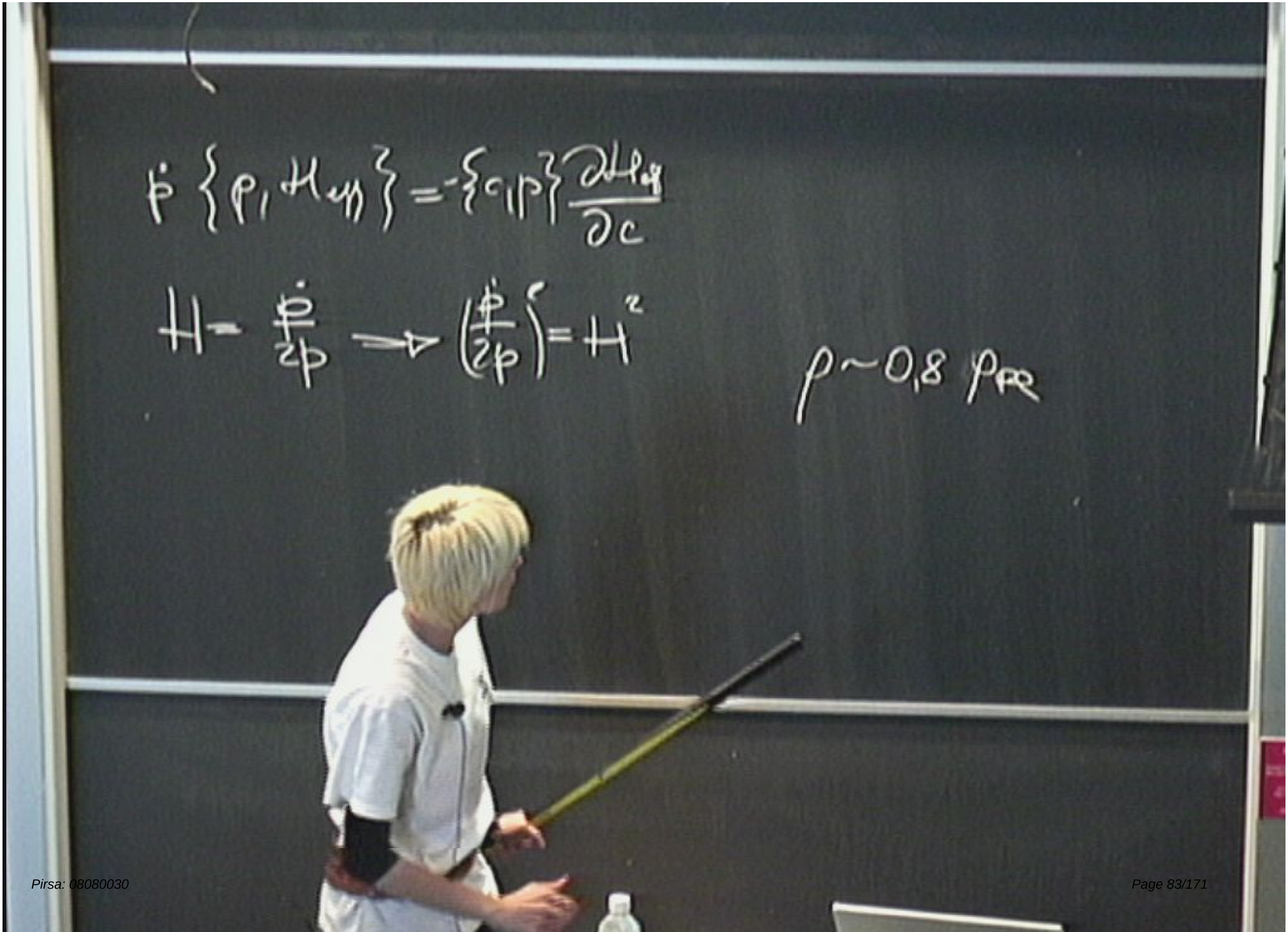

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Criteria for the physical viability

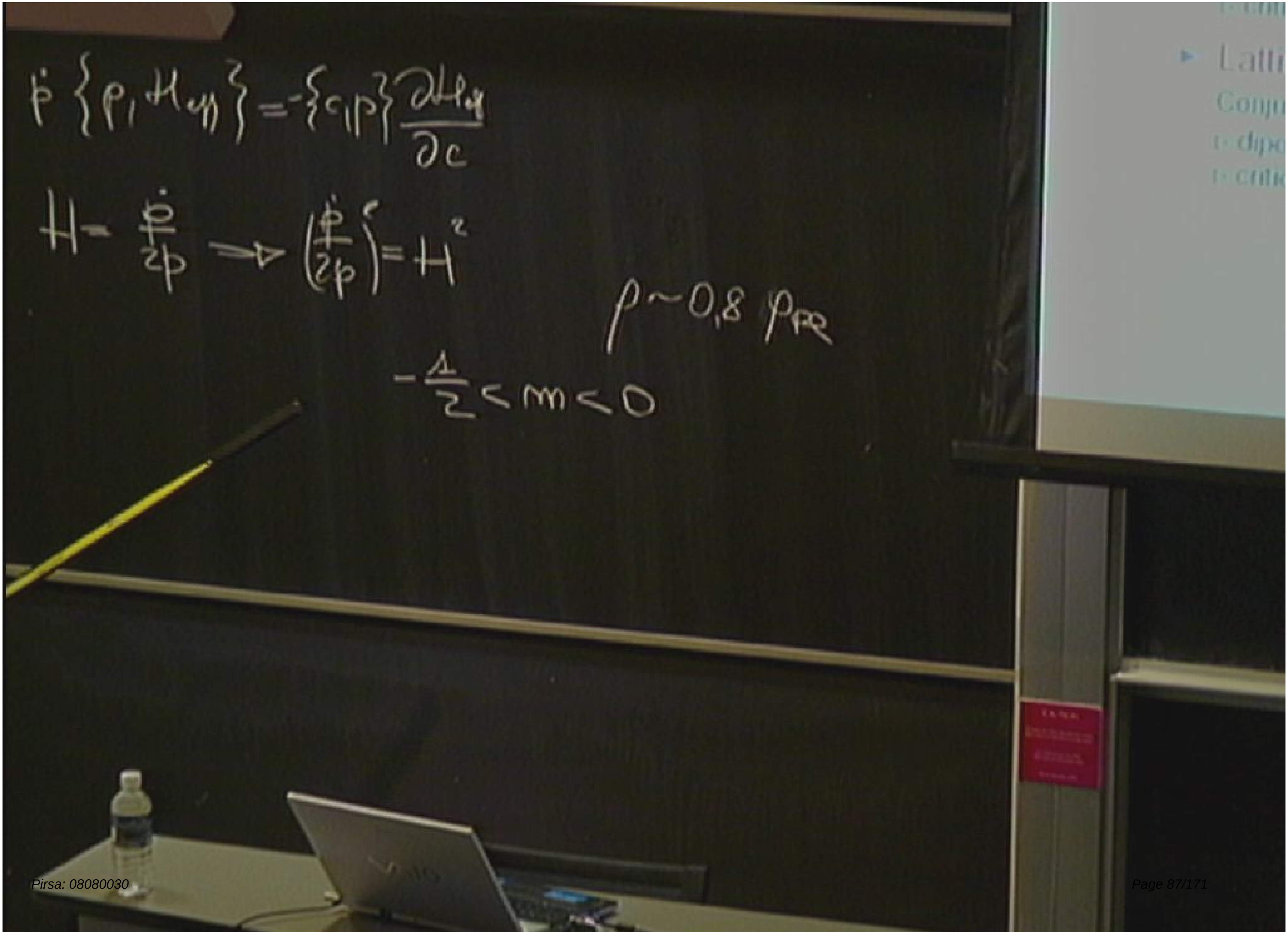
We shall ask that the resulting model be such:

1. That the predictions about physical entities, like the spacetime curvature and the energy density that do not depend on "auxiliary structures", should be independent in the quantum theory, of any choice related to such structures.
2. That the quantization prescription gives a well defined notion of "Planck scale", that is, the scale for which "quantum gravitational corrections" should become important;
3. That there exists a well defined classical limit that approximates general relativity when spacetime curvatures are small.

The "$\bar{\mu}-$quantization" satisfies all these requests.

Other Loop-Inspired Quantizations

- **Old Quantization**
  Δ is treated as a *constant* and plays the role of affine parameter.
  ▷ dependence on the fiducial cell
  ▷ critical density depends on P_ϕ and appearance of bounce at low density
- **Polymerized WDW Quantization**
  Wheleer-DeWitt model where the quantum constraint is written in terms of P_a.
  ▷ sensitive to change of fiducial structures
  ▷ critical density depends on P_ϕ and appearance of bounce at low density
- **Lattice Refinement**
  Conjugate variables: $P_g = cp^m$ and $g = \frac{p^{1-m}}{1-m}$ *with* -1 $\frac{}{2<m<0}$
  ▷ dipendence on change of variables
  ▷ critical density depends on P_ϕ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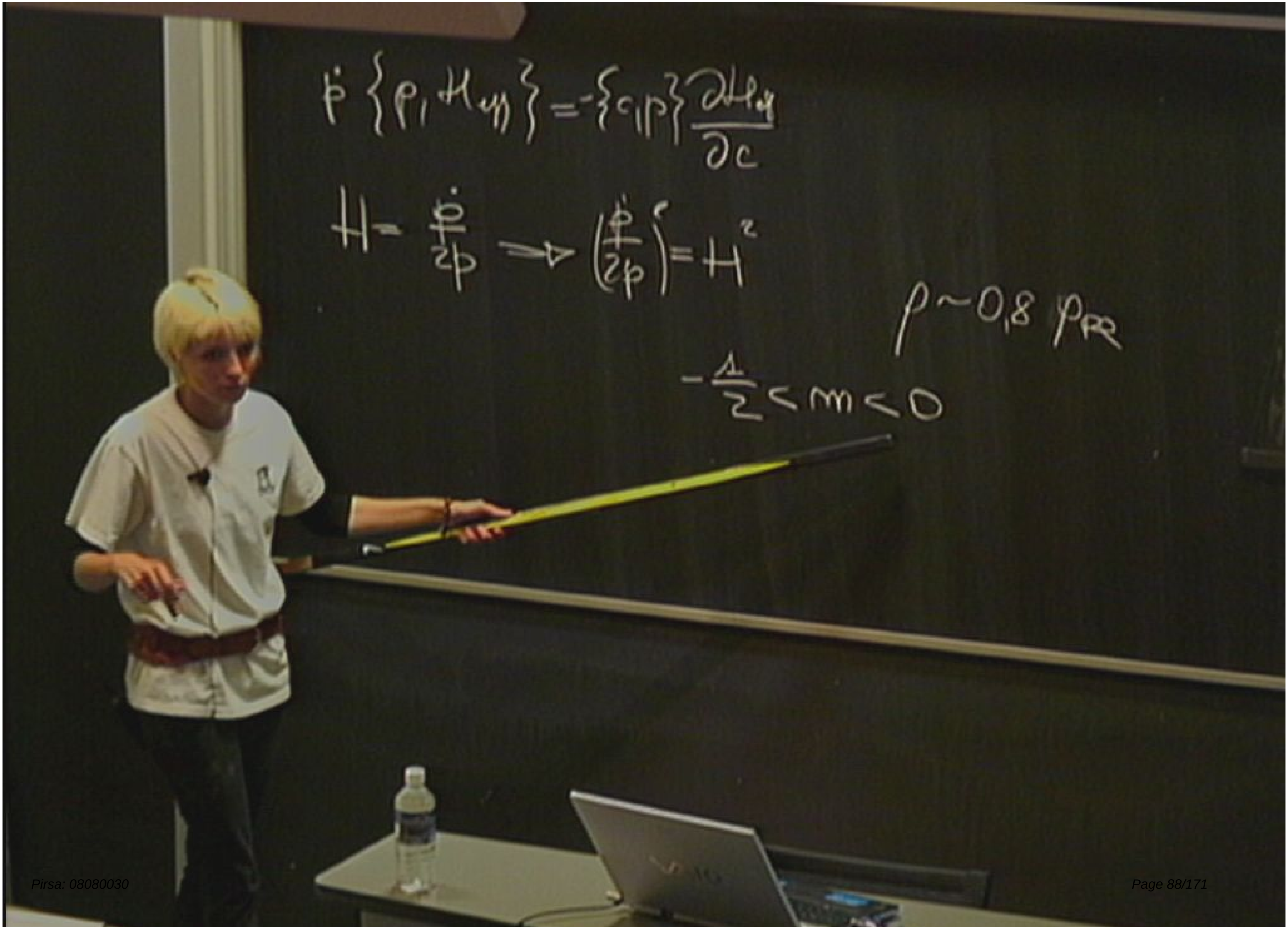
H = ṗ/2p ⟹ (ṗ/2p)² = H²
ρ ~ 0,8 ρ_PR
-1/2 < m < 0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All these quantization are ruled out by our criteria for physical viability. It has been shown in details for $k = 0$, but there is a lack of literature for $k \neq 0$. Note that when the spatial topology is compact there is no need to introduce an auxiliary structure such as a cell. Nonetheless there are more physically motivated conditions that need to be satisfied by any viable physical theory. In particular, apart from a well defined Planck scale, a “low curvature limit ” should also exist. These conditions turn out to be sufficient to rule out some quantizations.

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$k \neq 0$ models

$$|p| = a^2 \qquad\qquad c = \gamma \dot{a} - k$$

where the variable c is changed respect to the case $k = 0$. The fundamental Poisson bracket is still:

$$\{c, p\} = \frac{8\pi G\gamma}{3} \tag{8}$$

$$\mathcal{H}^k_{\text{eff}} = -\frac{3}{8\pi G\gamma^2}\frac{\sqrt{p}}{\bar{\mu}^2}\left[\sin^2(\bar{\mu}(c-k)) - kM\right] + \mathcal{H}_m\,. \tag{9}$$

where $\Delta = \bar{\mu}^2|p|$ and $M := \left[\sin^2(\bar{\mu}) - \bar{\mu}^2(1+\gamma^2)\right]$
We call $\bar{\mu}\sqrt{p} = \lambda$, that is the square root of the minimal area gap.
The modified Friedmann equation can be obtained from the vanishing of the Hamiltonian constraint (**??**):

$$\sin^2(\bar{\mu}(c-k)) = \frac{8}{3}\pi G\gamma^2\Delta\rho + kM = \frac{\rho}{\rho_{\text{crit}}} + kM \tag{10}$$

and using the equations of motion.

$$\dot{p} = \{p, \mathcal{H}^k_{\text{eff}}\} = \frac{2}{\gamma\mu}\sqrt{p}\,\sin(\bar{\mu}(c-k))\cos(\bar{\mu}(c-k)) \Rightarrow H = \frac{\dot{p}}{2p} \tag{11}$$

$k \neq 0$ for generalized matter

$$H^2 = \left(\frac{8}{3}\pi G\rho + \frac{kM}{\gamma^2\Delta}\right)\left(1 - \frac{\rho}{\rho_{\rm crit}} - kM\right) \quad (12)$$

$\rho = -M\rho_{\rm crit}$	$a = a_{max}$	$\rho = \rho_{min}$	recollapse
$\rho = (1-M)\rho_{\rm crit}$	$a = a_{min}$	$\rho = \rho_{max}$	bounce

Recollapse: Agreement with the classical Friedmann formula to one part in 10^5. For macroscopic universes, LQC prediction on recollapse indistinguishable from the classical Friedmann formula. Bounces: ρ_{max} equals $\rho_{\rm crit}$ to within 2%. For large universes, the two are indistinguishable.

$$\frac{\ddot{a}}{a} = \;\; = \;\; -\frac{4}{3}\pi G\rho\left[1 - 4\left(\frac{\rho}{\rho_{\rm crit}} + kM\right)\right] - 4\pi G P\left[1 - 2\left(\frac{\rho}{\rho_{\rm crit}} + kM\right)\right]$$
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$k \neq 0$ for different quantizations

$$\Delta = \bar{\mu}^2 p \quad \rightarrow \quad \Delta = \bar{\mu}^2 p^{2n} \qquad n \in \tfrac{1}{2}\mathbb{N}$$

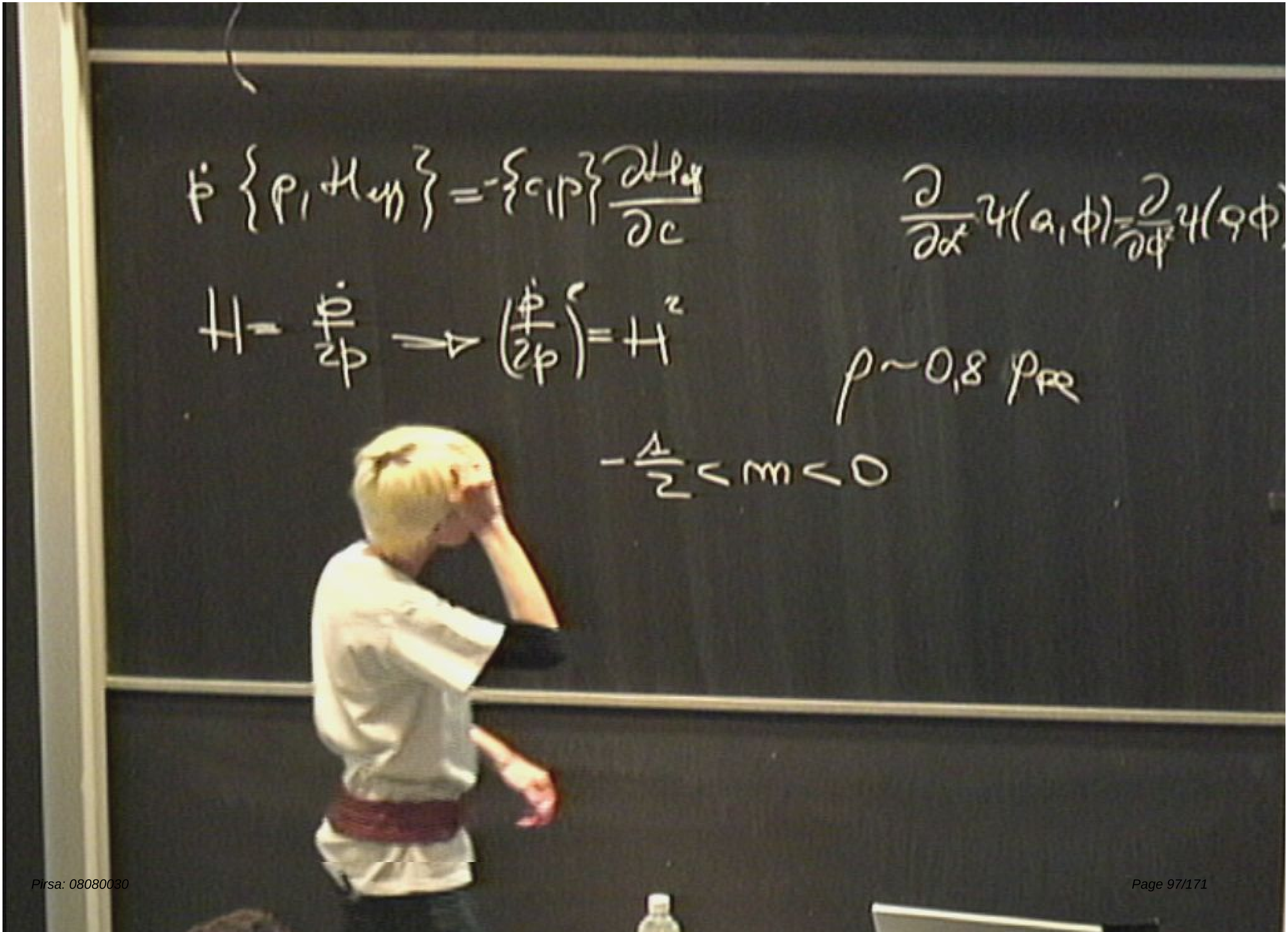
$$H^2 = \left(\frac{8}{3}\pi G\rho\, p^{1-2n} + \frac{kM_n}{\gamma^2\Delta}\right)\left(1 - \frac{\rho}{\rho_{\rm crit}}p^{1-2n} - kM_n\right) \tag{14}$$

$$\frac{\ddot{a}}{a} = -\frac{4}{3}\pi G\,\rho\, p^{1-2n}\left[1 - 4\left(\frac{\rho}{\rho_{\rm crit}}p^{1-2n} + kM_n\right)\right] - 4\pi G\, P\, p^{1-2n}\left[1 - 2\left(\frac{\rho}{\rho_{\rm crit}}p^{1-2n} + kM_n\right)\right]$$
$$+ 2n\frac{k\tilde{M}_n}{\gamma^2\Delta}\left[1 - 2\left(\frac{\rho}{\rho_{\rm crit}}p^{1-2n} + kM_n\right)\right] + \frac{kM_n}{\gamma^2\Delta}\left[1 - \frac{\rho}{\rho_{\rm crit}}p^{1-2n} - kM_n\right] \tag{15}$$

$\tilde{M}_n$ comes from the derivative of M respect to p, so it differs now from $\tilde{M}$.

Summary

- We have studied in detail equations of LQC for the case of $k \neq 0$, going trough an explicit calculation of equations of motion.
- We have stated from the case of a massless scalar field and we have generalized our analysis for every kind of matter.
- We have consider quantizations other respect to $\bar{\mu}$ and we have ruled out them.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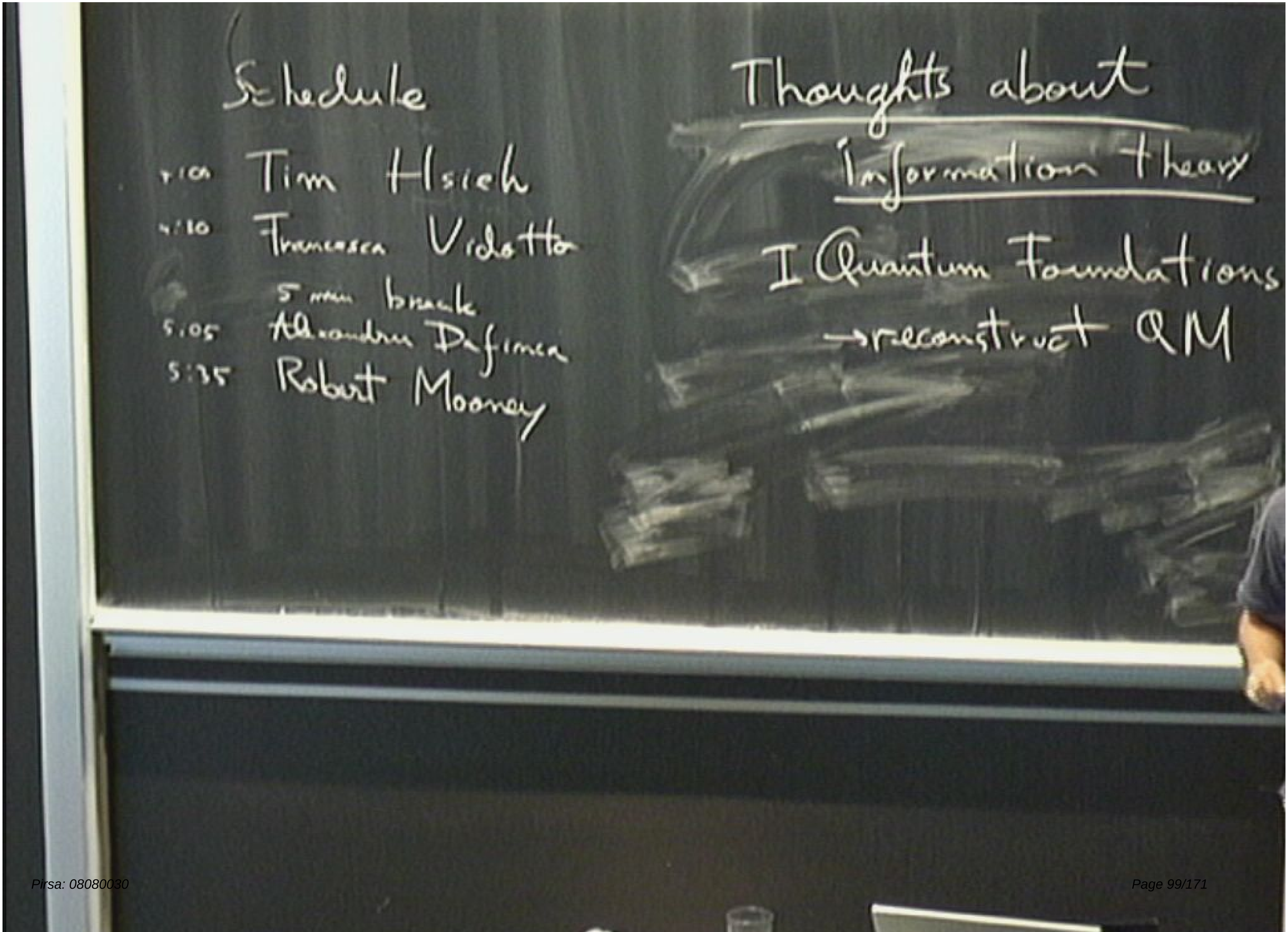
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5 min break
5:05 Alexandru Dafinca
5:35 Robert Mooney
Thoughts about Information theory
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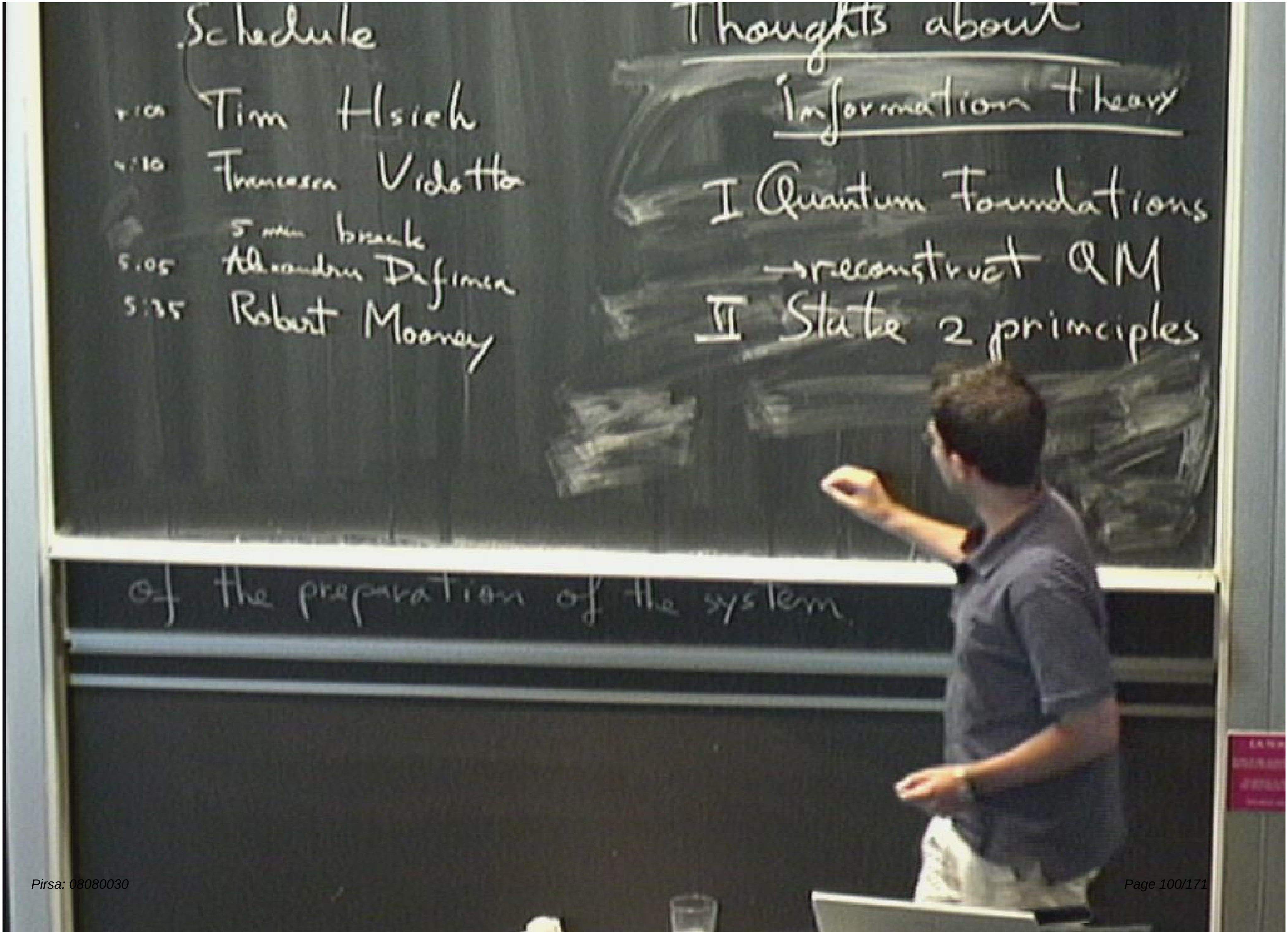
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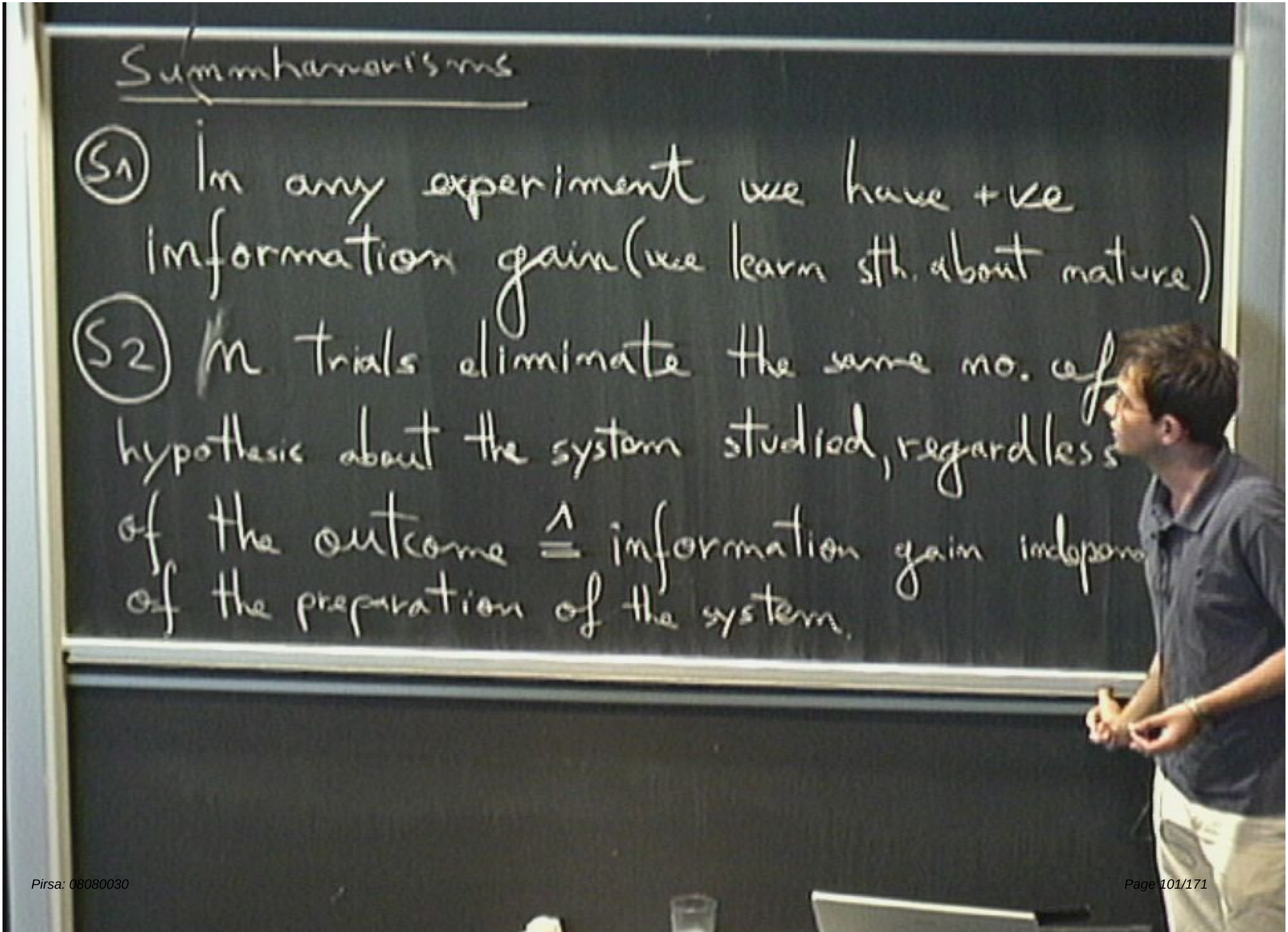
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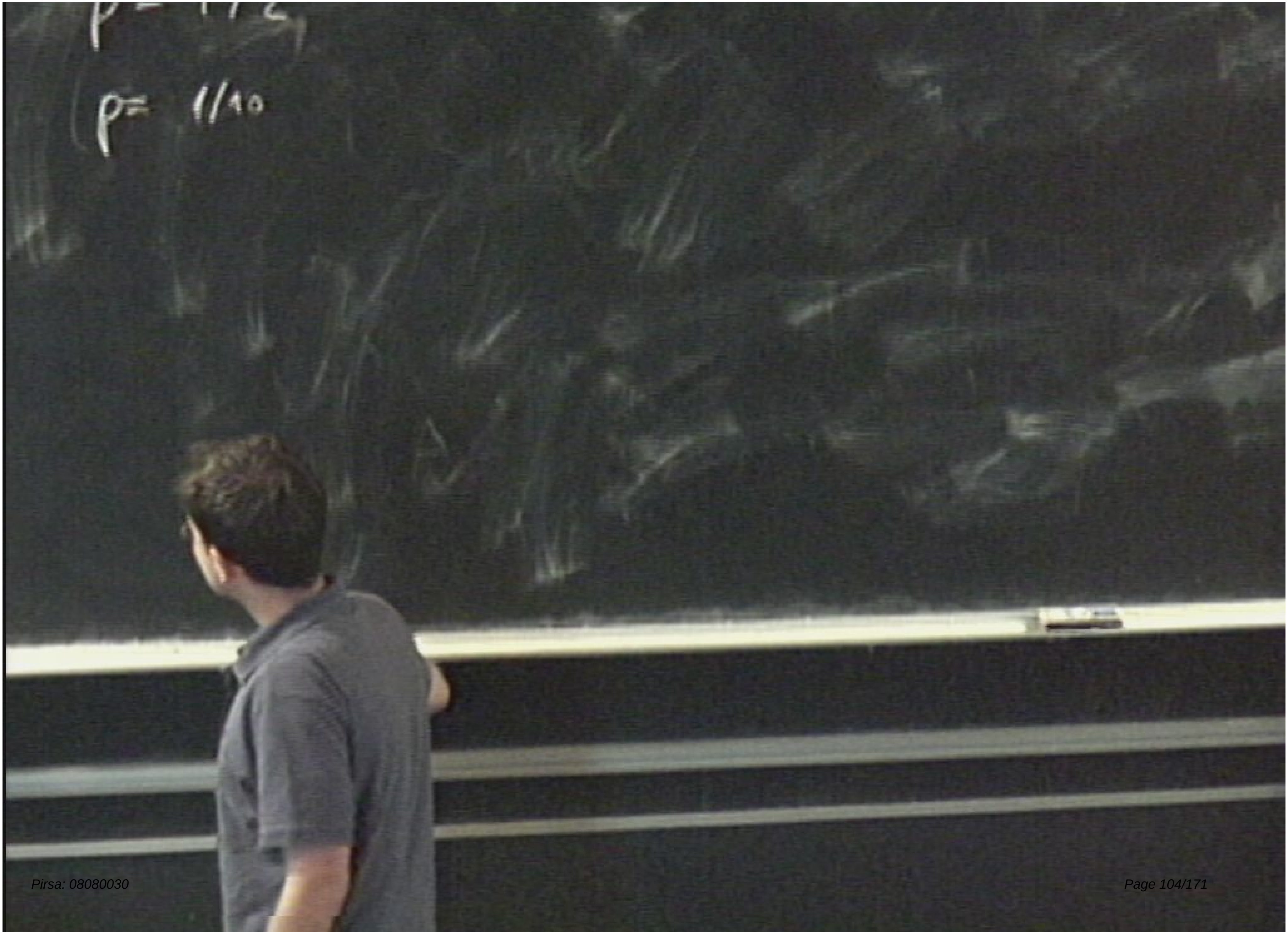
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p= 1/2
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pH= 1/2
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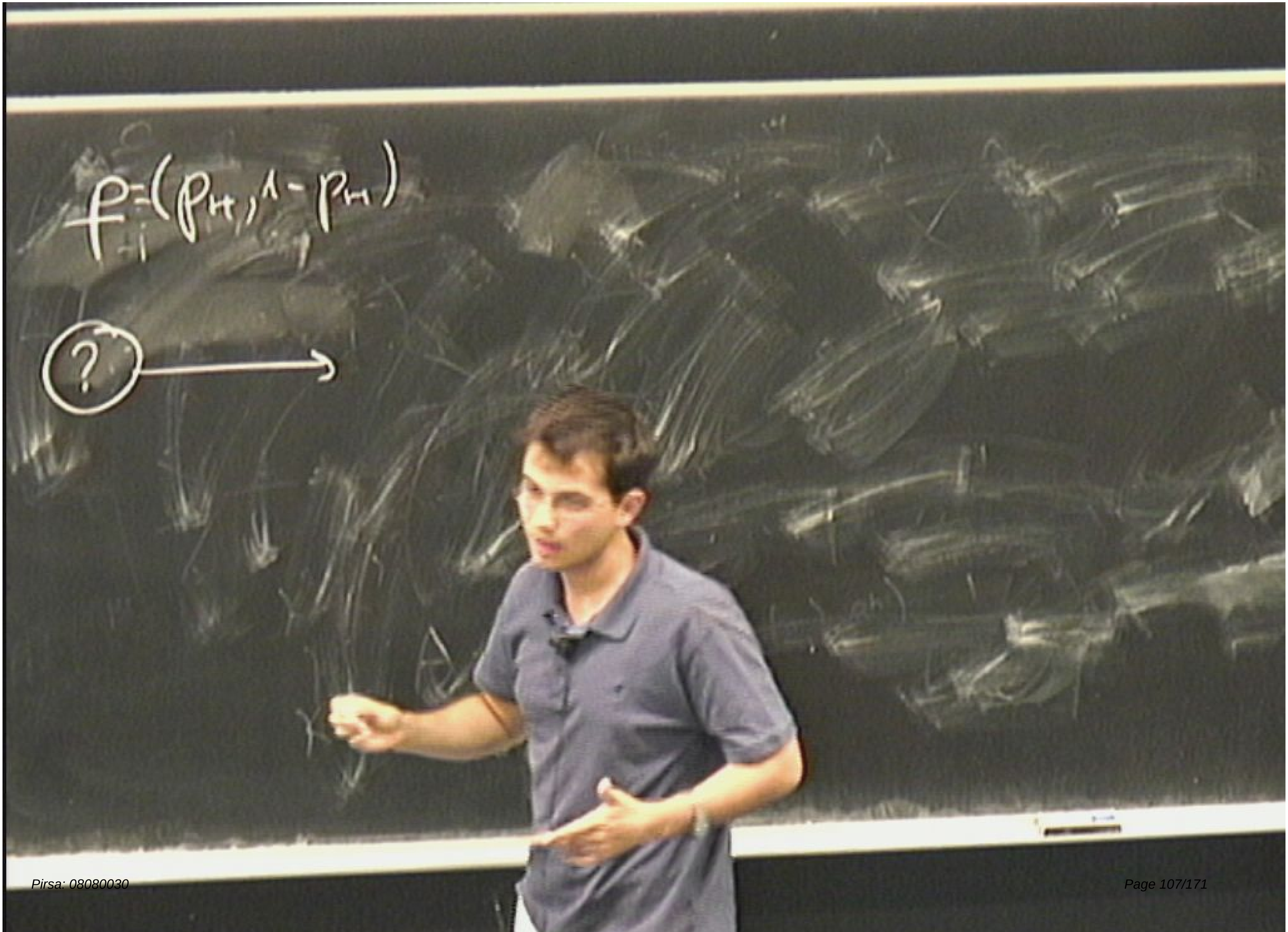
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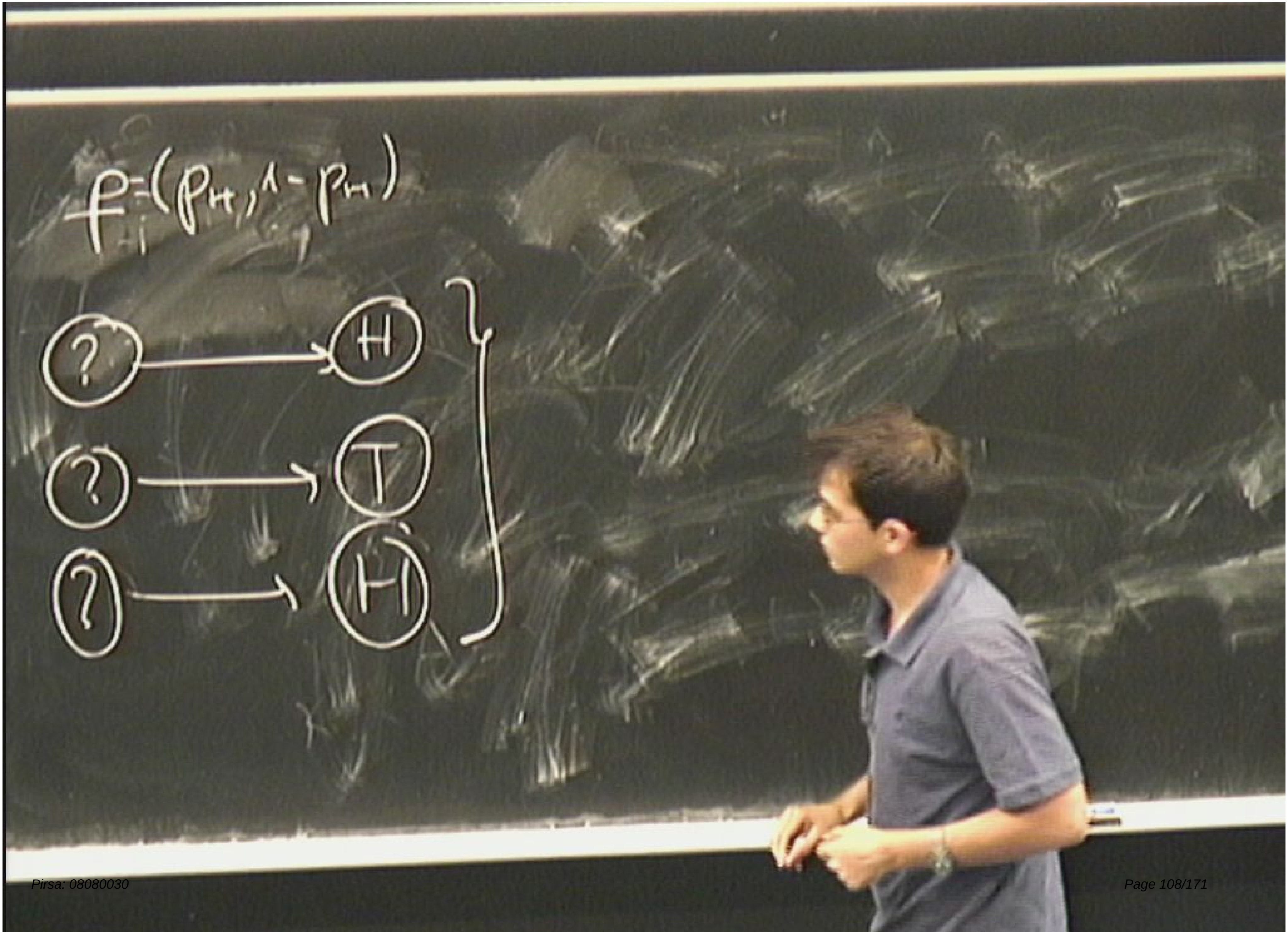
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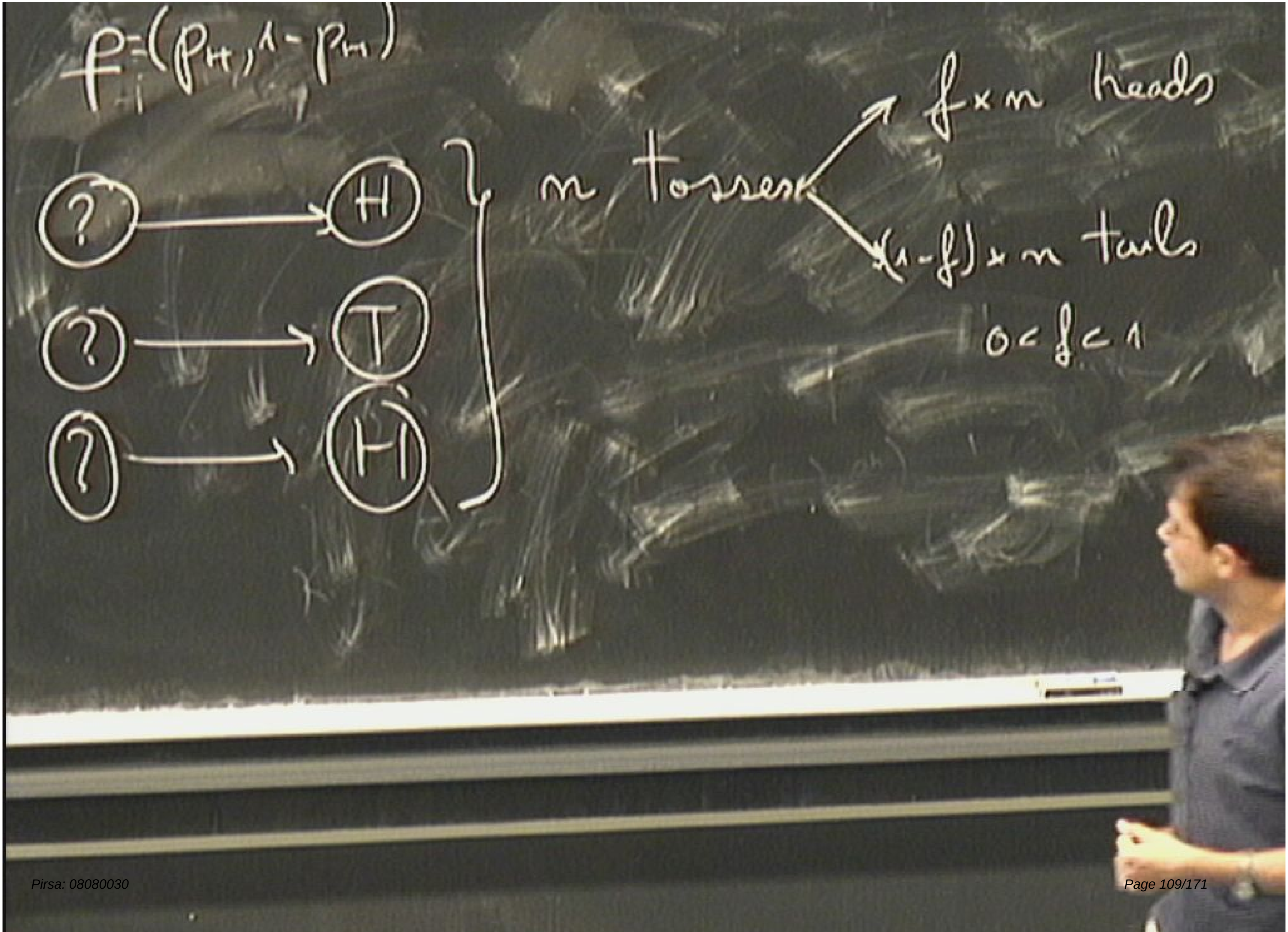
ρ = (p_H, 1 - p_H)
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H
T
H
n tosses
f × n heads
(1-f) × n tails
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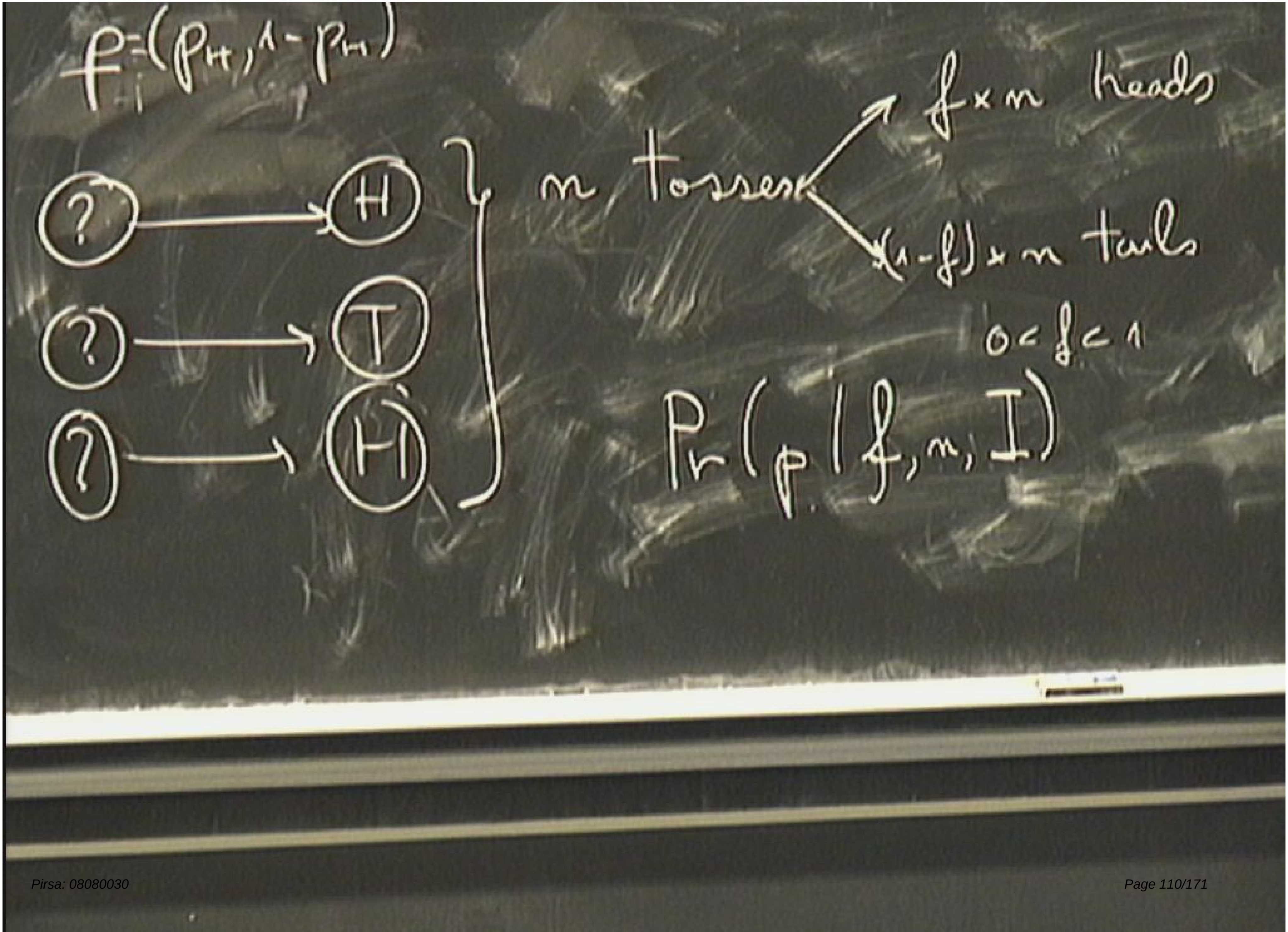
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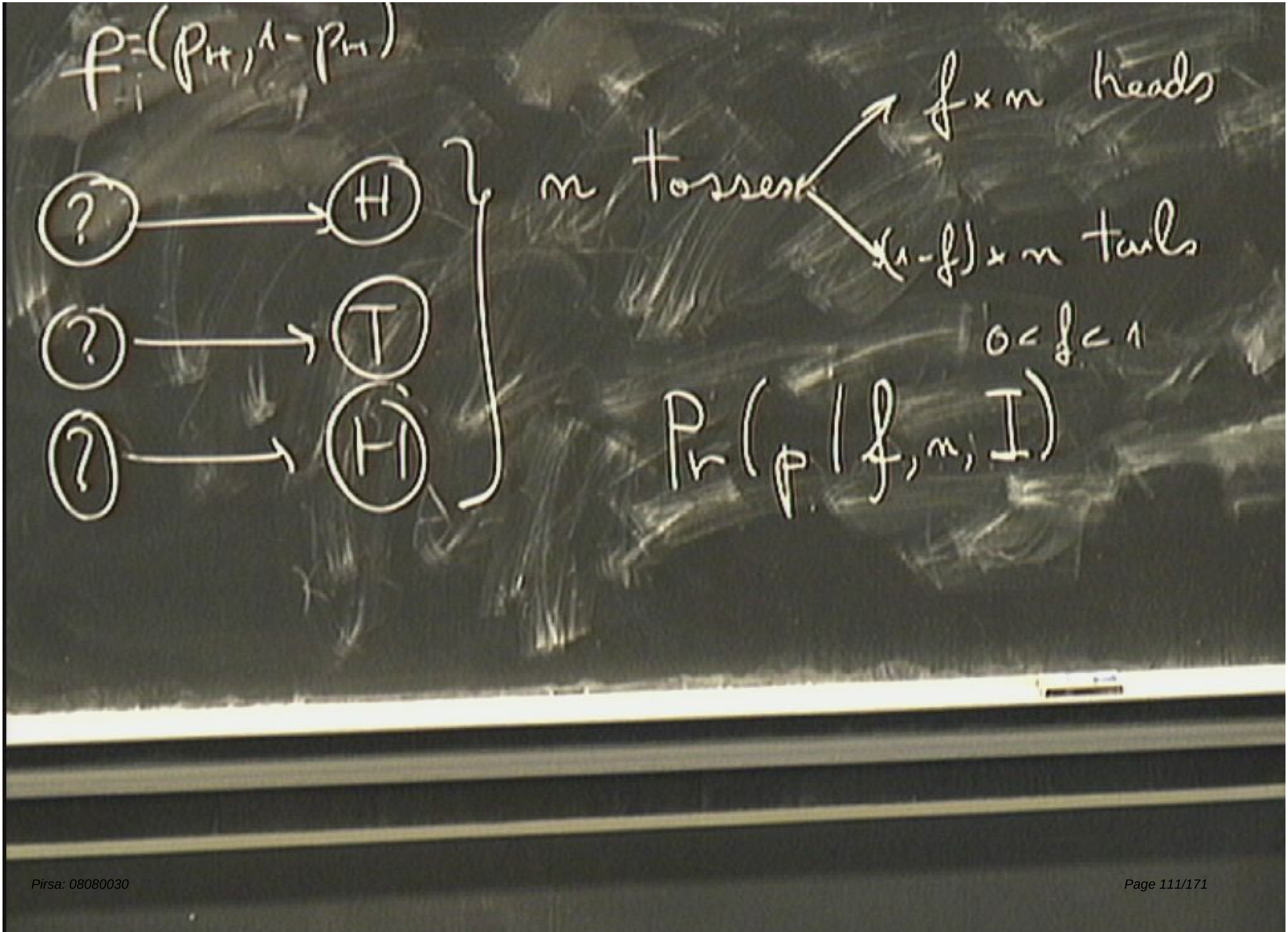
Pr(p | f, n, I)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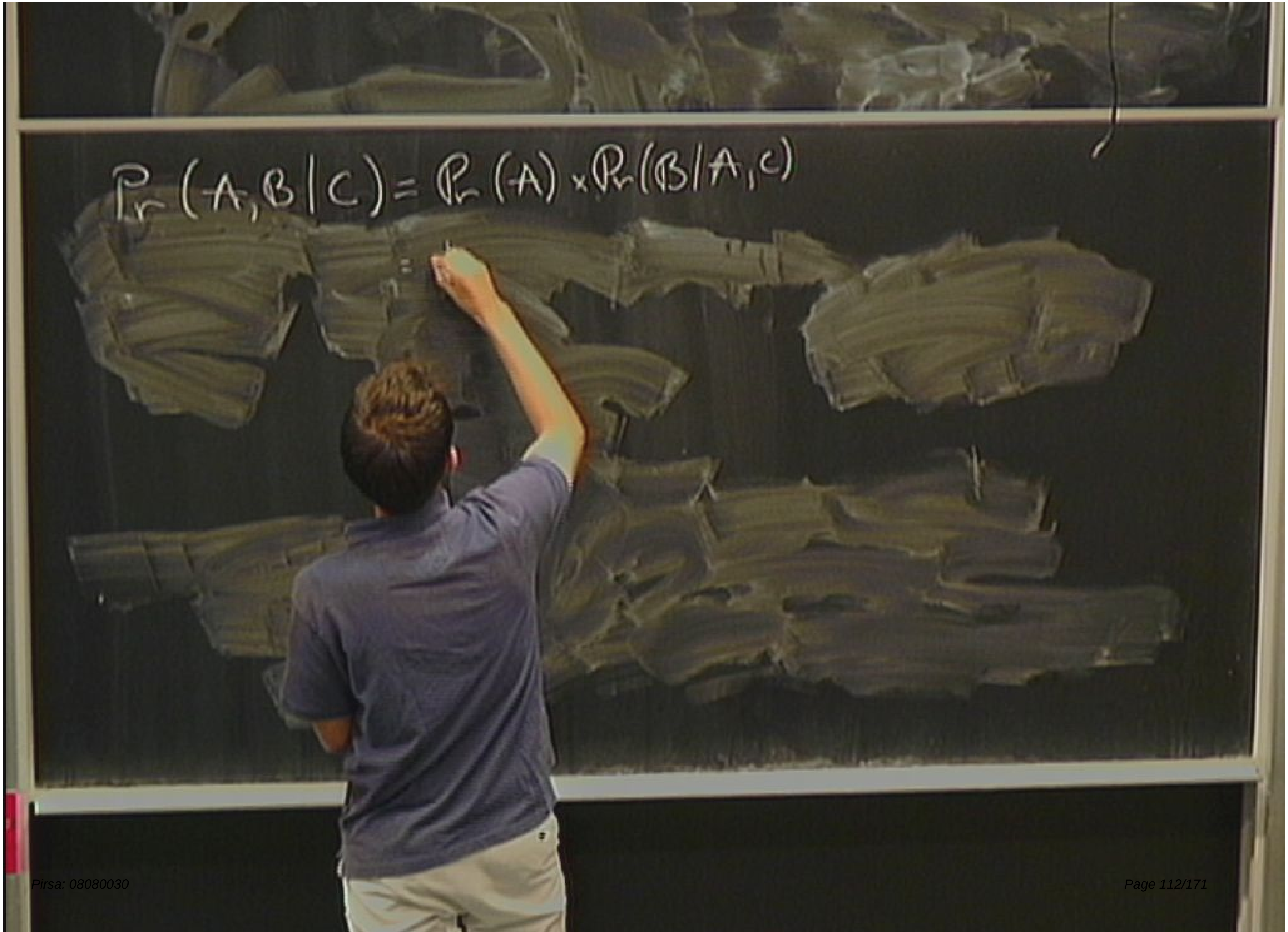
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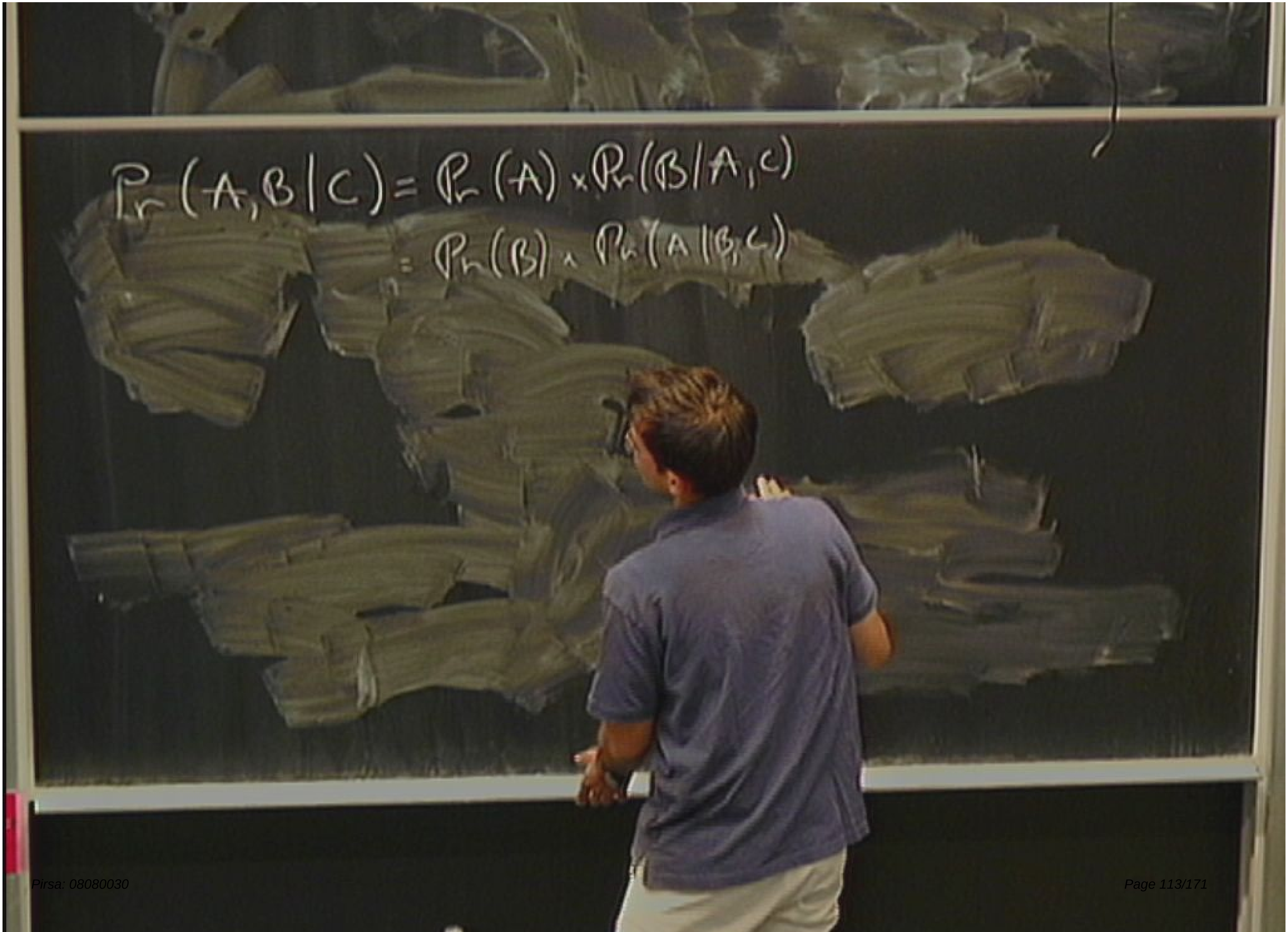
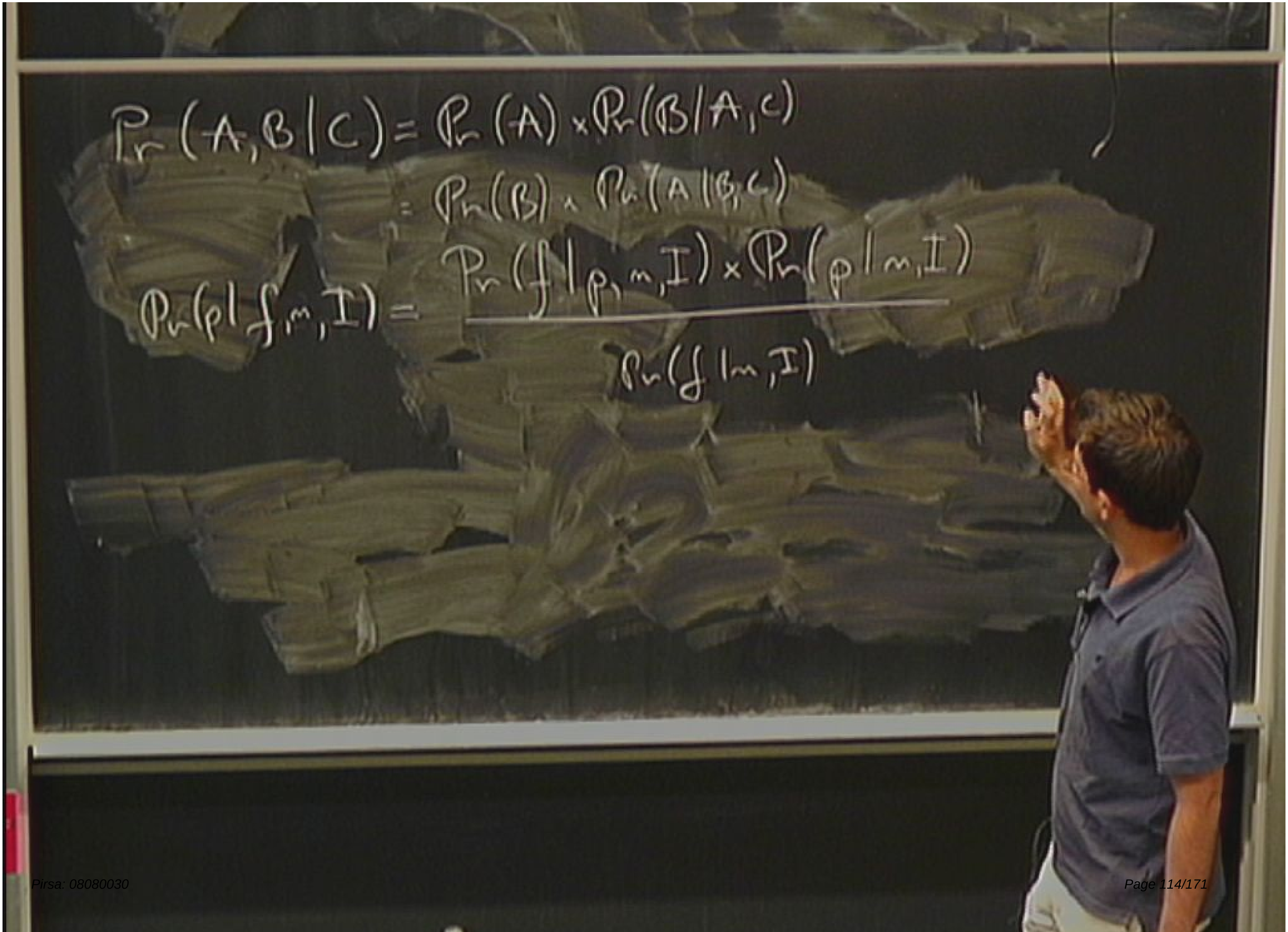
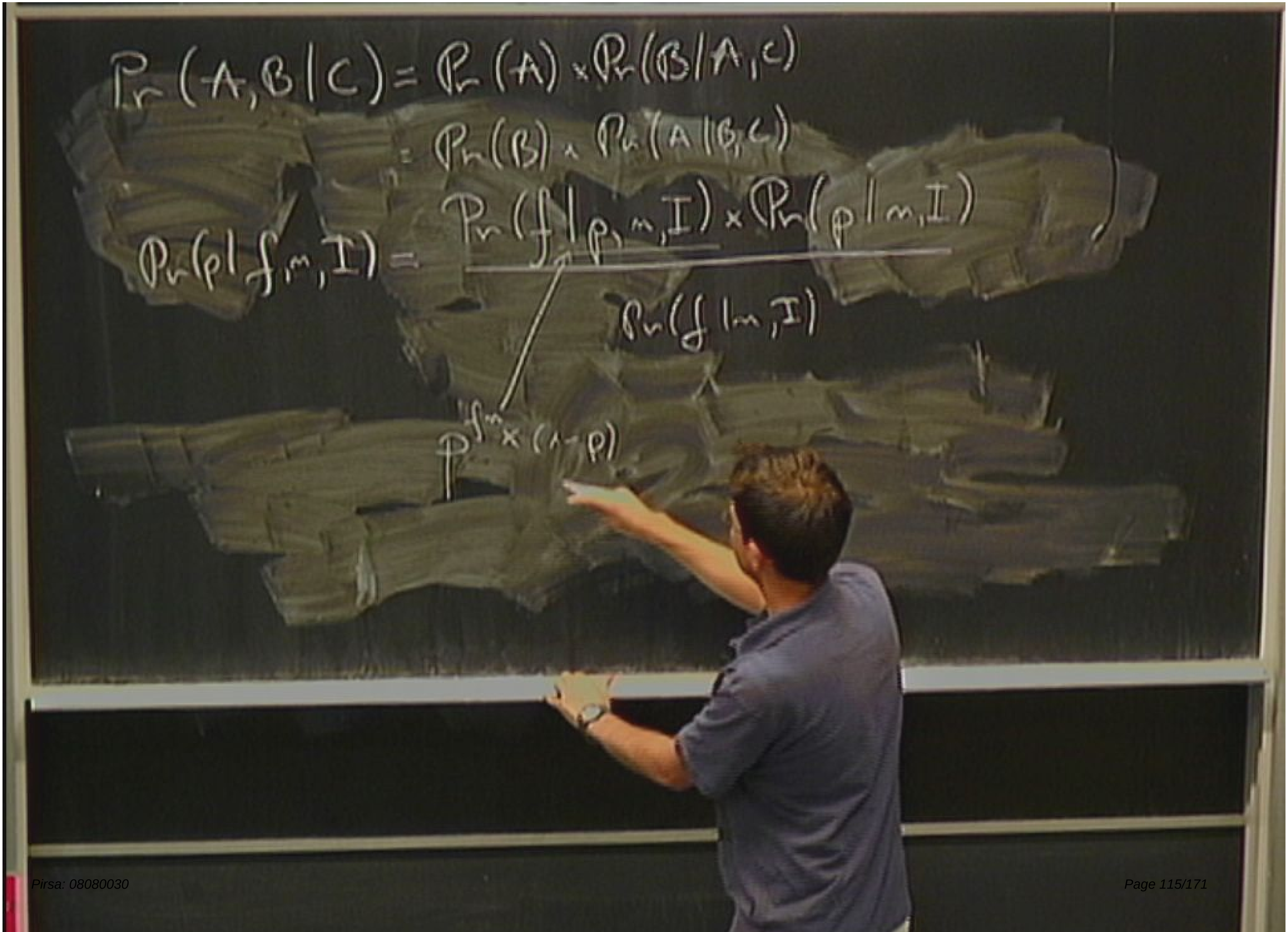
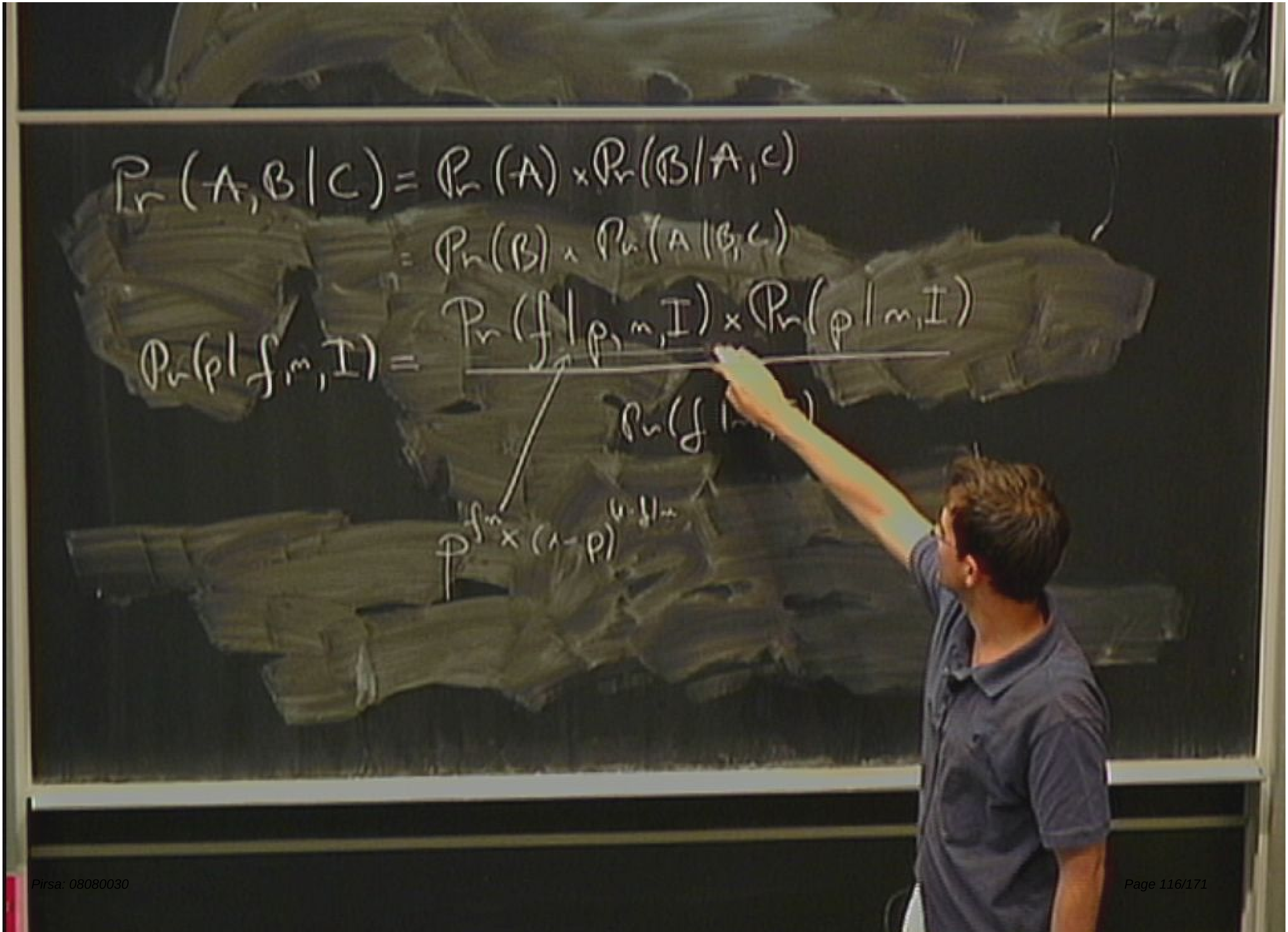
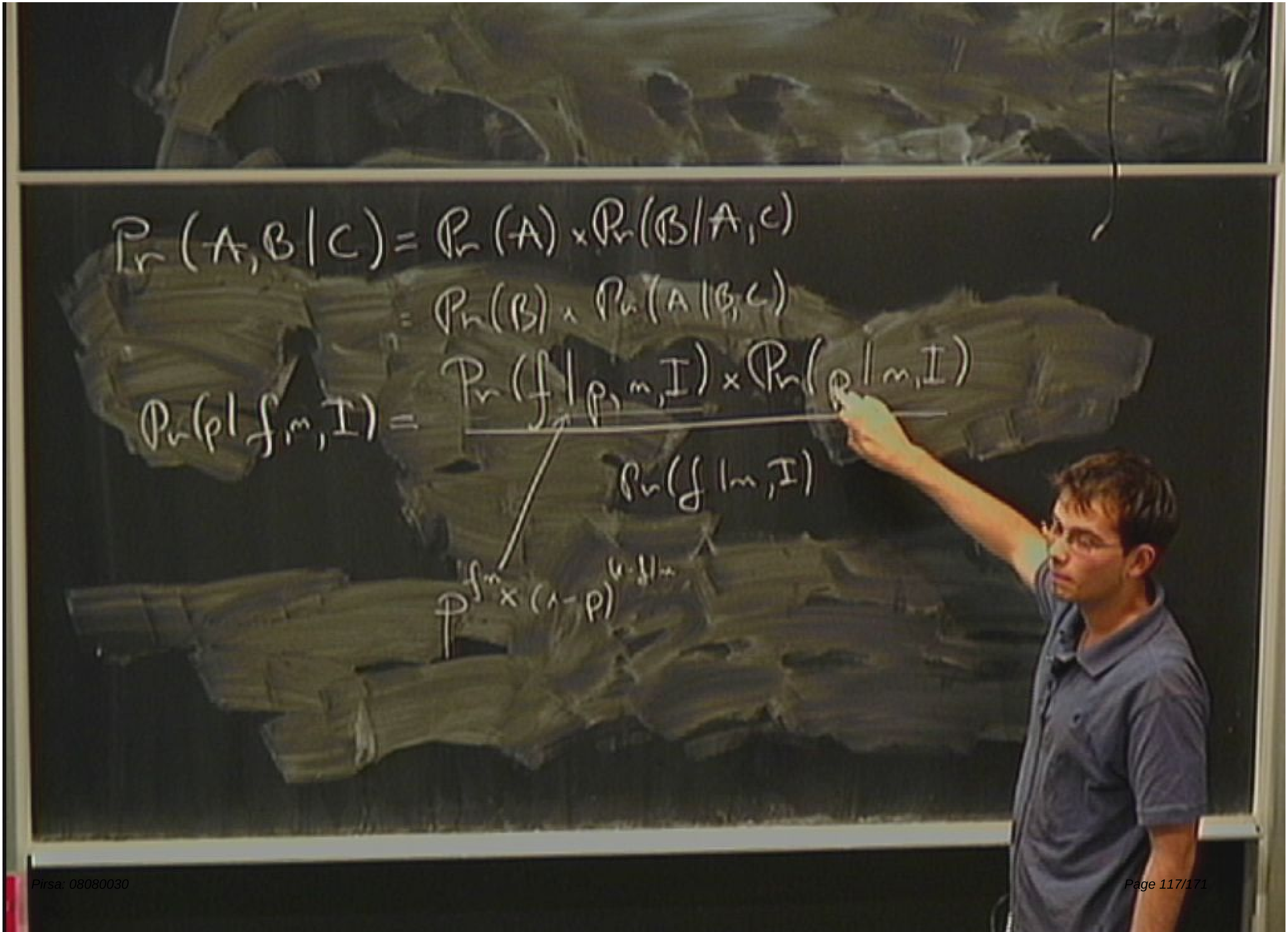

Pr(A,B|C) = Pr(A) x Pr(B|A,C)
= Pr(B) x Pr(A|B,C)

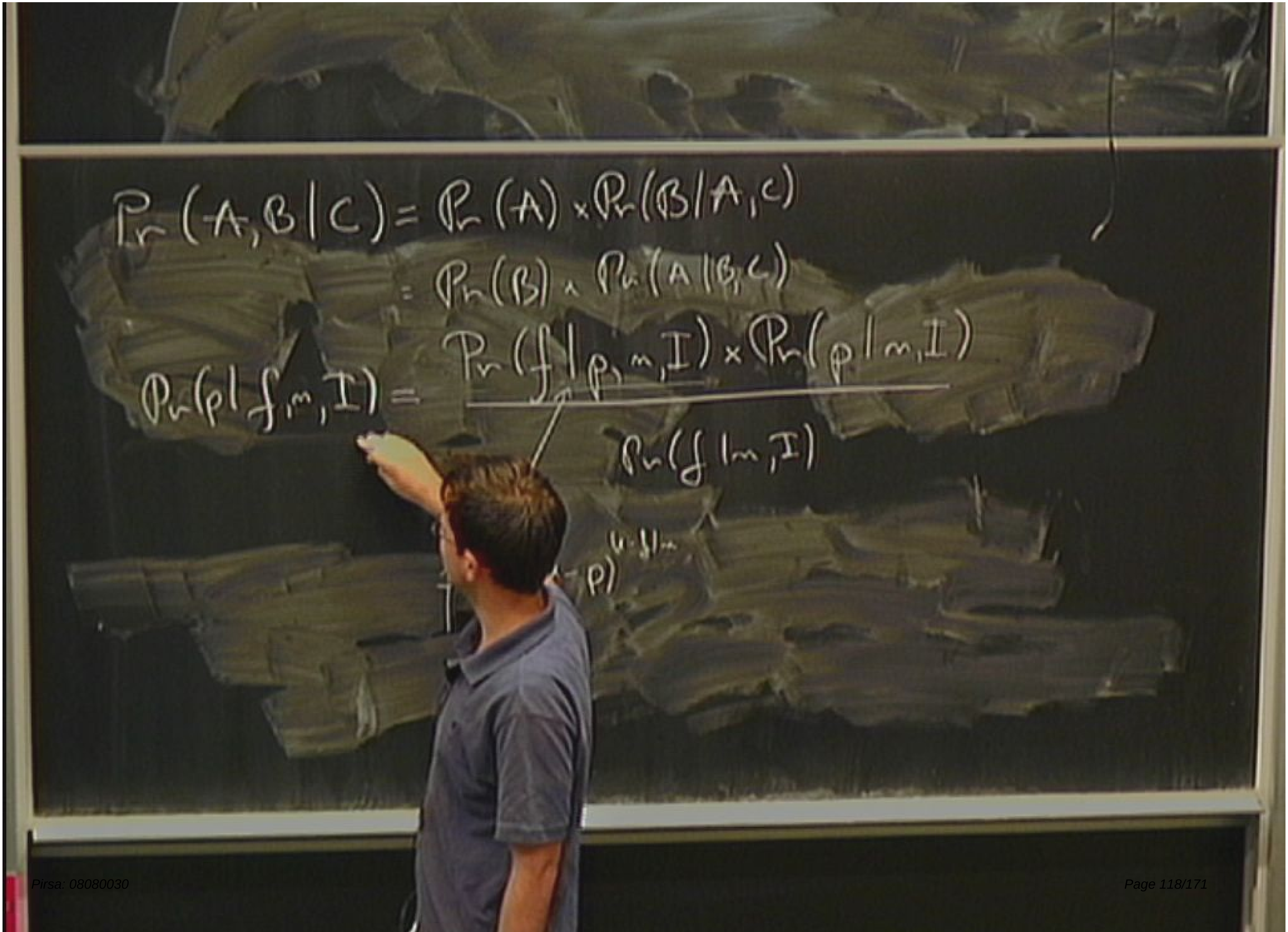

Pr(A,B|C) = Pr(A) × Pr(B|A,C)
= Pr(B) × Pr(A|B,C)
Pr(p|f,m,I) = Pr(f|p,m,I) × Pr(p|m,I) / Pr(f|m,I)

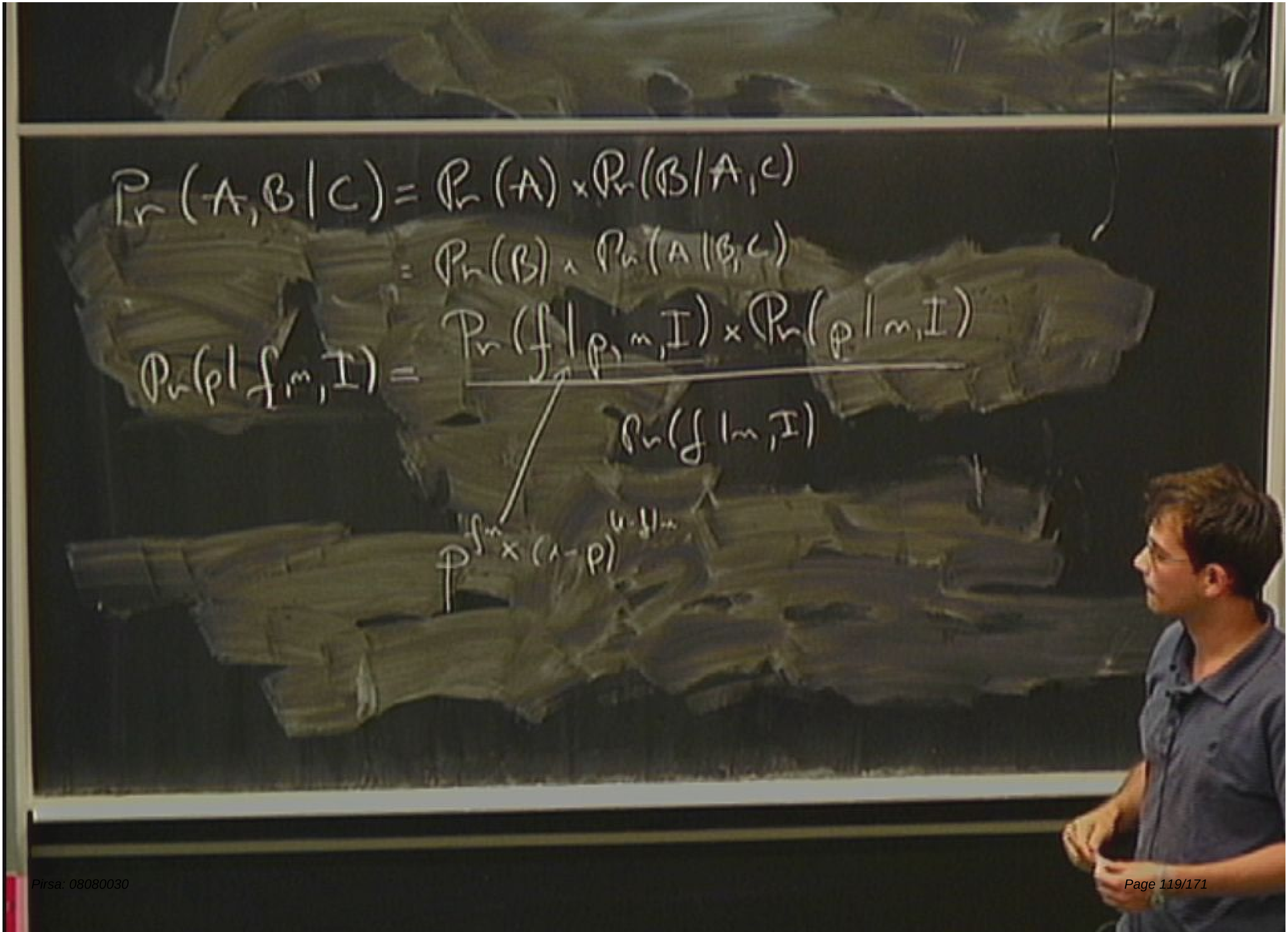


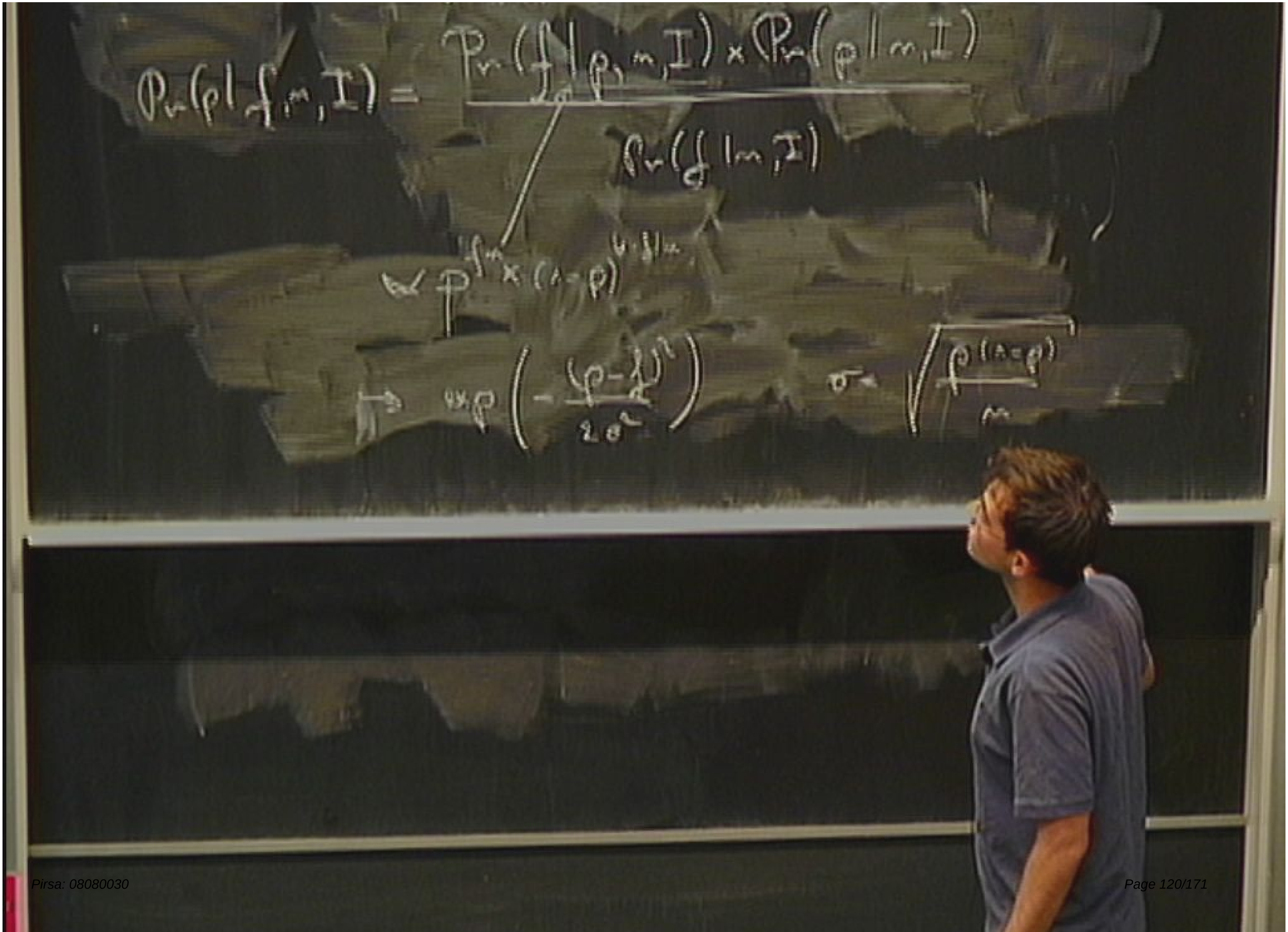
Pr(A,B|C) = Pr(A) × Pr(B|A,C)
= Pr(B) × Pr(A|B,C)
Pr(p|f,m,I) = Pr(f|p,m,I) × Pr(p|m,I)
Pr(f|m,I)


Pr(A,B|C) = Pr(A) × Pr(B|A,C)
= Pr(B) × Pr(A|B,C)
Pr(p|f,m,I) =
Pr(f|p,m,I) × Pr(p|m,I)


Pr(A,B|C) = Pr(A) × Pr(B|A,C)
= Pr(B) × Pr(A|B,C)
Pr(p|f,m,I) = Pr(f|p,m,I) × Pr(p|m,I) / Pr(f|m,I)
p^{fm} × (1-p)^{(1-f)m}


Pr(A,B|C) = Pr(A) × Pr(B|A,C)
= Pr(B) × Pr(A|B,C)
Pr(p|f,m,I) = Pr(f|p,m,I) × Pr(p|m,I)
Pr(f|m,I)


Pr(A,B|C) = Pr(A) × Pr(B|A,C)
= Pr(B) × Pr(A|B,C)
Pr(p|f,m,I) = Pr(f|p,m,I) × Pr(p|m,I) / Pr(f|m,I)
p^{fm} × (1-p)^{(1-f)m}


Pr(p | f, n, I) = Pr(f | p, n, I) × Pr(p | n, I) / Pr(f | n, I)
∝ p^{f n} × (1 - p)^{(1-f) n}
→ exp(- (p - f)^2 / 2σ^2)
σ = √(p(1-p) / n)

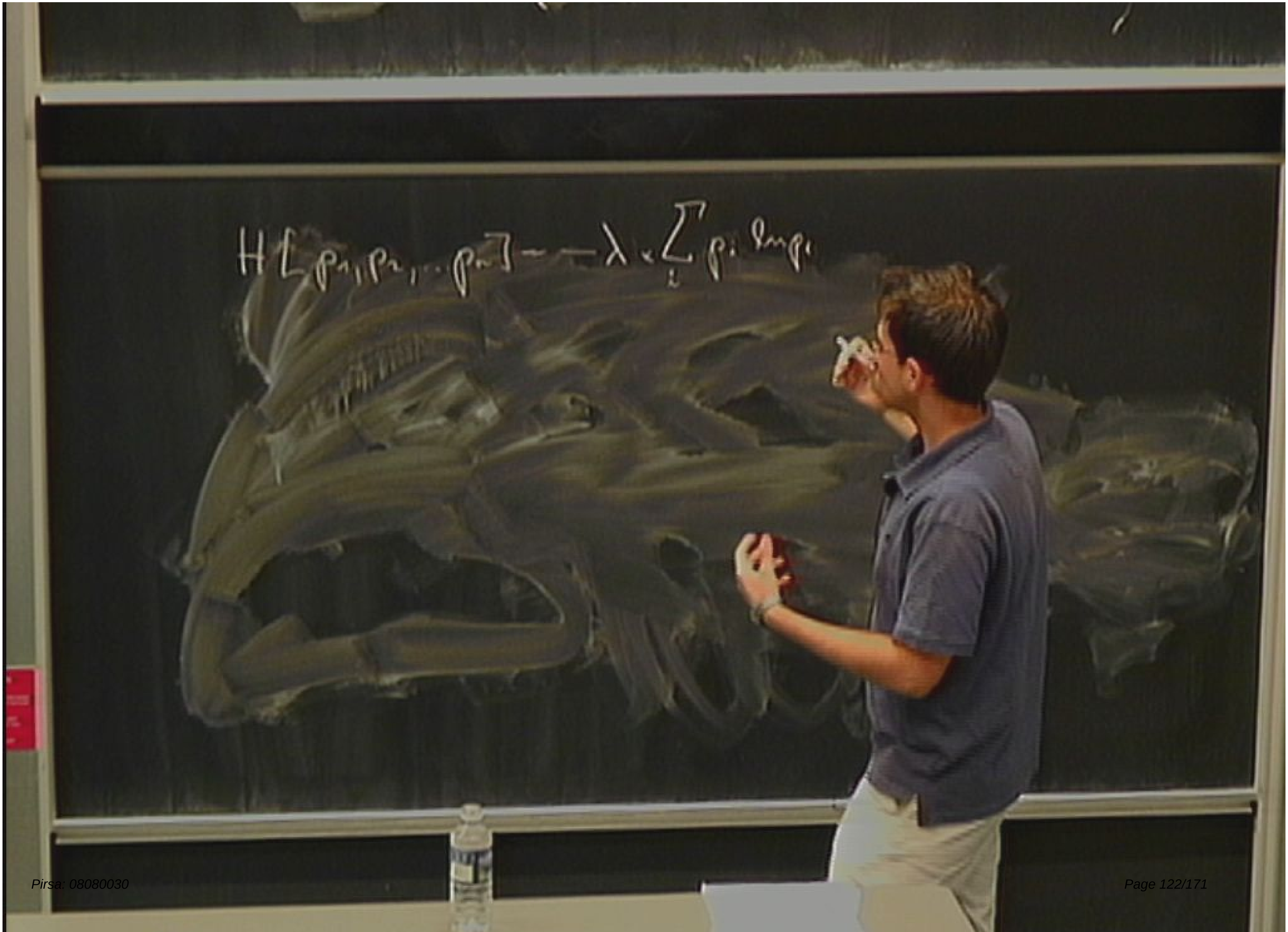
$$\Pr(A,B|C) = \Pr(A) \times \Pr(B|A,C)$$

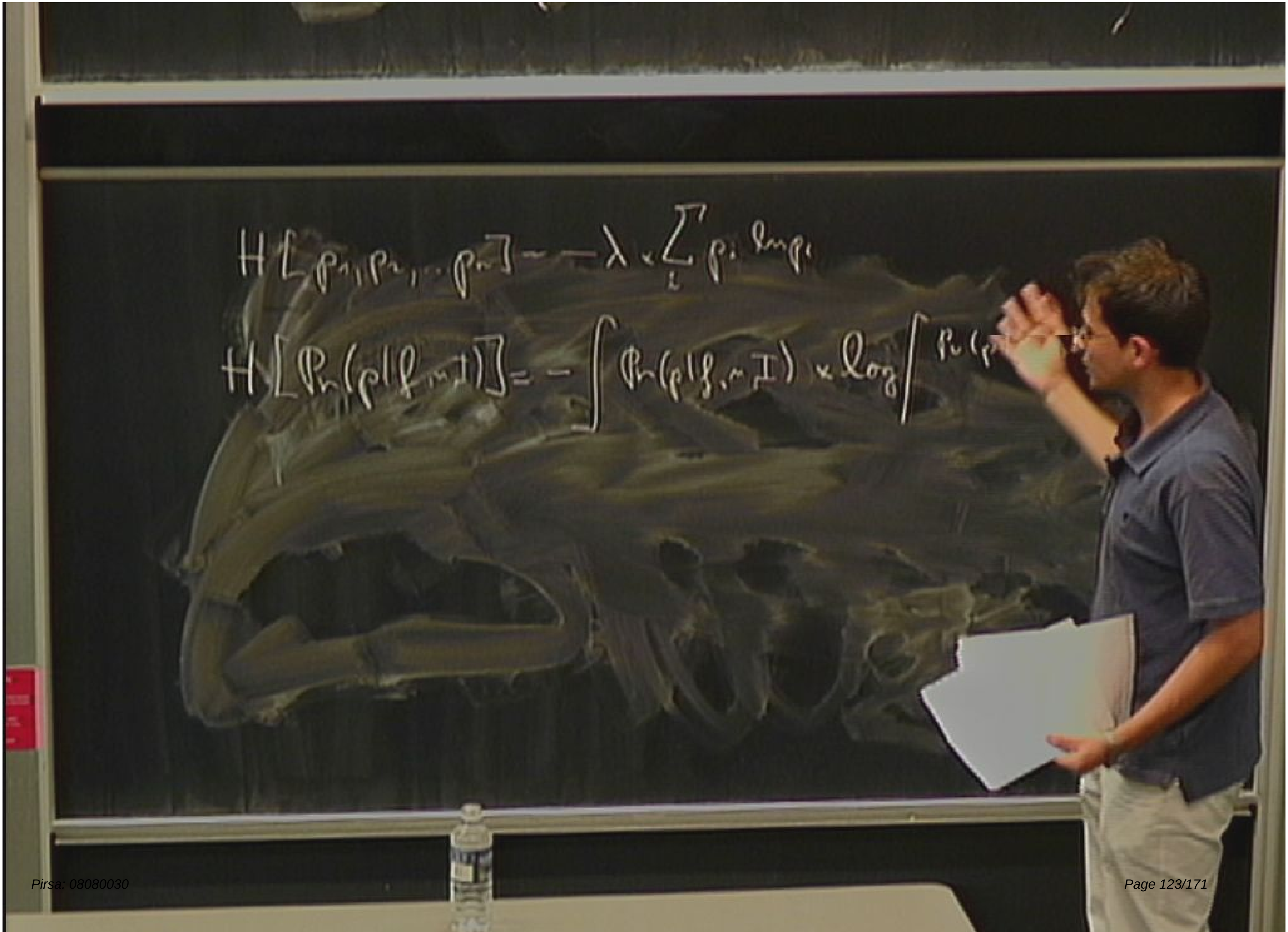
$$= \Pr(B) \times \Pr(A|B,C)$$

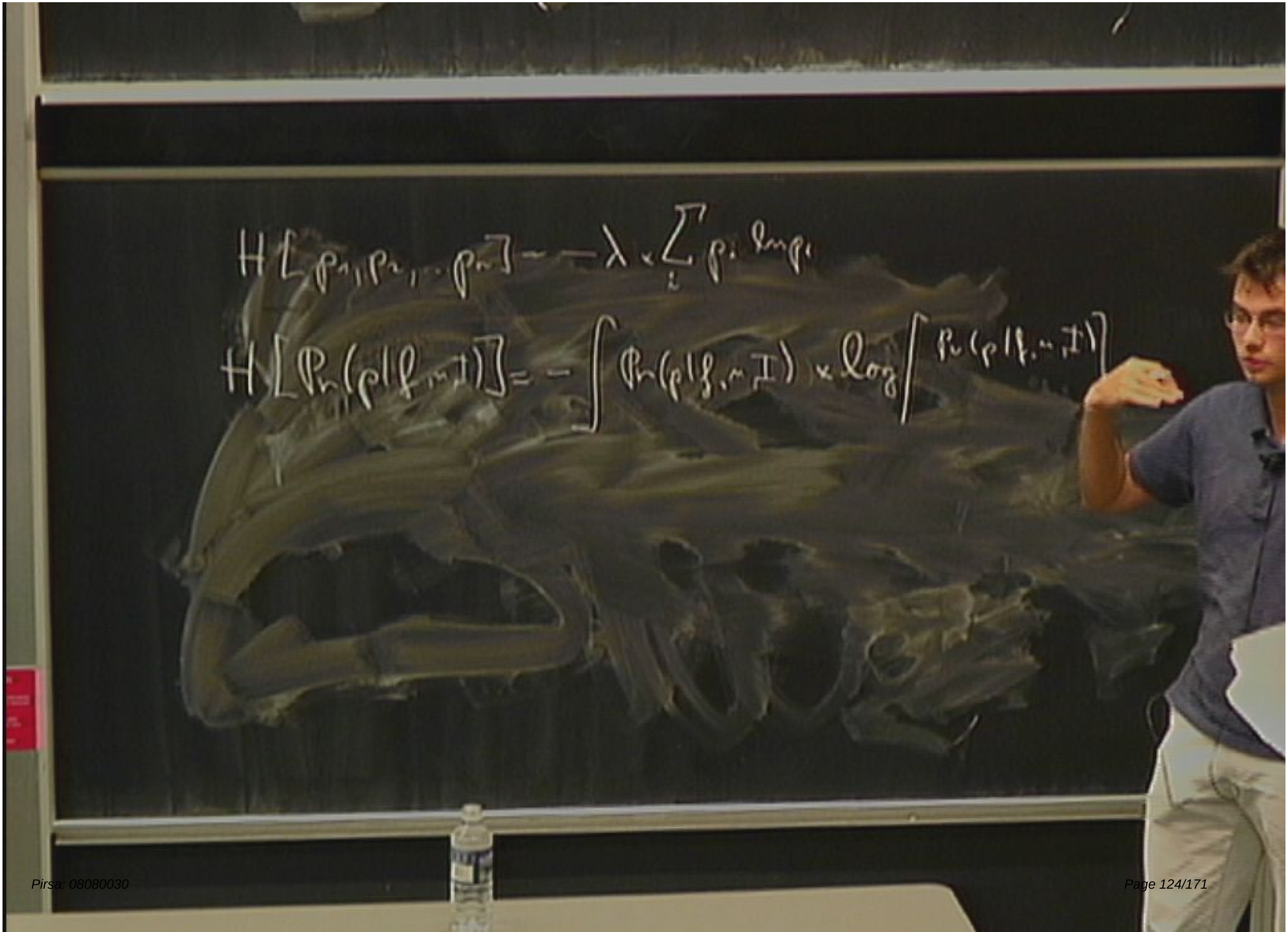
$$\Pr(p|f,m,I) = \frac{\Pr(f|p,m,I) \times \Pr(p|m,I)}{\Pr(f|m,I)}$$

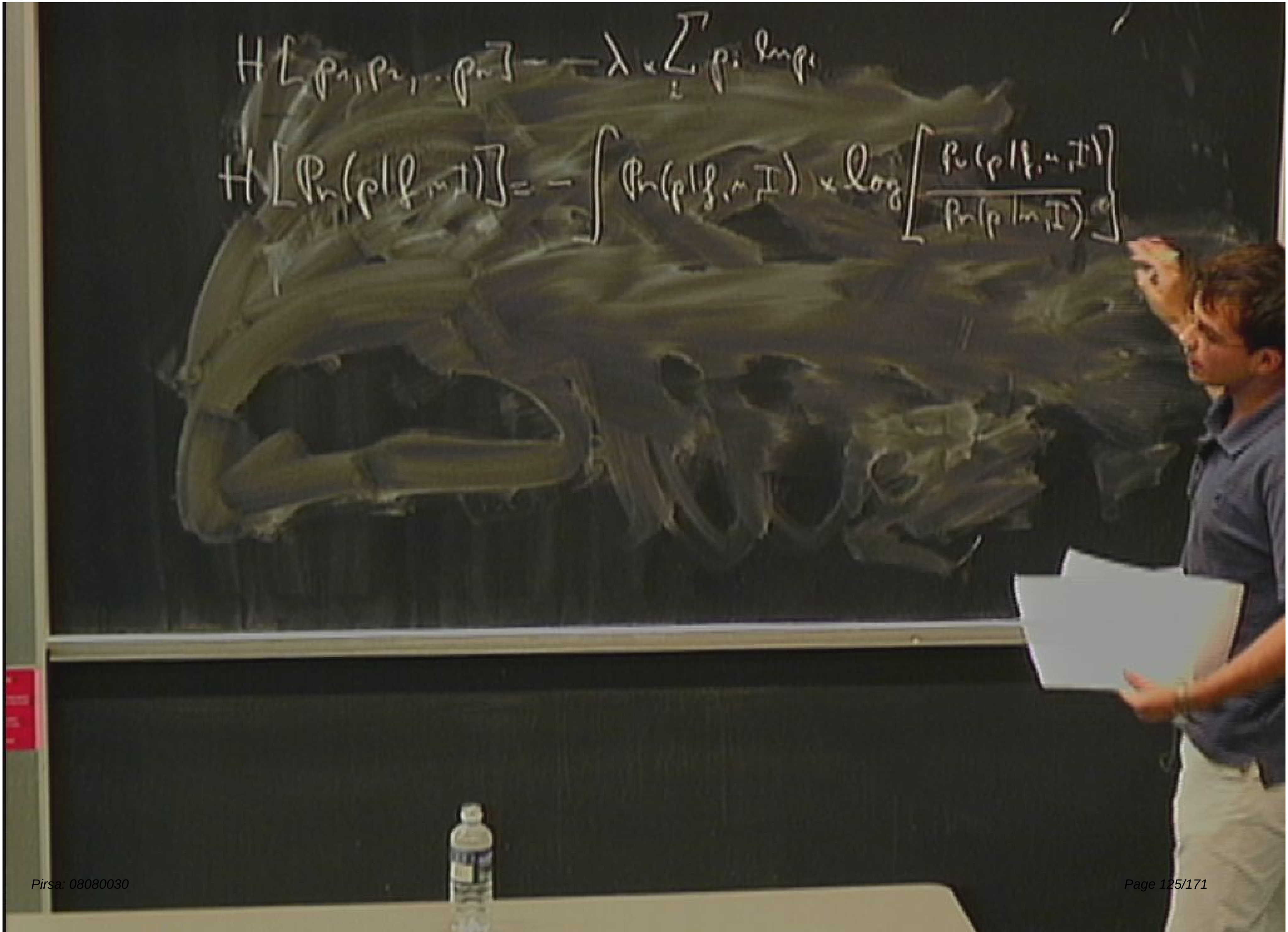
$$\propto p^{fm} \times (1-p)^{(1-f)m}$$

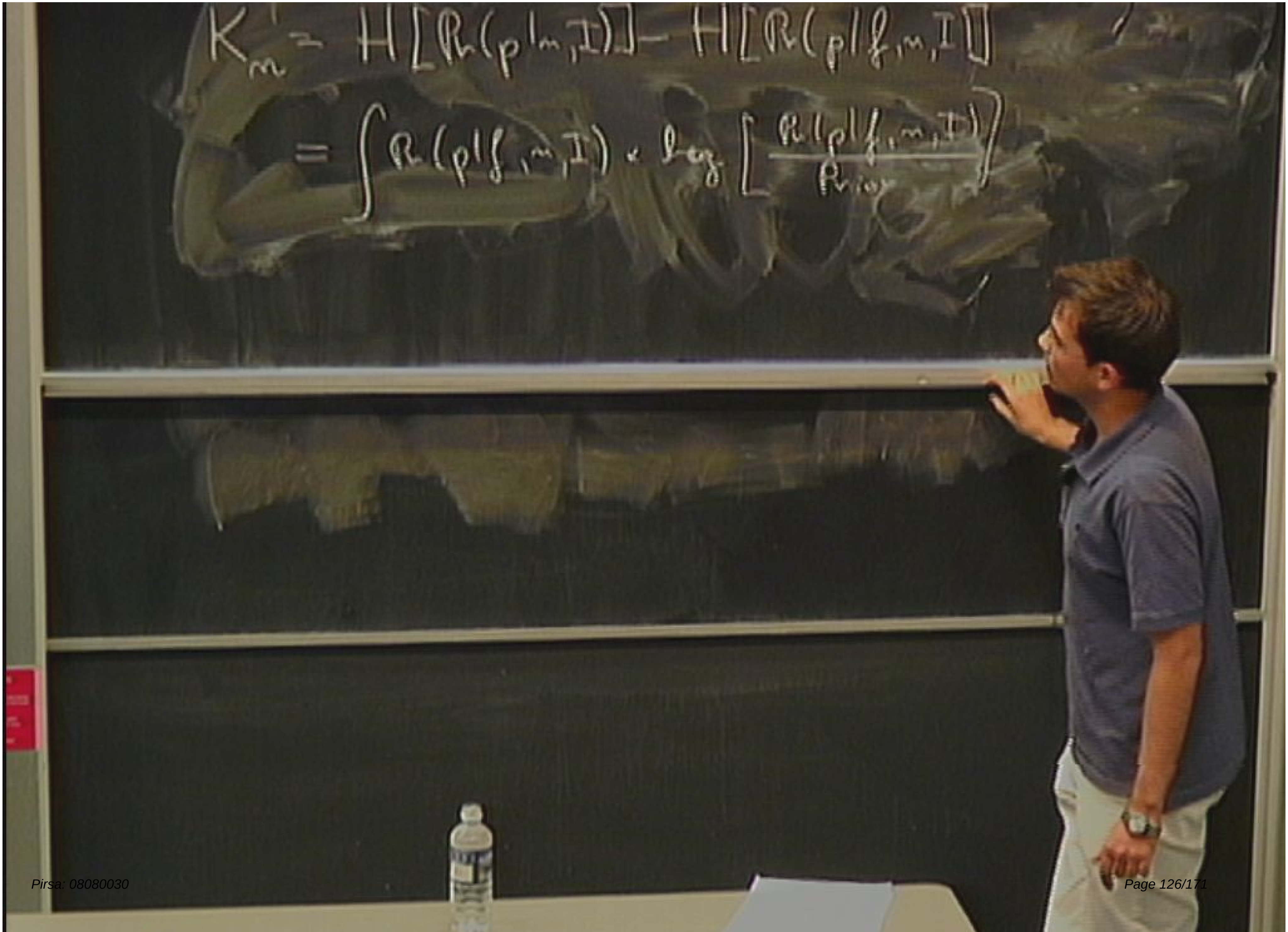
$$\rightarrow \exp\left(-\frac{(p-f)^2}{2\sigma^2}\right) \qquad \sigma = \sqrt{\frac{p(1-p)}{m}}$$

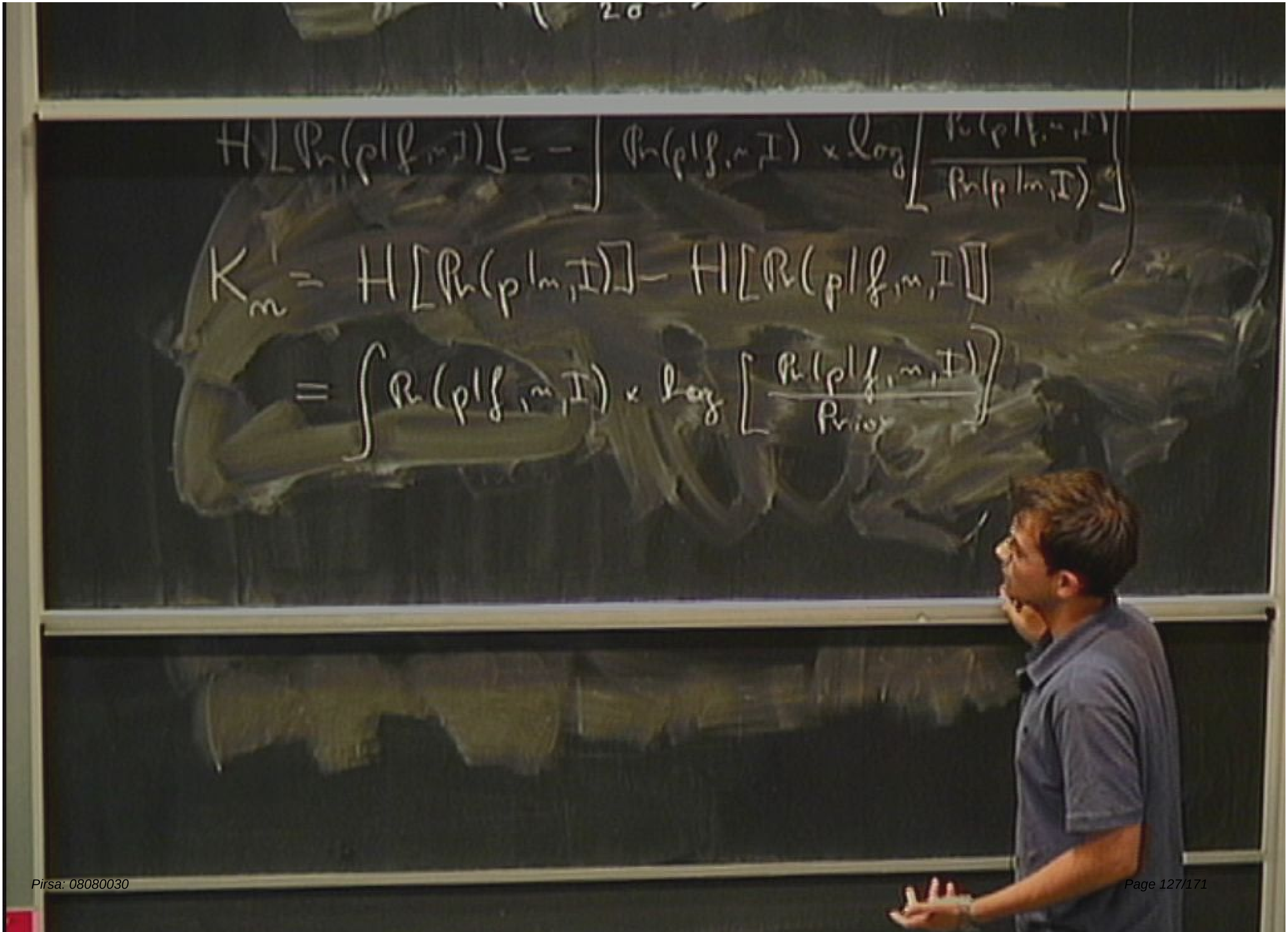

$H[p_1, p_2, \ldots p_n] = -\lambda \sum_i p_i \ln p_i$

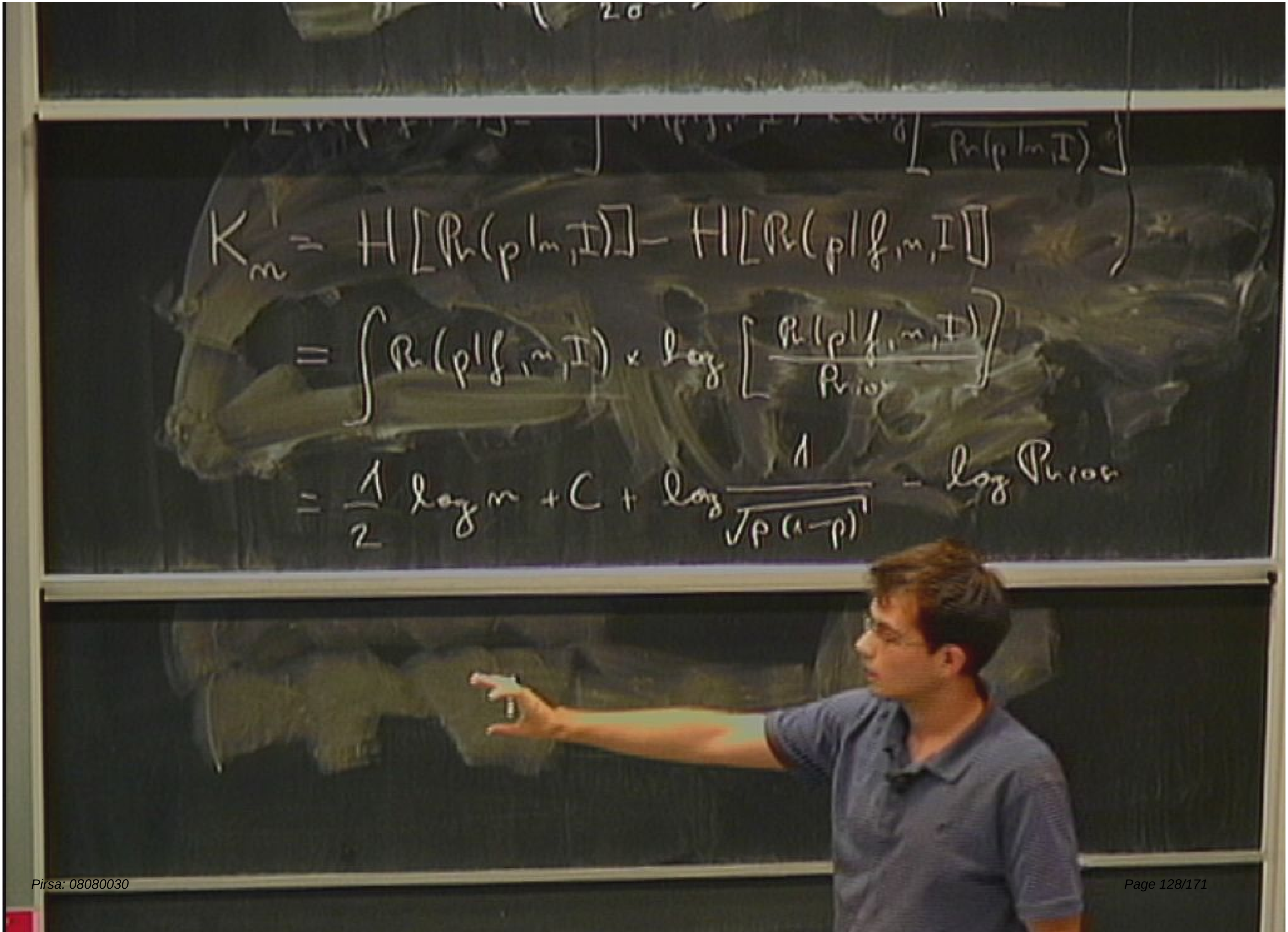

H[p1, p2, ... pn] = − λ × Σi pi log pi
H[Pr(p|f, m, I)] = − ∫ Pr(p|f, m, I) × log ∫

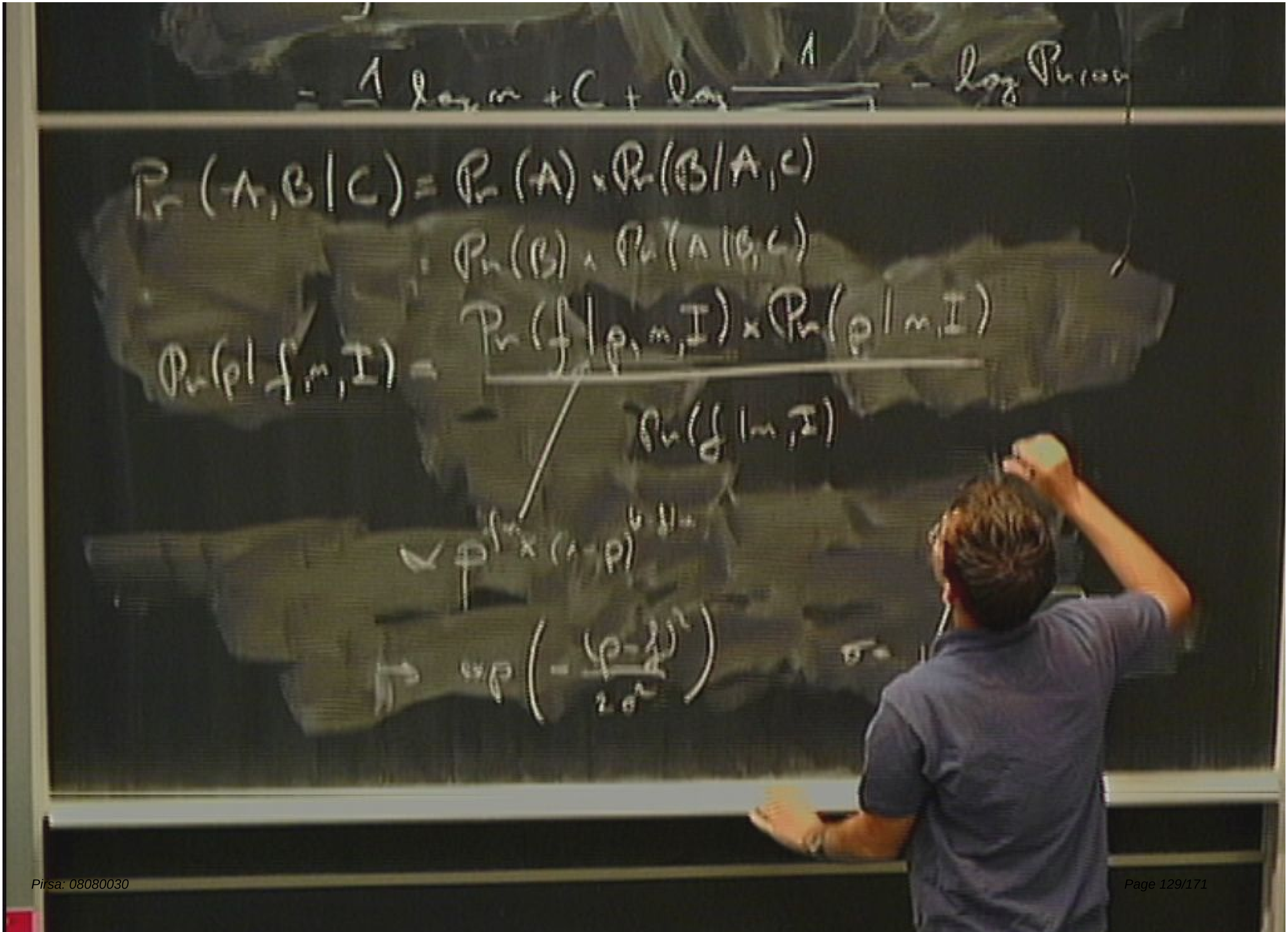

H[p_1, p_2, ... p_n] = −λ × Σ_i p_i log p_i
H[Pr(p|f, ..., I)] = − ∫ Pr(p|f, ..., I) × log [Pr(p|f, ..., I)]

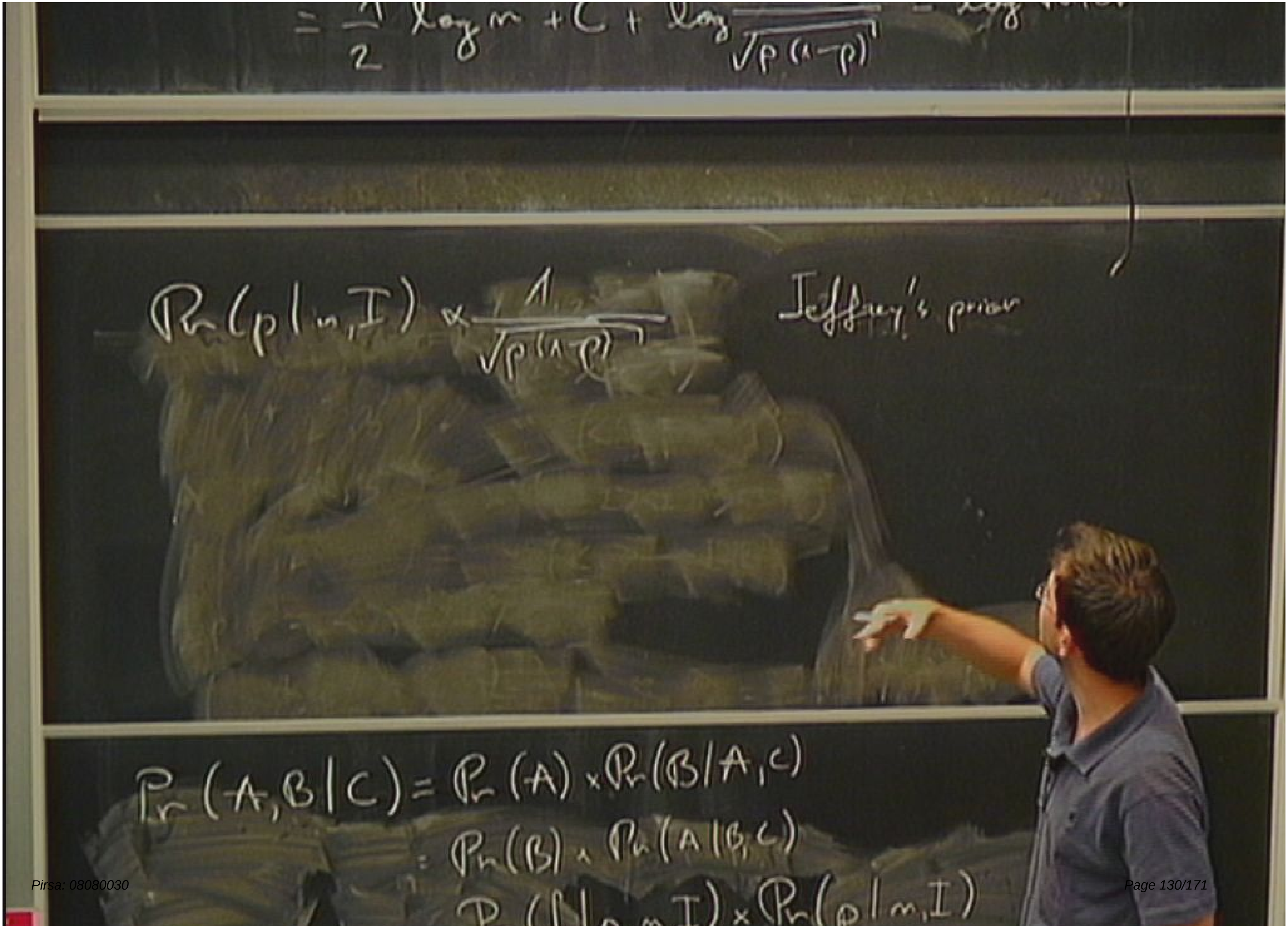

H[p1, p2, ... pn] = − λ × Σi pi log pi
H[Pr(p|f, m, I)] = − ∫ Pr(p|f, m, I) × log [Pr(p|f, m, I) / Pr(p|m, I)]

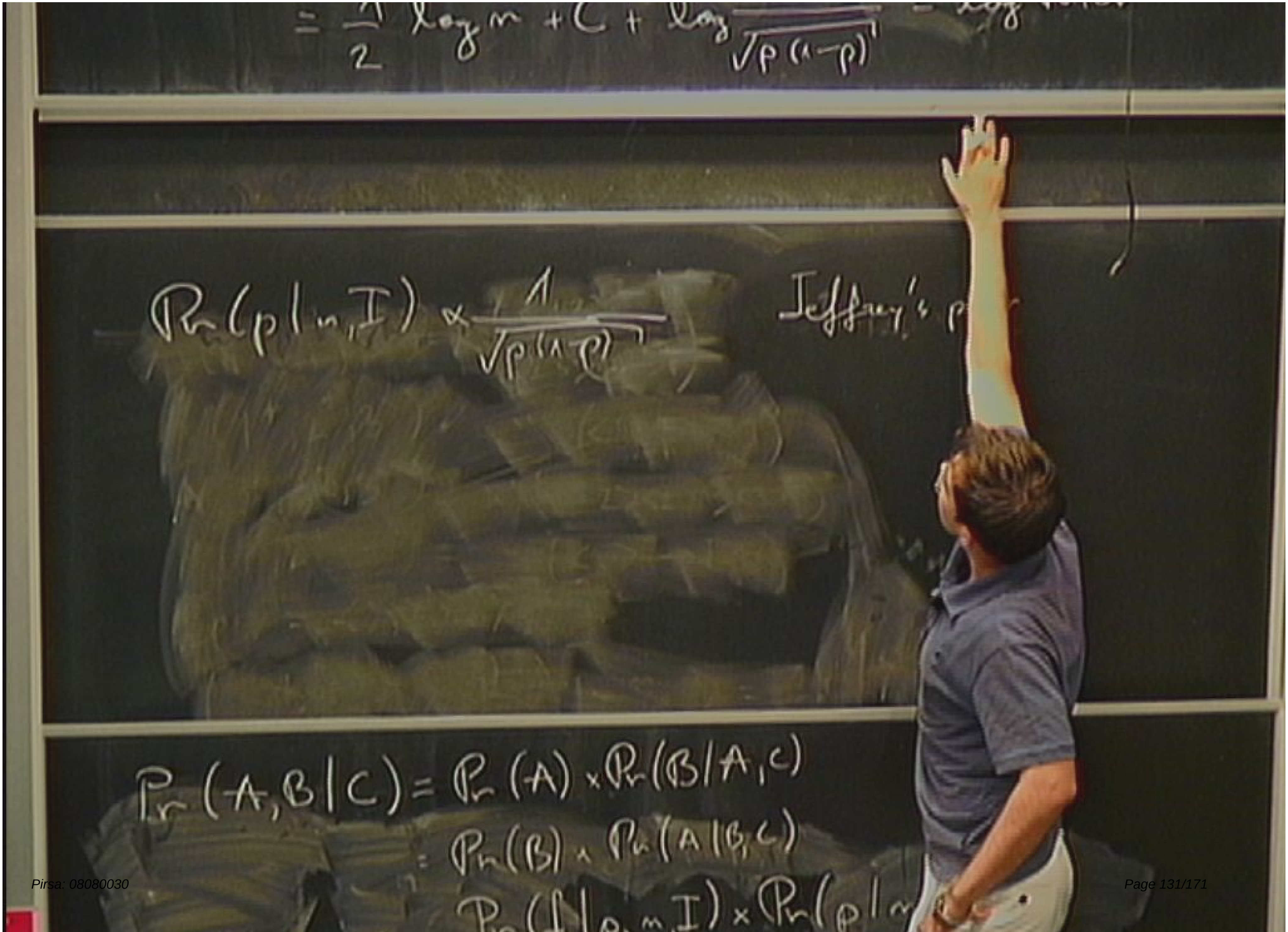

K_m = H[P(p|m,I)] – H[P(p|f,m,I)]


H[Pr(p|f,m,I)] = − ∫ Pr(p|f,m,I) × log[Pr(p|f,m,I) / Pr(p|m,I)]
K_m = H[Pr(p|m,I)] − H[Pr(p|f,m,I)]
= ∫ Pr(p|f,m,I) × log[Pr(p|f,m,I) / Prior]

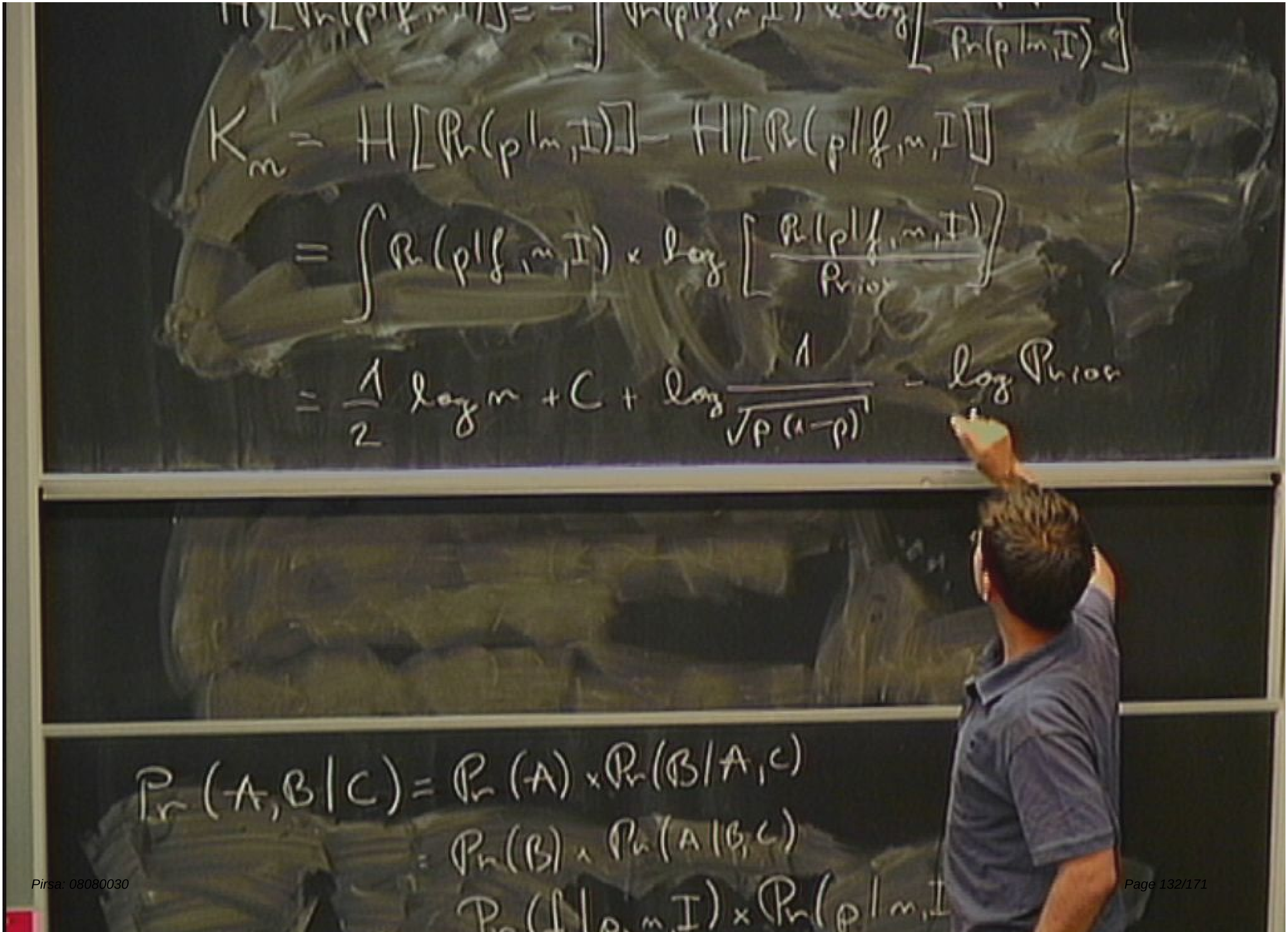

K_m = H[Pr(p|m,I)] − H[Pr(p|f,m,I)]
= ∫ Pr(p|f,m,I) × log [Pr(p|f,m,I) / Prior]
= 1/2 log m + C + log 1/√(p(1−p)) − log Prior


Pr(A,B|C) = Pr(A) × Pr(B|A,C)
= Pr(B) × Pr(A|B,C)
Pr(p|f,m,I) = Pr(f|p,m,I) × Pr(p|m,I) / Pr(f|m,I)
∝ p^{fm} × (1-p)^{(1-f)m}
→ exp(-(p-f)^2 / 2σ^2)


Pr(p|n,I) ∝ 1/√(p(1-p))
Jeffrey's prior
Pr(A,B|C) = Pr(A) × Pr(B|A,C)
= Pr(B) × Pr(A|B,C)



Jeffrey's p
Pr (A,B|C) = Pr (A) × Pr (B|A,C)
= Pr (B) × Pr (A|B,C)


K'_m = H[Pr(p|m, I)] − H[Pr(p|f, m, I)]
= ∫ Pr(p|f, m, I) × log [Pr(p|f, m, I) / Prior]
= 1/2 log m + C + log 1/√(p(1−p)) − log Prior
Pr(A, B|C) = Pr(A) × Pr(B|A, C)
= Pr(B) × Pr(A|B, C)

$$= \frac{1}{2}\log n + C + \log\frac{1}{\sqrt{p(1-p)}} - \log \text{Prior}$$

$$\Pr(p|n,I) \propto \frac{1}{\sqrt{p(1-p)}}$$ Jeffrey's prior

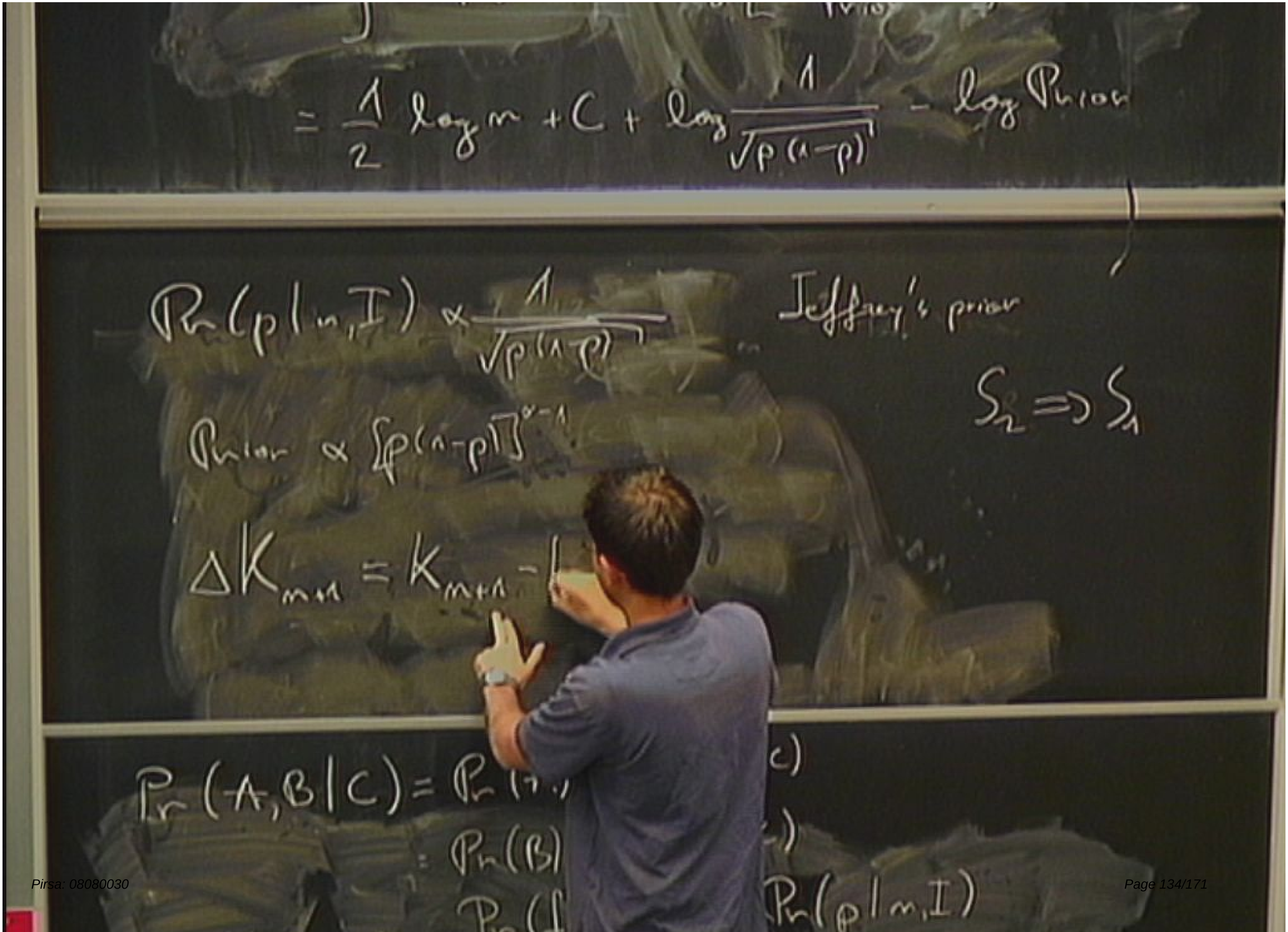
$$\text{Prior} \propto [p(1-p)]^{\alpha-1}$$

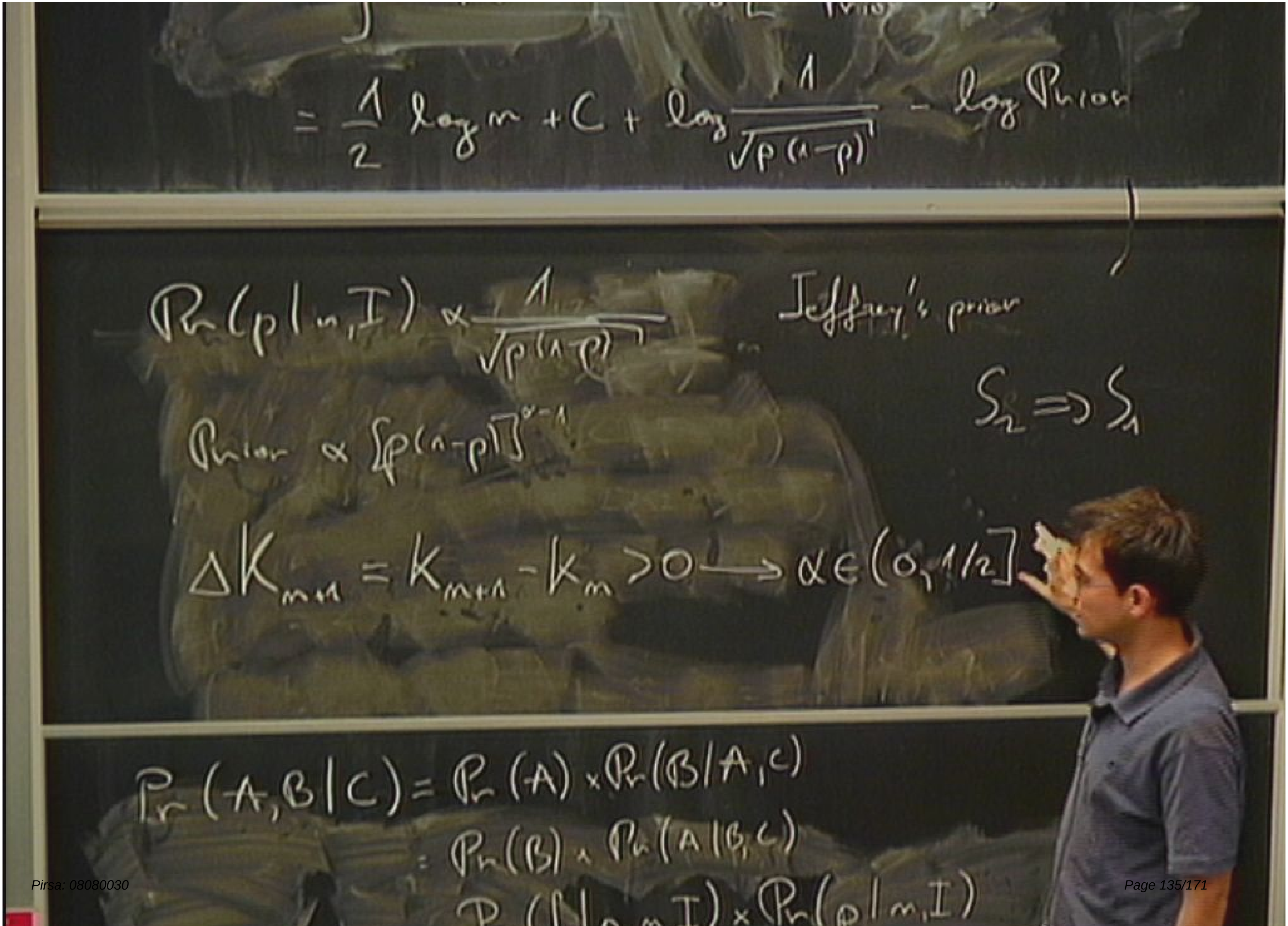
$$S_2 \Rightarrow S_1$$

$$\Pr(A,B|C) = \Pr(A) \times \Pr(B|A,C)$$

$$= \Pr(B) \times \Pr(A|B,C)$$

$$\Pr(\ldots|p,n,I) \times \Pr(p|n,I)$$


= 1/2 log m + C + log 1/√(p(1−p)) − log Prior
Pr(p | m, I) ∝ 1/√(p(1−p))
Jeffrey's prior
S2 ⟹ S1
Prior ∝ [p(1−p)]^(α−1)
ΔK_{m+1} = K_{m+1} −
Pr(A,B|C) = Pr(
= Pr(B)
Pr(p | m, I)



$= \frac{1}{2} \log m + C + \log \frac{1}{\sqrt{p(1-p)}} - \log \text{Prior}$
$\Pr(p \mid m, I) \propto \frac{1}{\sqrt{p(1-p)}}$
Jeffrey's prior
$S_2 \Rightarrow S_1$
$\text{Prior} \propto [p(1-p)]^{\alpha-1}$
$\Delta K_{m+1} = K_{m+1} - K_m > 0 \longrightarrow \alpha \in (0, 1/2]$
$\Pr(A, B \mid C) = \Pr(A) \times \Pr(B \mid A, C)$
$= \Pr(B) \times \Pr(A \mid B, C)$

$$= \frac{1}{2}\log m + C + \log \frac{1}{\sqrt{p(1-p)}} - \log \Pr\text{ior}$$

$$\Pr(p \mid n, I) \propto \frac{1}{\sqrt{p(1-p)}}$$ Jeffrey's prior

$$S_2 \Longrightarrow S_1$$

$$\Pr\text{ior} \propto [p(1-p)]^{\alpha-1}$$

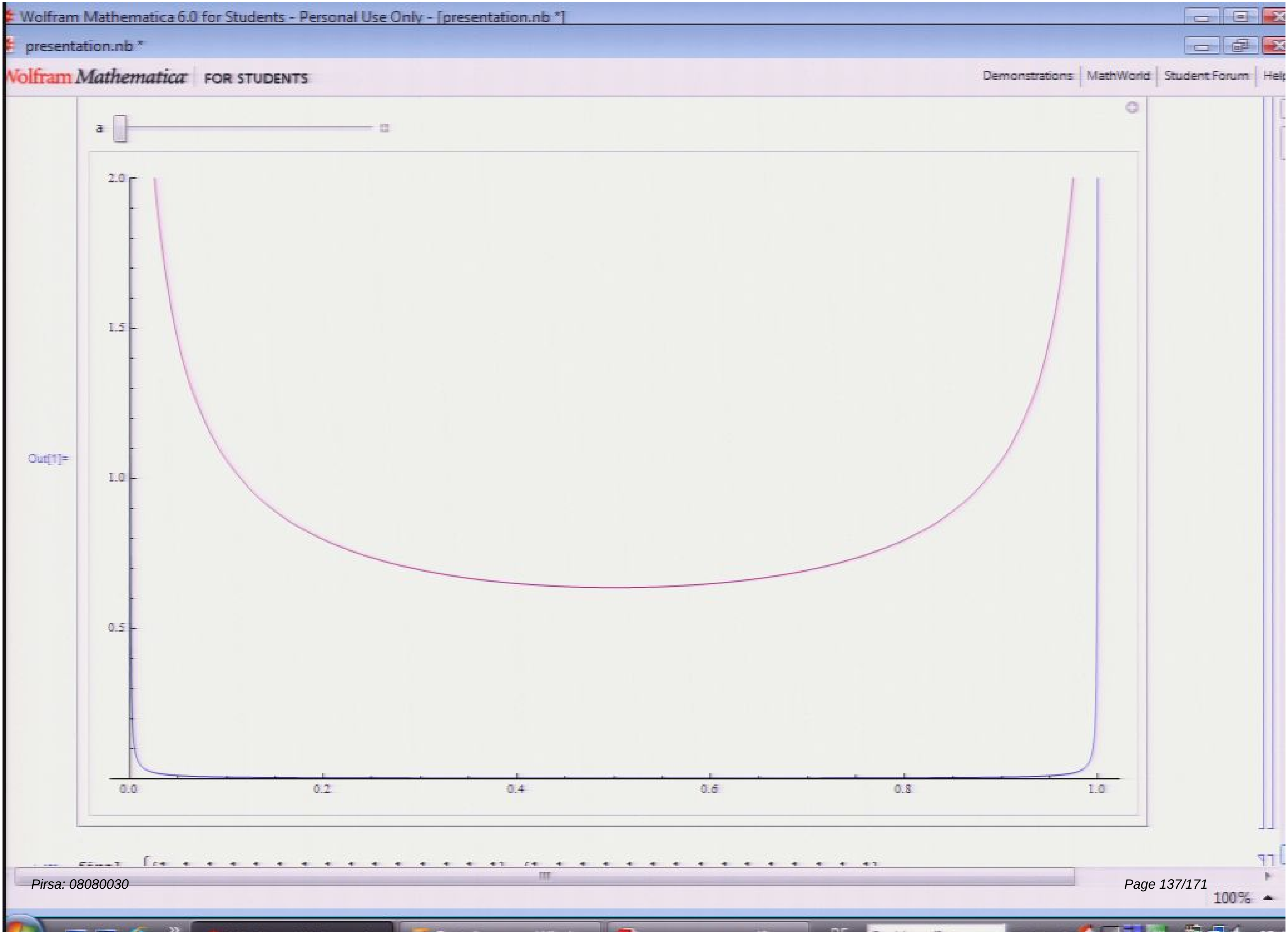
$m \to \infty$?

$$\Delta K_{m+1} = K_{m+1} - K_m > 0 \longrightarrow \alpha \in (0, 1/2]$$

$$\Pr(A, B \mid C) = \Pr(A) \times \Pr(B \mid A, C)$$

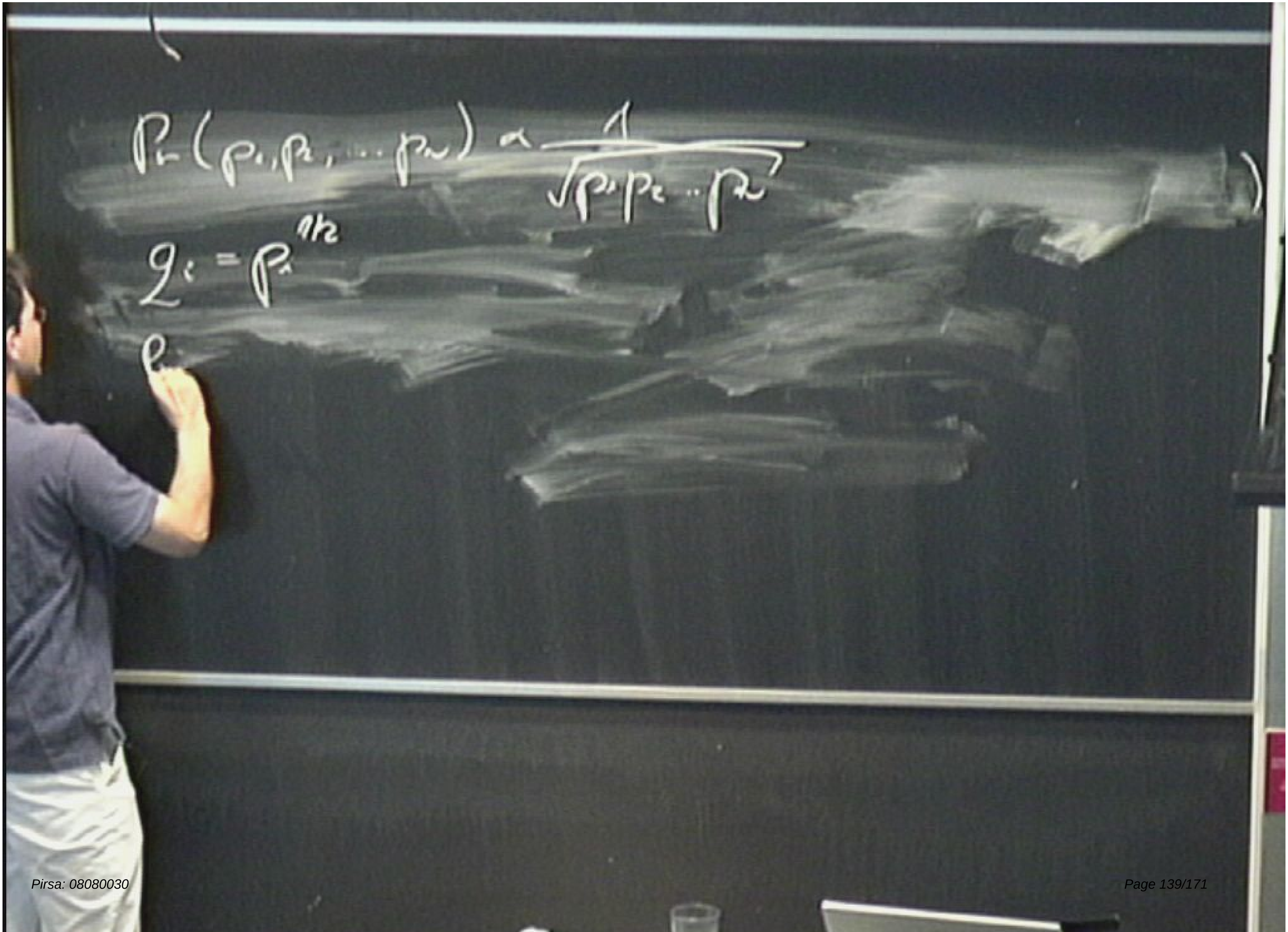
$$= \Pr(B) \times \Pr(A \mid B, C)$$

$$\Pr(\ldots \mid \ldots, m, I) \times \Pr(p \mid m, I)$$



Wolfram Mathematica 6.0 for Students - Personal Use Only - [presentation.nb *]
presentation.nb *
Wolfram Mathematica FOR STUDENTS
Demonstrations | MathWorld | Student Forum
a
Out[1]=
2.0
1.5
1.0
0.5
0.0
0.2
0.4
0.6
0.8
1.0
100%

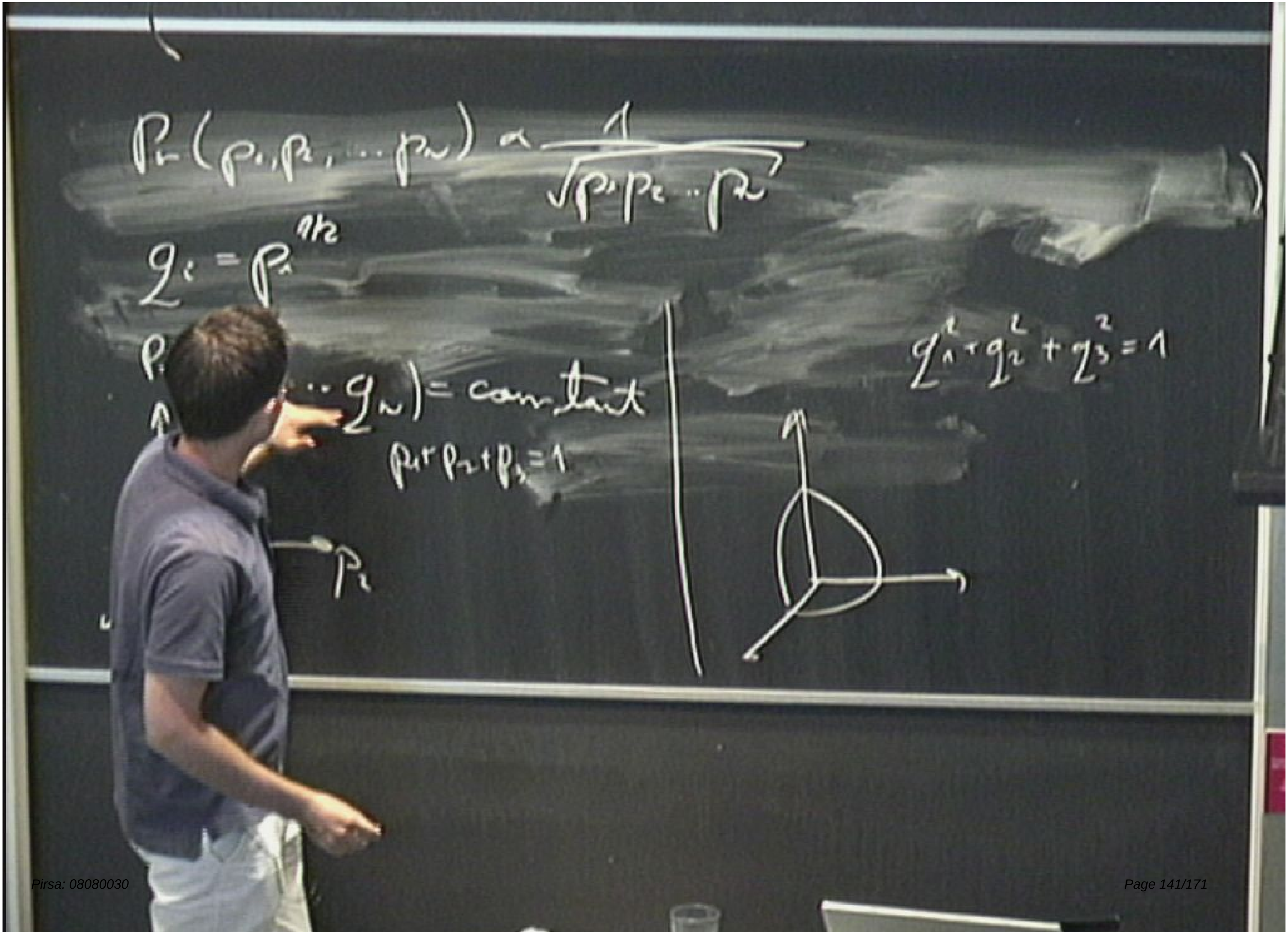
$$\Pr(p_1, p_2, \ldots p_N) \propto \frac{1}{\sqrt{p_1 p_2 \ldots p_N}}$$

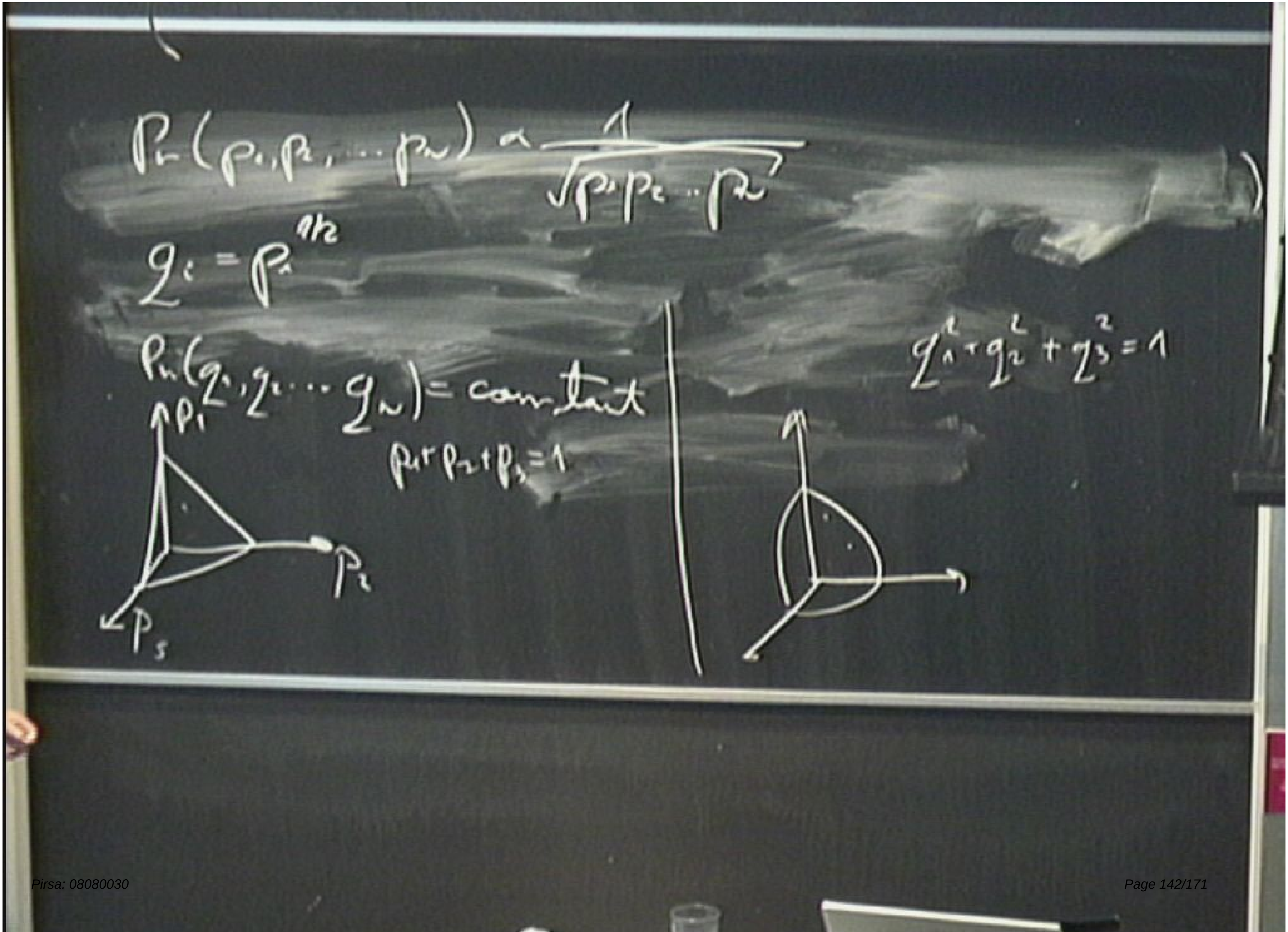

Pr(p1, p2, ... pN) ∝ 1/√(p1 p2 ... pN)
qi = pi^1/2

$$P_N(p_1, p_2, \ldots p_N) \propto \frac{1}{\sqrt{p_1 p_2 \ldots p_N}}$$

$$q_i = p_i^{1/2}$$

$$P_N(q_1, q_2 \ldots q_N) = \text{constant}$$


Pr(p1, p2, ... pn) ∝ 1 / √(p1 p2 .. pn)
qi = pi^1/2
qn) = constant
p1 + p2 + p3 = 1
q1² + q2² + q3² = 1
p2



P_N(p_1, p_2, ... p_N) ∝ 1 / √(p_1 p_2 .. p_N)
q_i = p_i^{1/2}
P_N(q_1, q_2 ... q_N) = constant
p_1 + p_2 + p_3 = 1
q_1^2 + q_2^2 + q_3^2 = 1
p_1
p_2
p_3

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presentation.nb *

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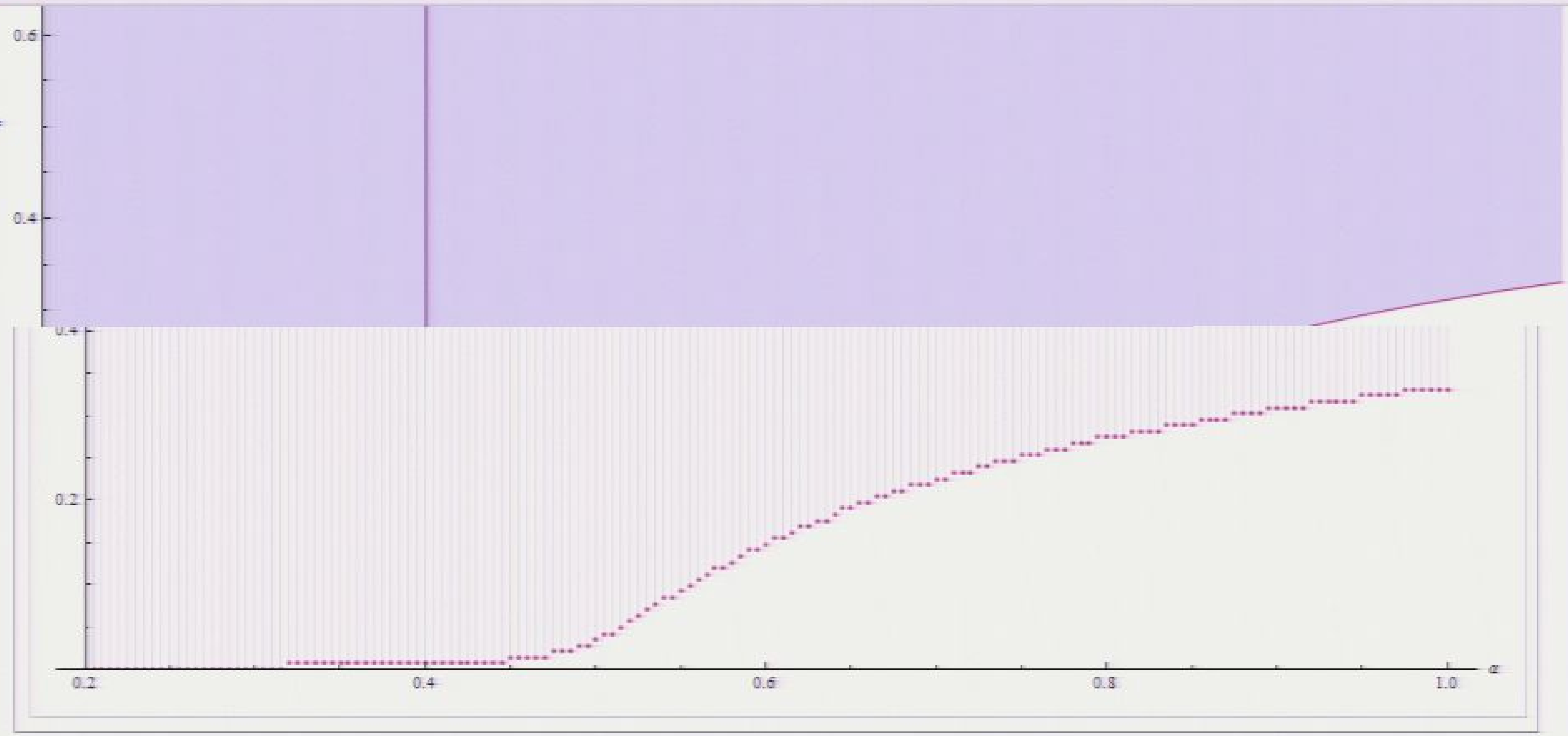
Out[4]=

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100%


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presentation.nb *
Wolfram Mathematica FOR STUDENTS
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Out[7]=
f
1.0
0.8
0.6
0.4
0.2
0.2
0.4
0.6
0.8
1.0
α
100%

Wolfram Mathematica 6.0 for Students - Personal Use Only - [presentation.nb *]

presentation.nb *

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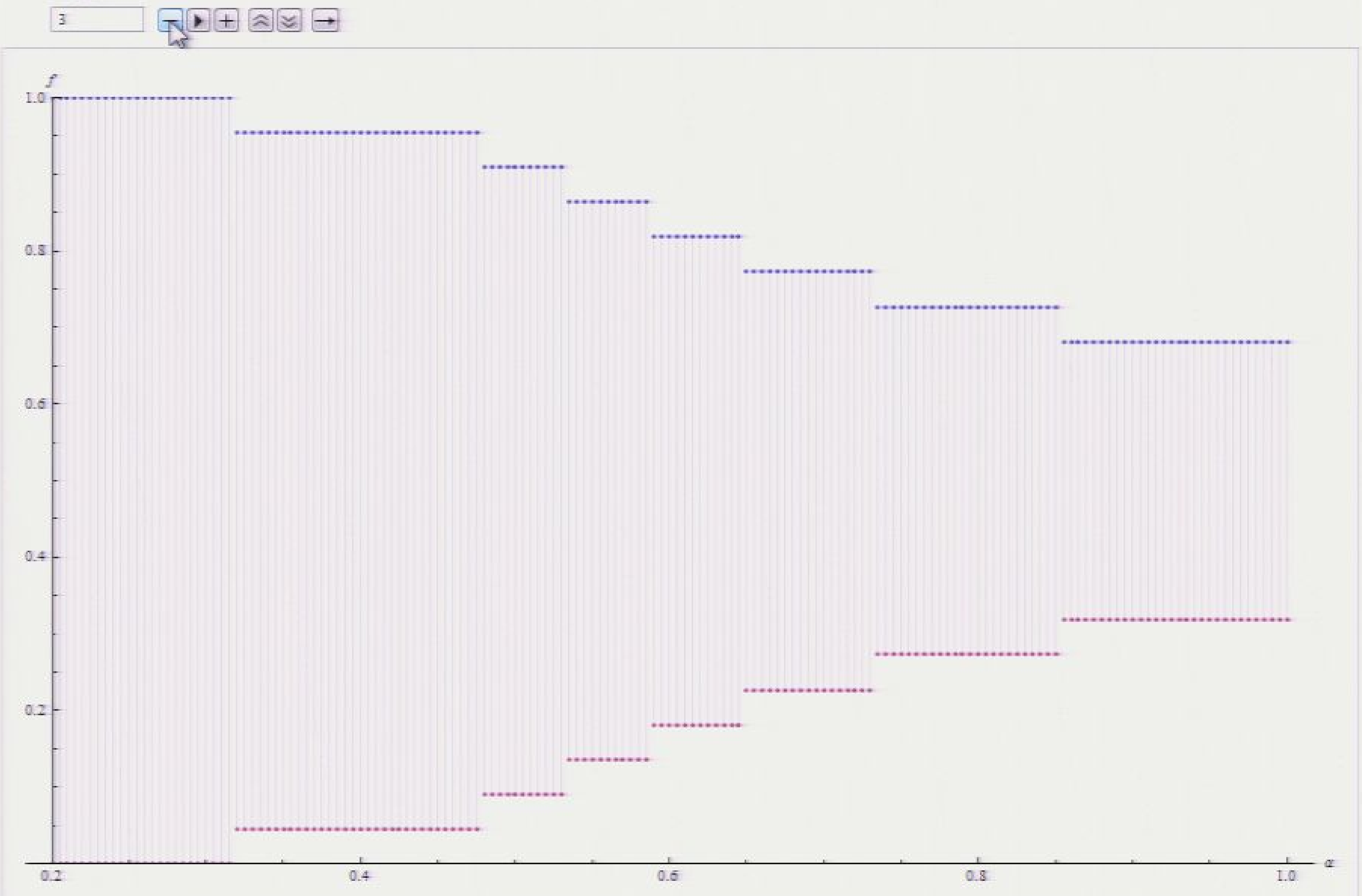
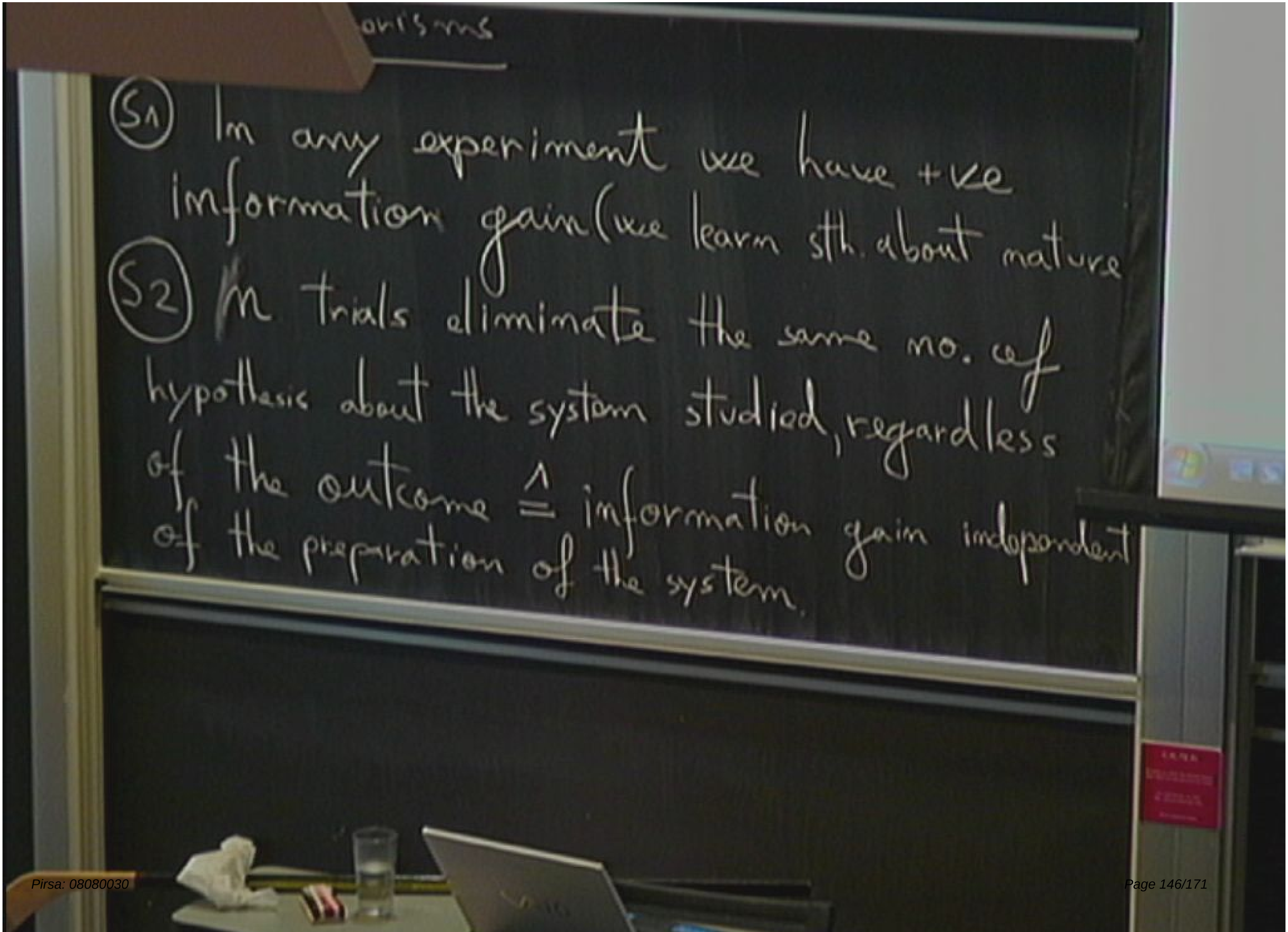
Out[7]=



100%



...onisms
(S1) In any experiment we have +ve information gain (we learn sth. about nature
(S2) n trials eliminate the same no. of hypothesis about the system studied, regardless of the outcome ≙ information gain independent of the preparation of the system.

$$H[\Pr(p|f,m,I)] = -\int \Pr(p|f,m,I) \times \log\left[\frac{\Pr(p|f,m,I)}{\Pr(p|m,I)}\right] dp$$

$$K_m = H[\Pr(p|m,I)] - H[\Pr(p|f,m,I)]$$

$$= \int \Pr(p|f,m,I) \times \log\left[\frac{\Pr(p|f,m,I)}{\text{Prior}}\right]$$

$$= \frac{1}{2}\log m + C + \log\frac{1}{\sqrt{p(1-p)}} - \log \text{Prior}$$

$$\Pr(A,B|C) = \Pr(A) \times \Pr(B|A,C)$$

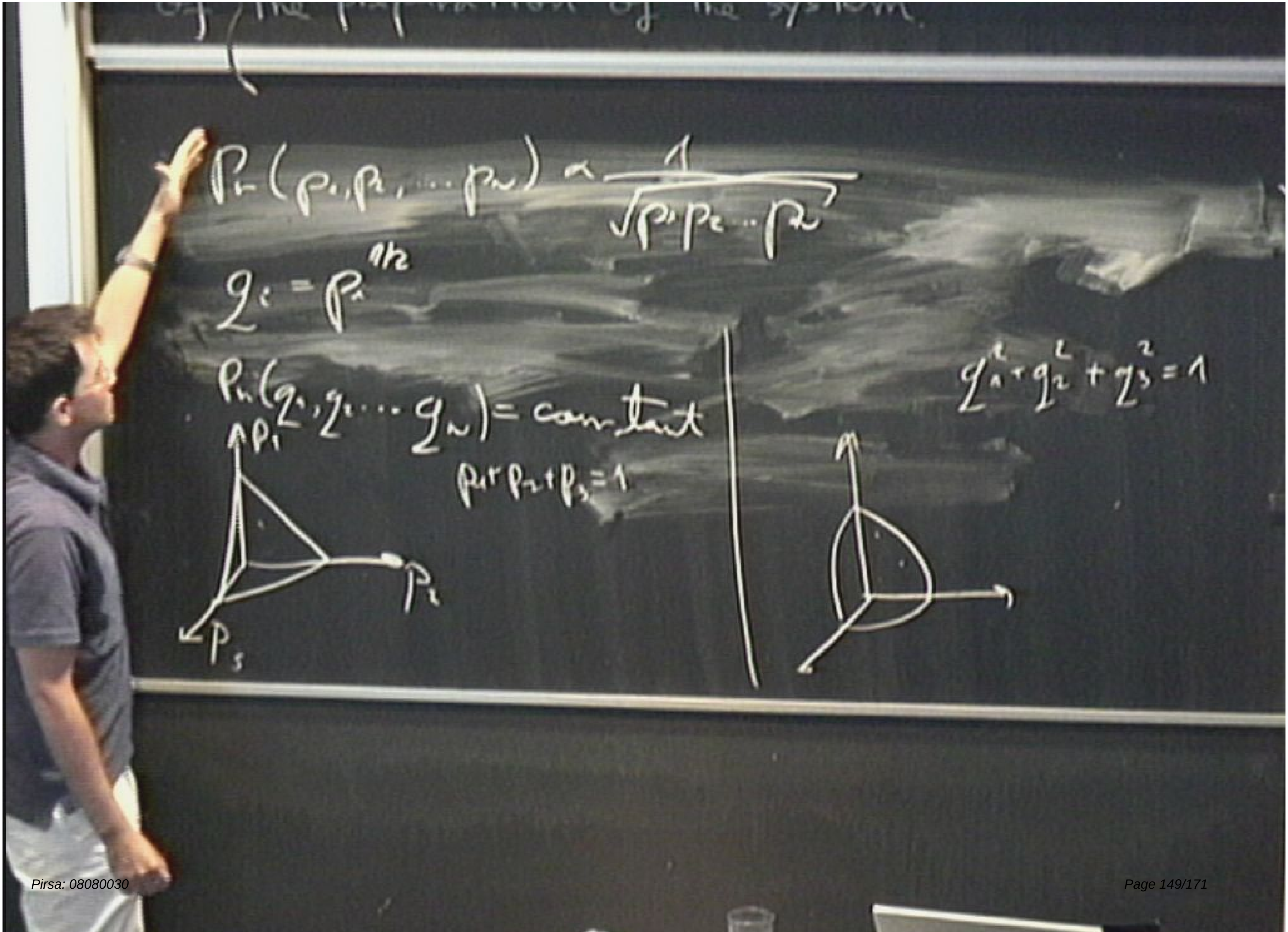
$$= \Pr(B) \times \Pr(A|B,C)$$

$$\Pr(p|f,m,I) = \frac{\Pr(f|p,m,I) \times \Pr(p|m,I)}{\Pr(f|m,I)}$$

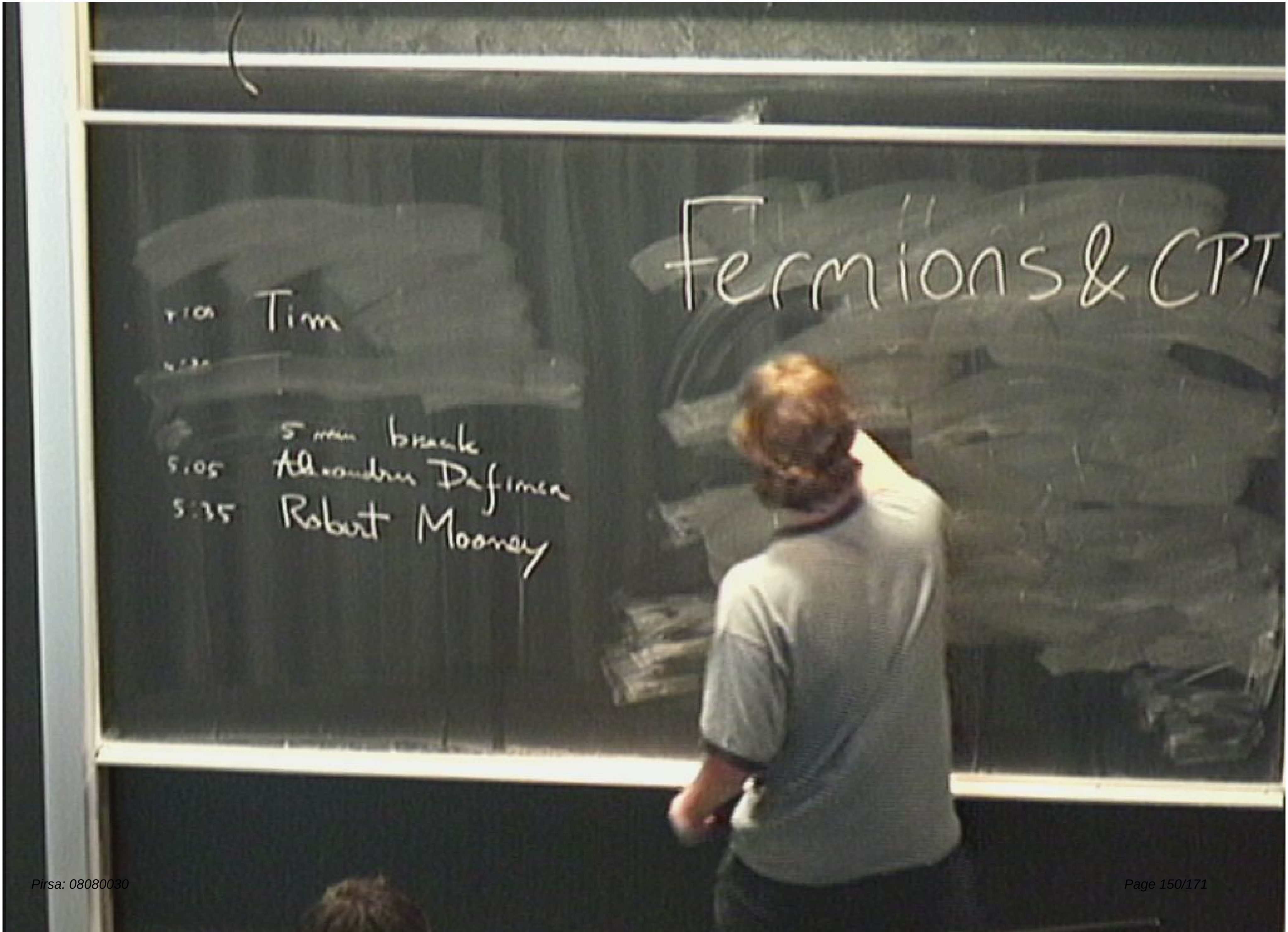
Summharmonisms

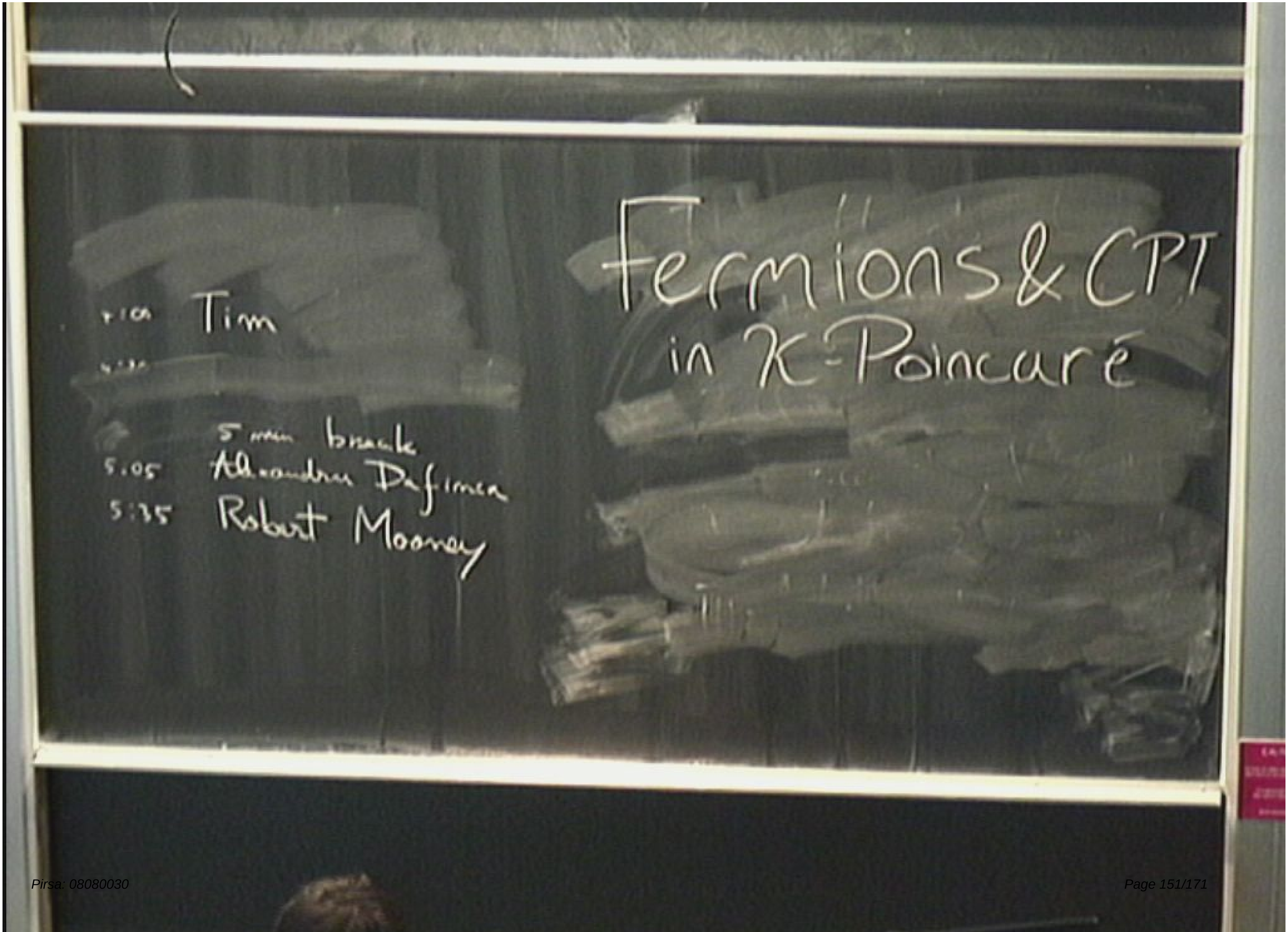
(S1) In any experiment we have +ve information gain (we learn sth. about nature)

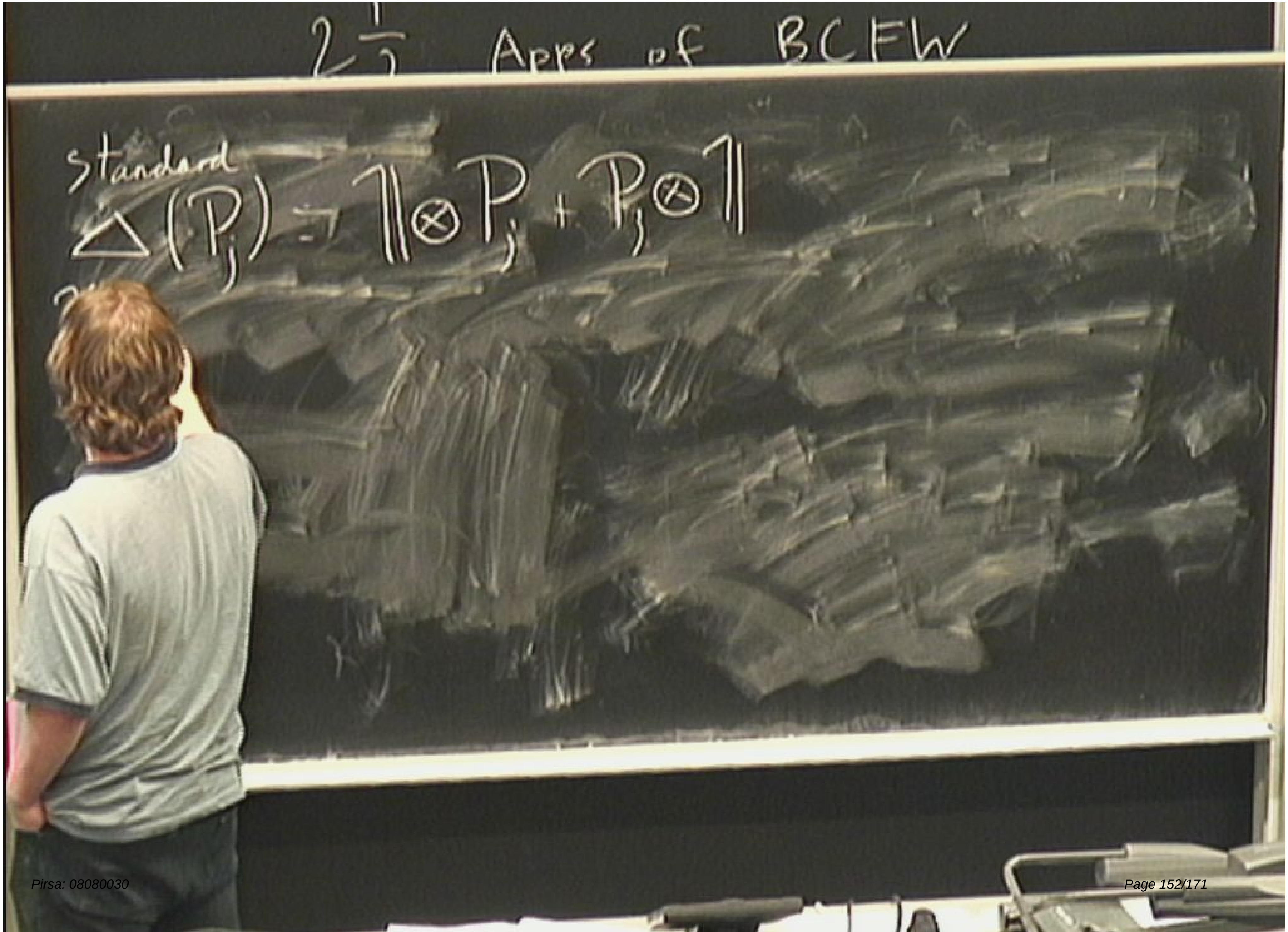
(S2) n trials eliminate the same no. of hypothesis about the system studied, regardless of the outcome $\hat{=}$ information gain independent of the preparation of the system.

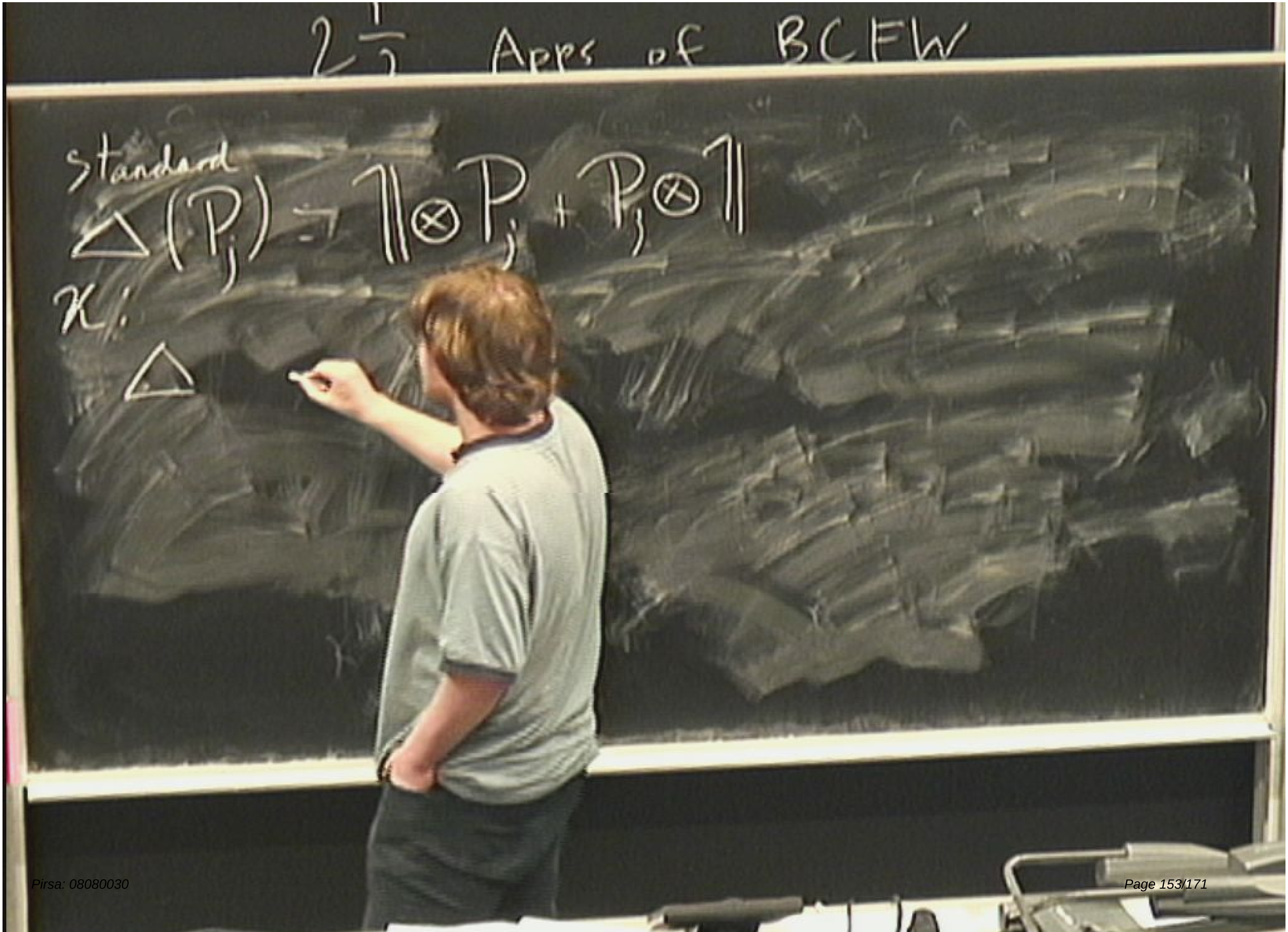


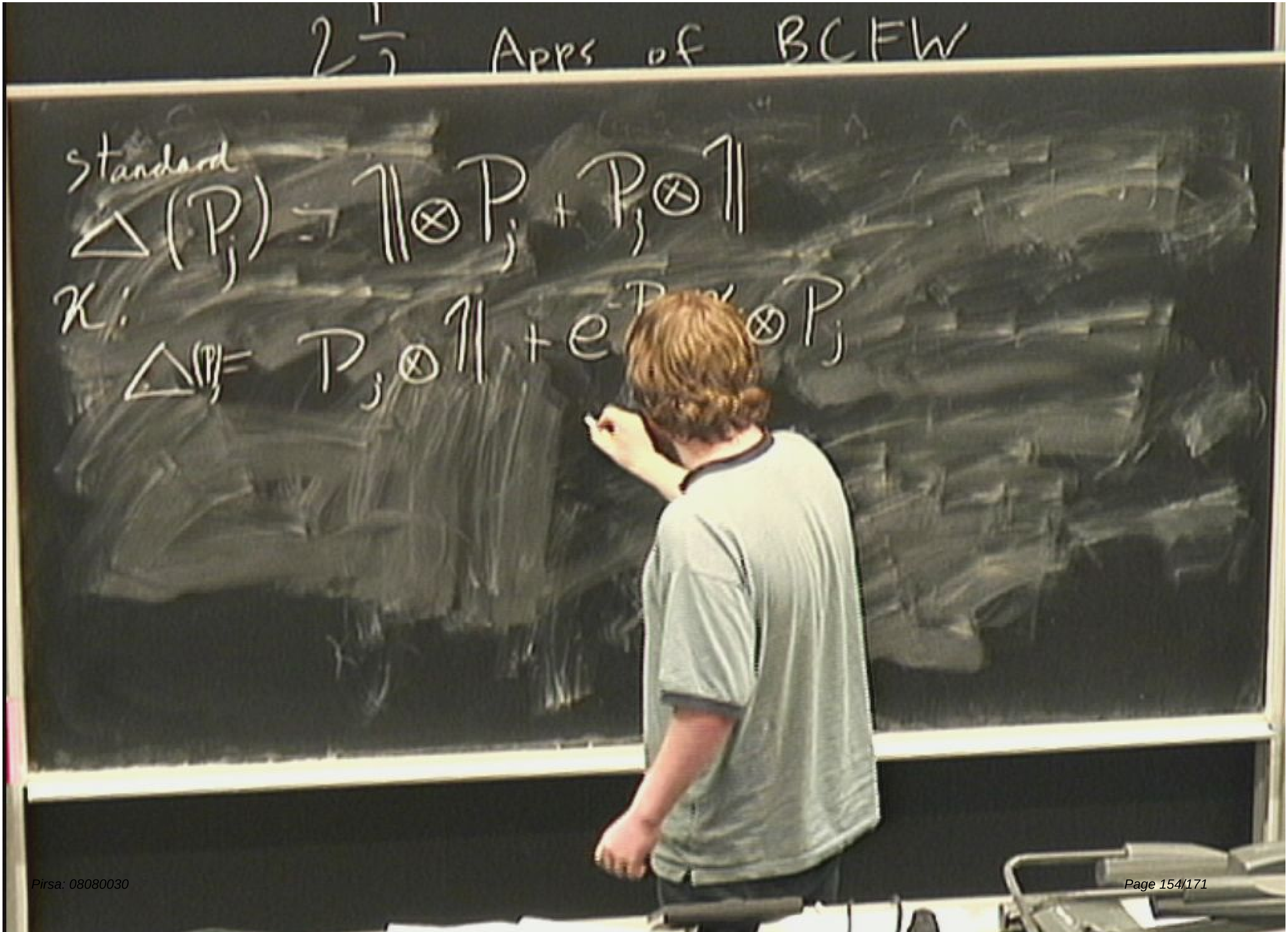
Pr(p1, p2, ... pN) ∝ 1 / √(p1 p2 ... pN)
qi = pi^1/2
Pr(q1, q2 ... qN) = constant
p1 + p2 + p3 = 1
p1
p2
p3
q1^2 + q2^2 + q3^2 = 1

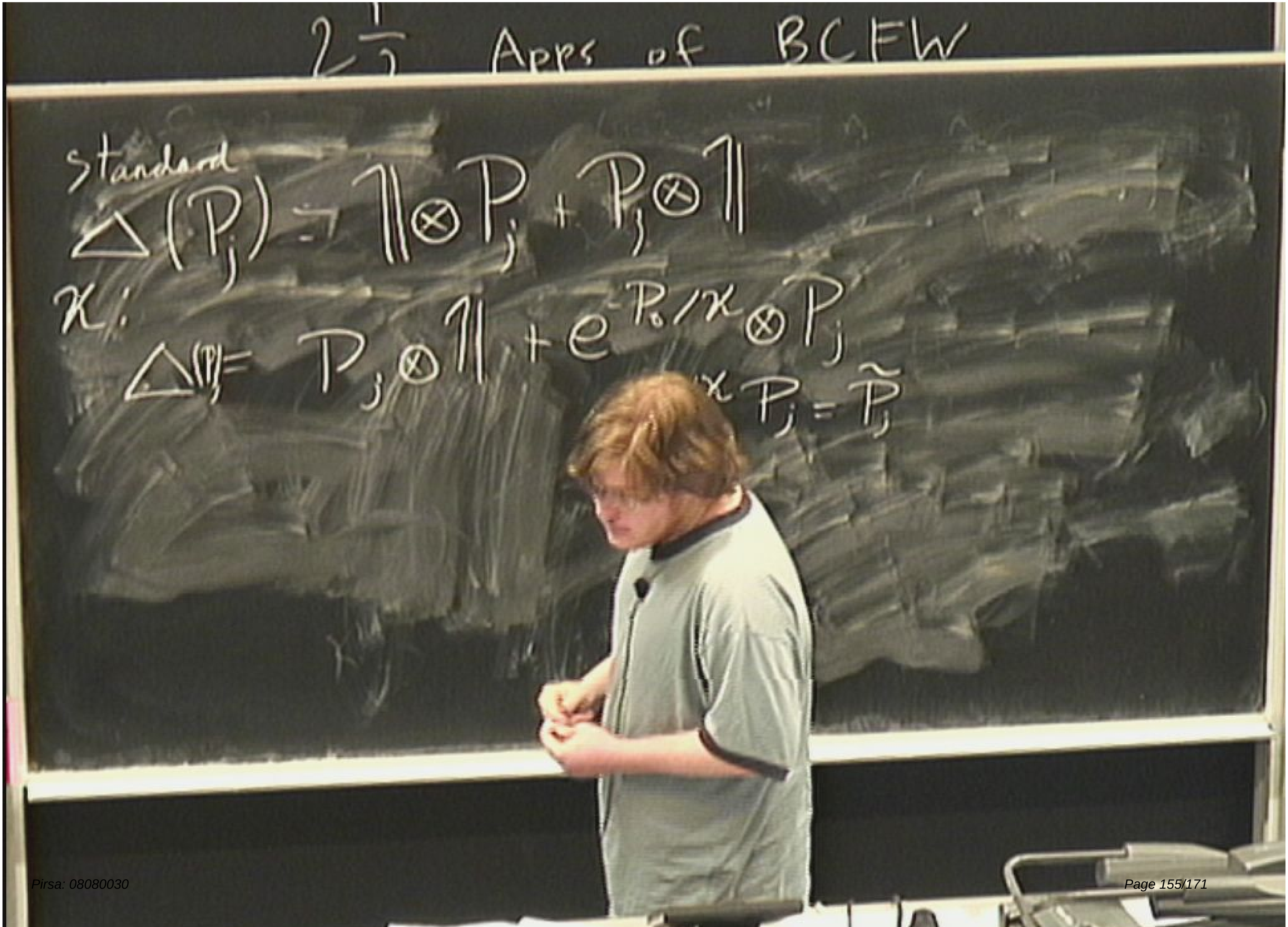

Fermions & CPT
Tim
5 min break
5:05
5:35 Robert Mooney

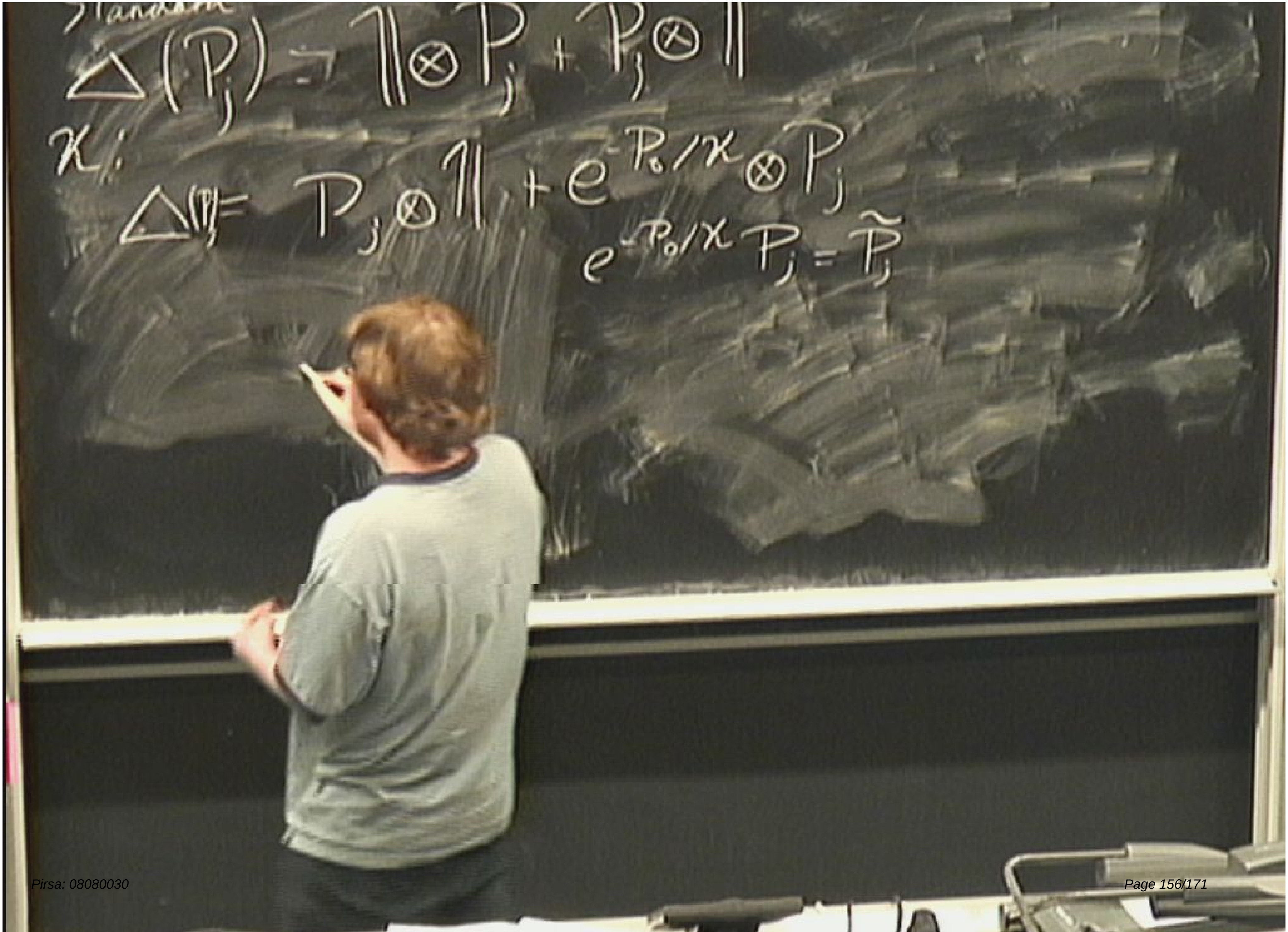

Fermions & CPT
in κ-Poincaré
Tim
5 min break
5:35 Robert Mooney

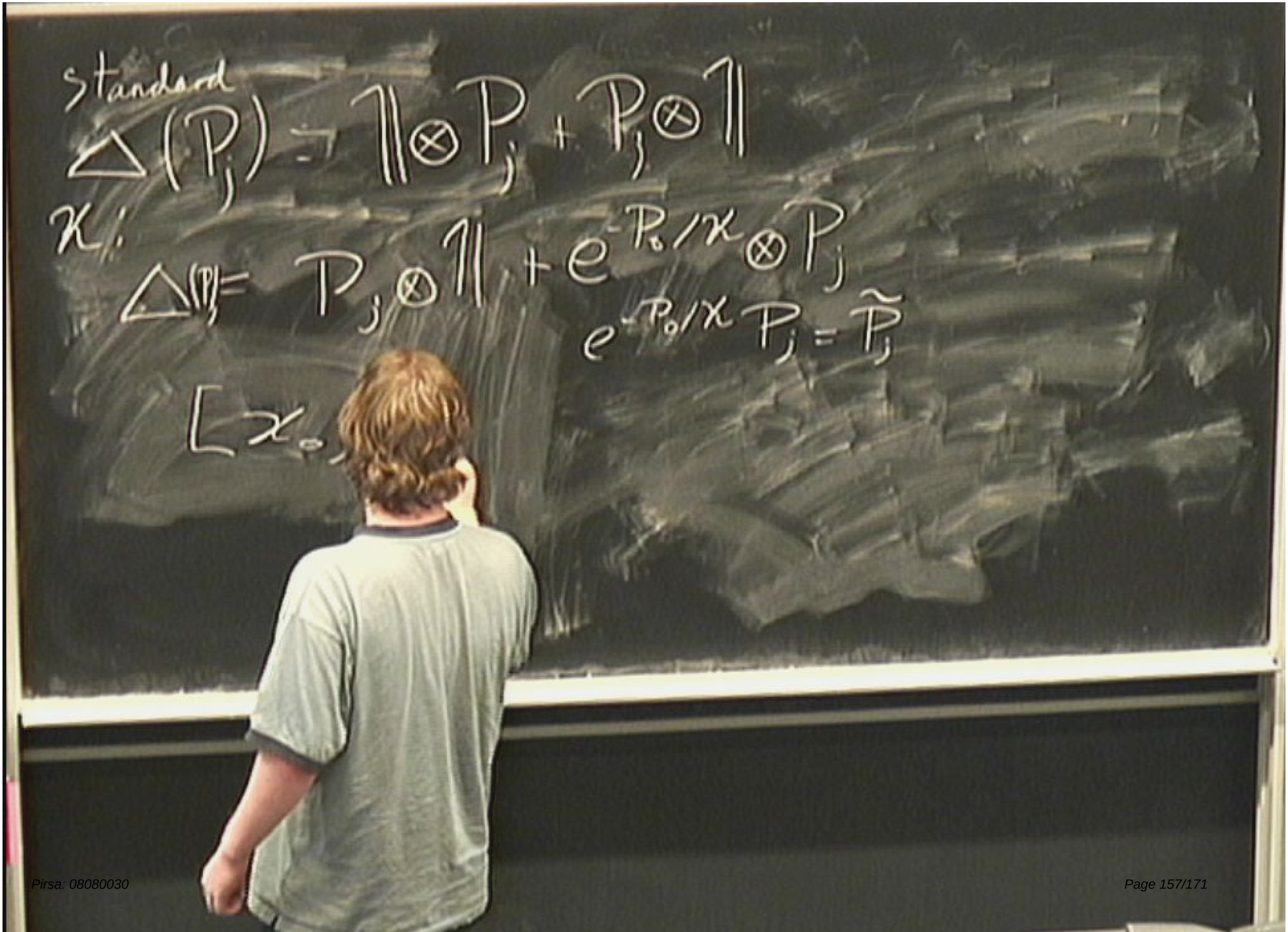

2 1/2 Apps of BCFW
standard
Δ(P_j) = 1 ⊗ P_j + P_j ⊗ 1

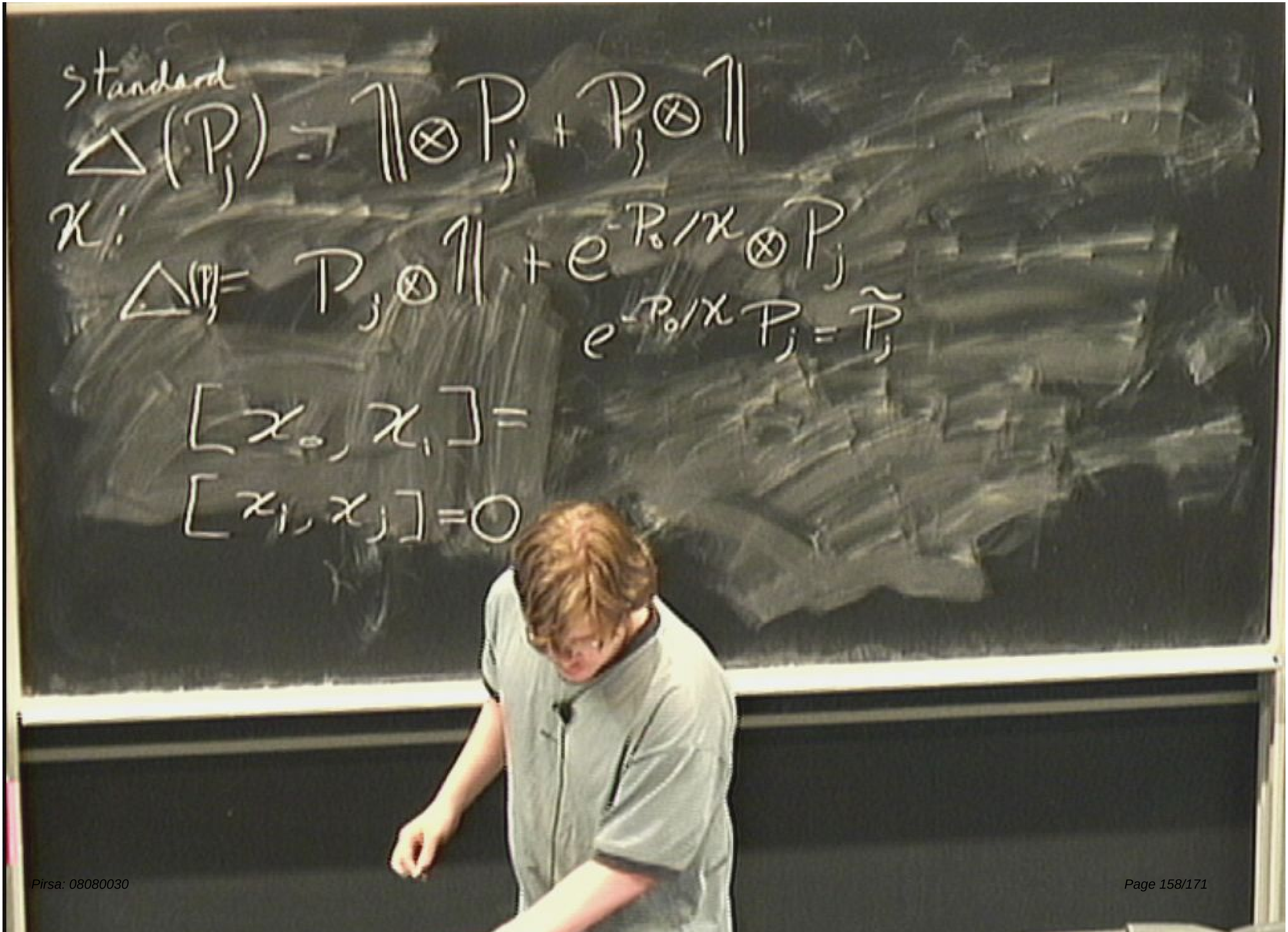

2 1/2 Apps of BCFW
standard
Δ(P_j) = 1 ⊗ P_j + P_j ⊗ 1
K.:
Δ

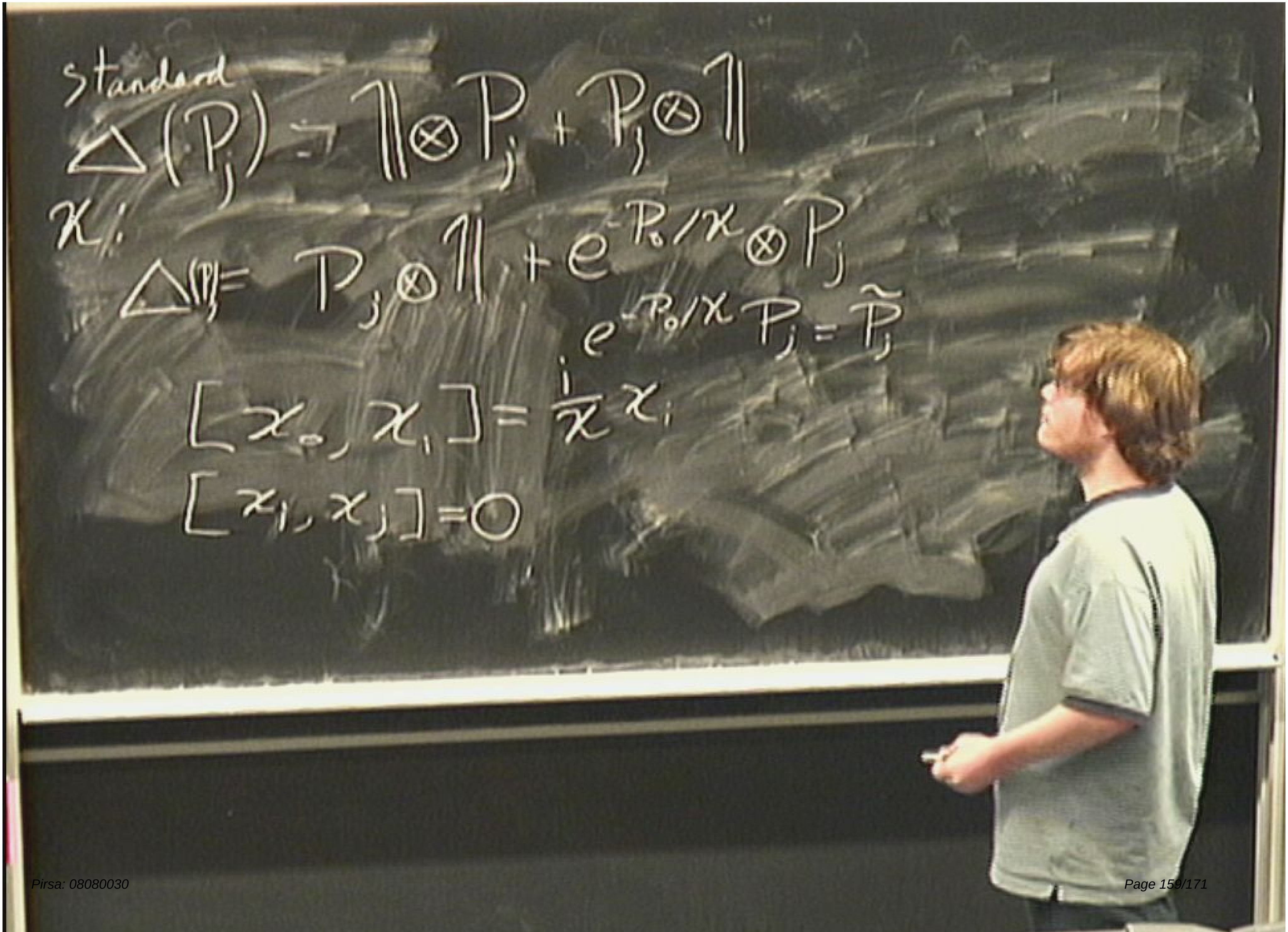

2½ Apps of BCFW
standard
Δ(P_j) = 1⊗P_j + P_j⊗1
κ:
Δ(P_j) = P_j ⊗ 1 + e
⊗ P_j


2 1/2 Apps of BCFW
standard
Δ(P_j) = 1 ⊗ P_j + P_j ⊗ 1
κ:
Δ(P_j) = P_j ⊗ 1 + e^{-P_0/κ} ⊗ P_j
κ P_j = P̃_j


Standard
Δ(P_j) = 1 ⊗ P_j + P_j ⊗ 1
κ:
Δ(P_j) = P_j ⊗ 1 + e^{-P_0/κ} ⊗ P_j
e^{-P_0/κ} P_j = P̃_j


standard
Δ(P_j) = 1 ⊗ P_j + P_j ⊗ 1
κ:
Δ(P_j) = P_j ⊗ 1 + e^{-P_0/κ} ⊗ P_j
e^{-P_0/κ} P_j = P̃_j
[x_0,


standard
$\Delta(P_j) = \mathbb{1} \otimes P_j + P_j \otimes \mathbb{1}$
κ:
$\Delta(P_j) = P_j \otimes \mathbb{1} + e^{-P_0/\kappa} \otimes P_j$
$e^{-P_0/\kappa} P_j = \tilde{P}_j$
$[x_0, x_1] =$
$[x_1, x_j] = 0$


standard
$\Delta(P_j) = 1 \otimes P_j + P_j \otimes 1$
κ:
$\Delta(P_j) = P_j \otimes 1 + e^{-P_0/\kappa} \otimes P_j$
$e^{-P_0/\kappa} P_j = \tilde{P}_j$
$[x_0, x_i] = \frac{i}{\kappa} x_i$
$[x_i, x_j] = 0$

standard

$$\Delta(P_j) = 1\!\!1 \otimes P_j + P_j \otimes 1\!\!1$$

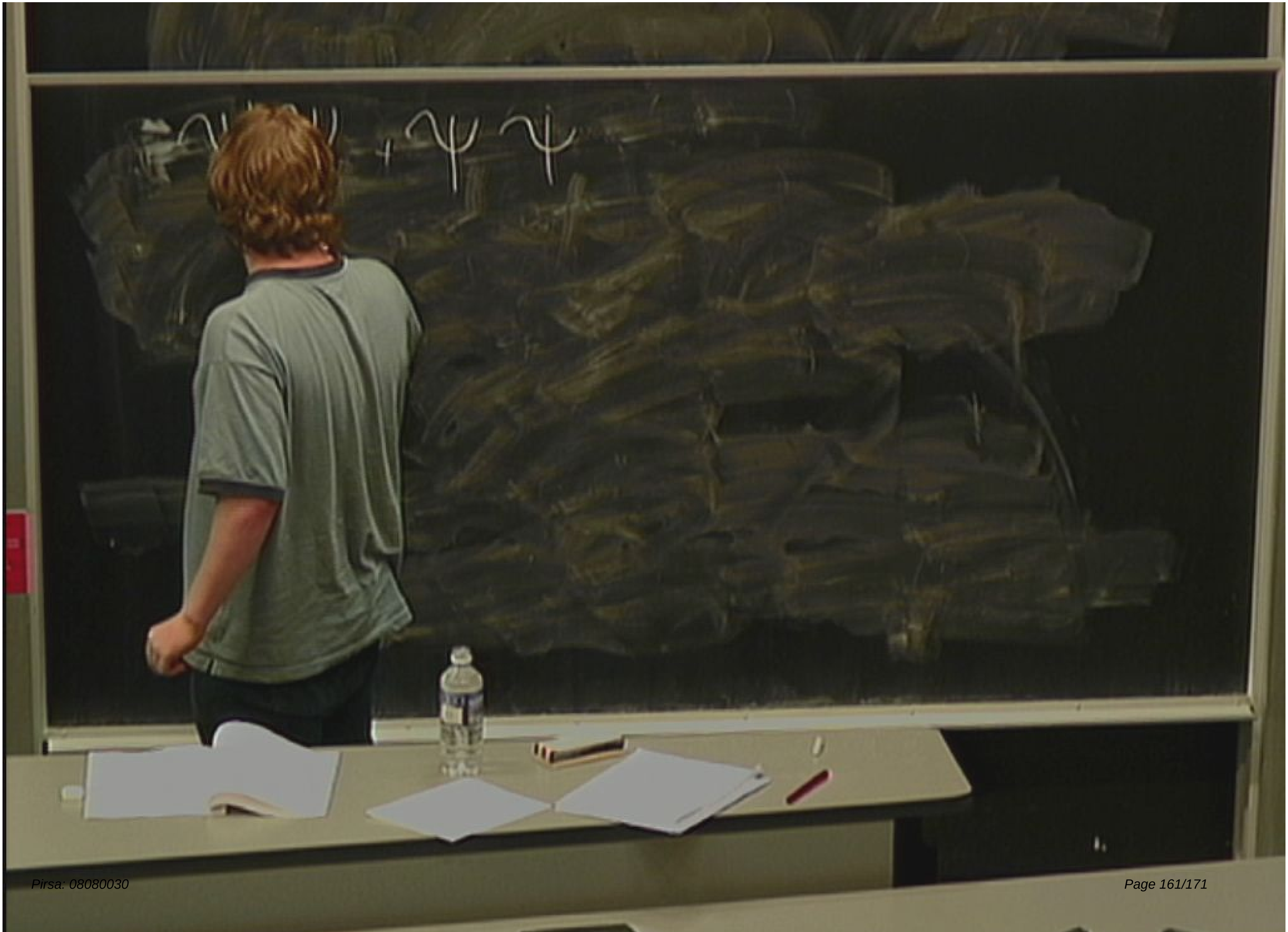
κ:

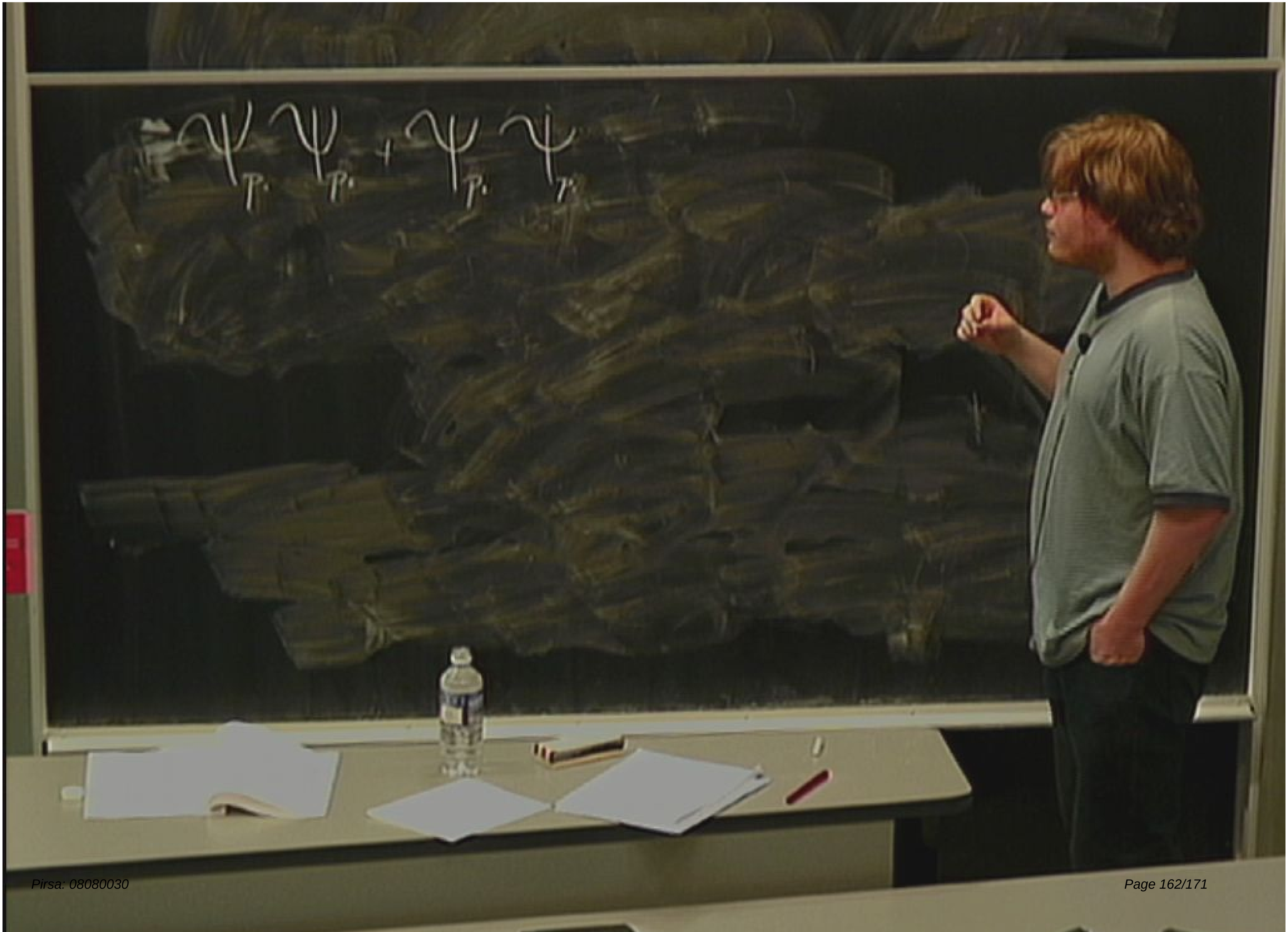
$$\Delta(P_j) = P_j \otimes 1\!\!1 + e^{-P_0/\kappa} \otimes P_j$$

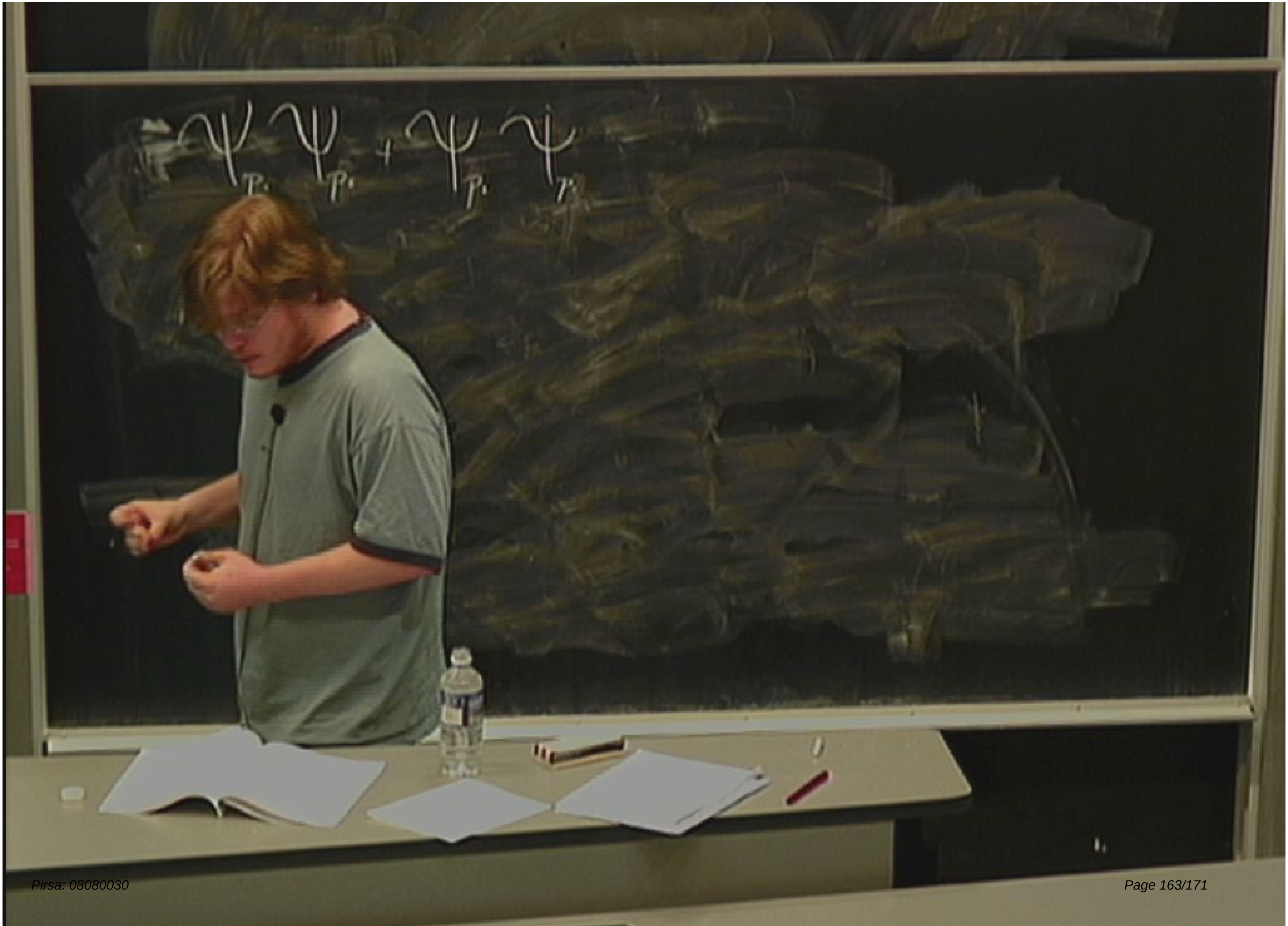
$$e^{-P_0/\kappa} P_j = \tilde{P}_j$$

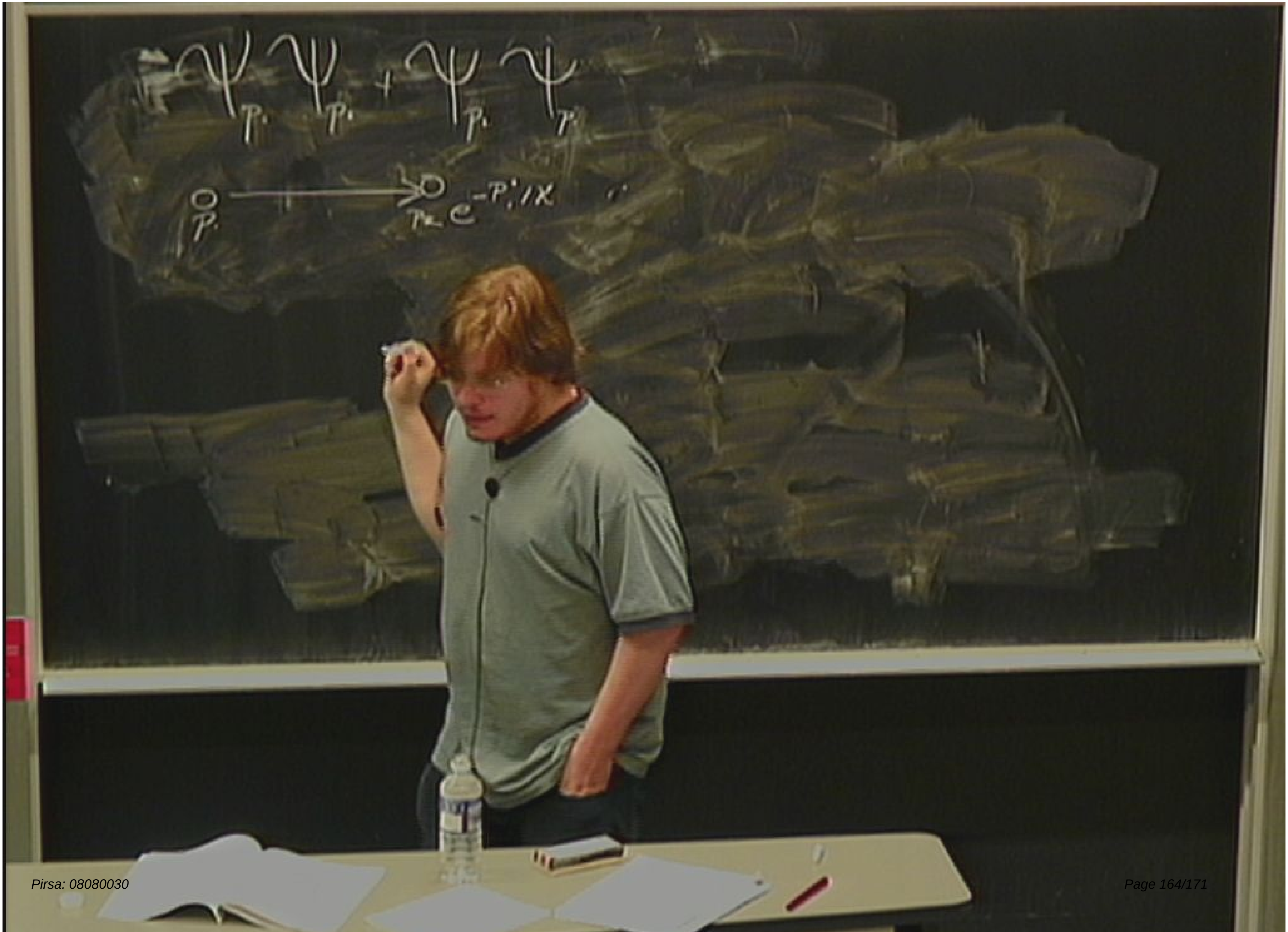
$$[x_0, x_i] = \frac{i}{\kappa} x_i$$

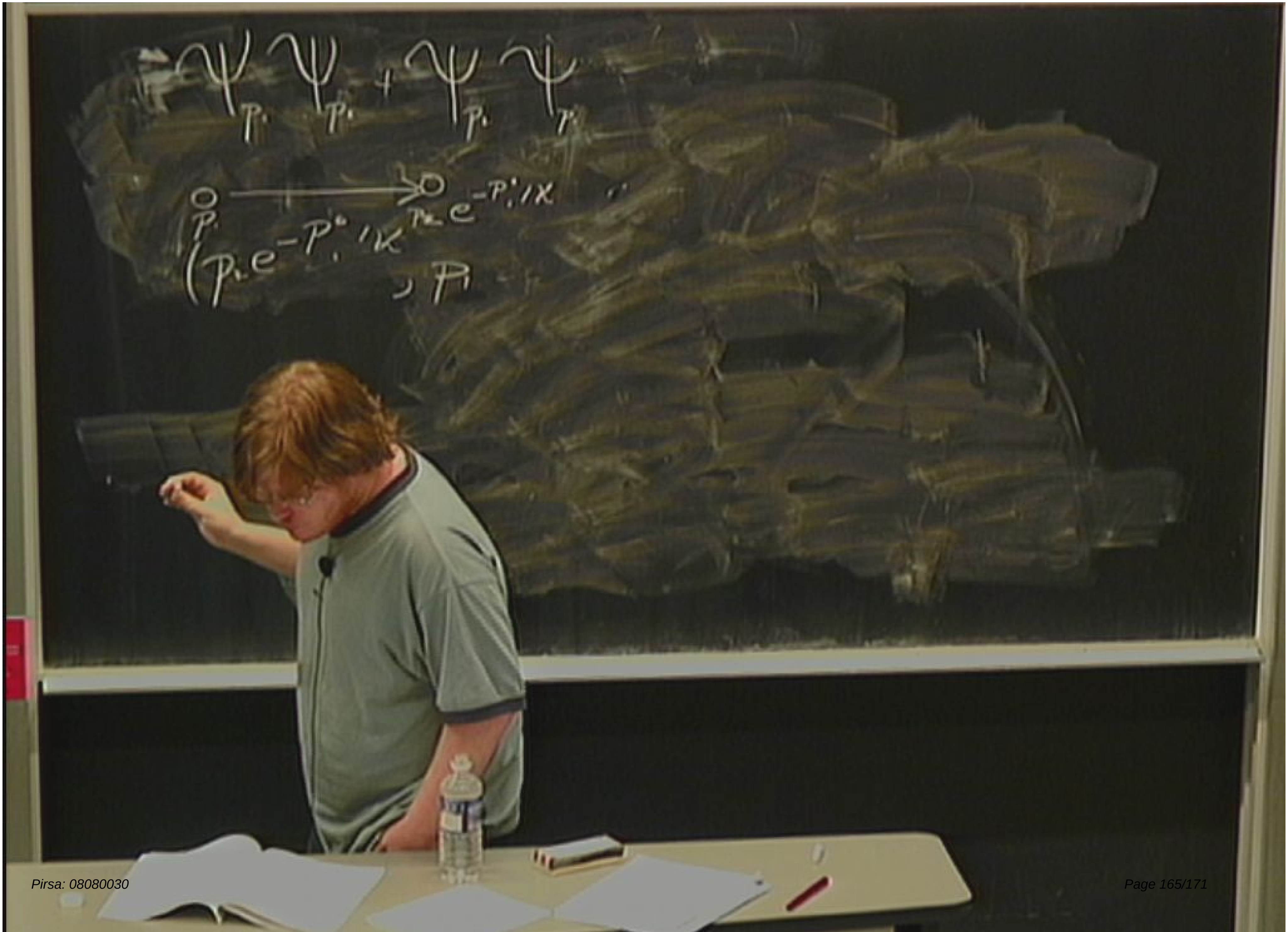
$$[x_i, x_j] = 0$$

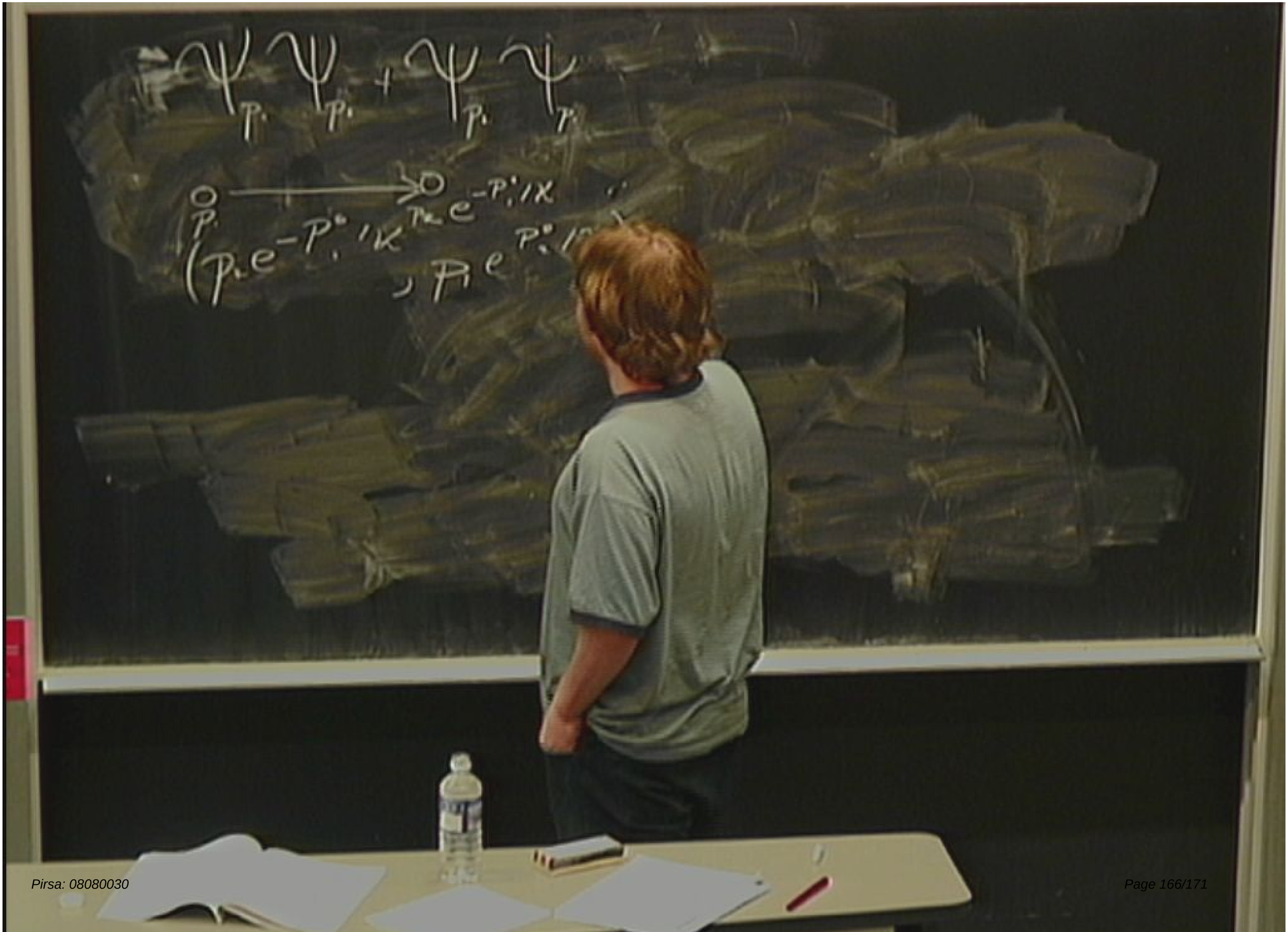


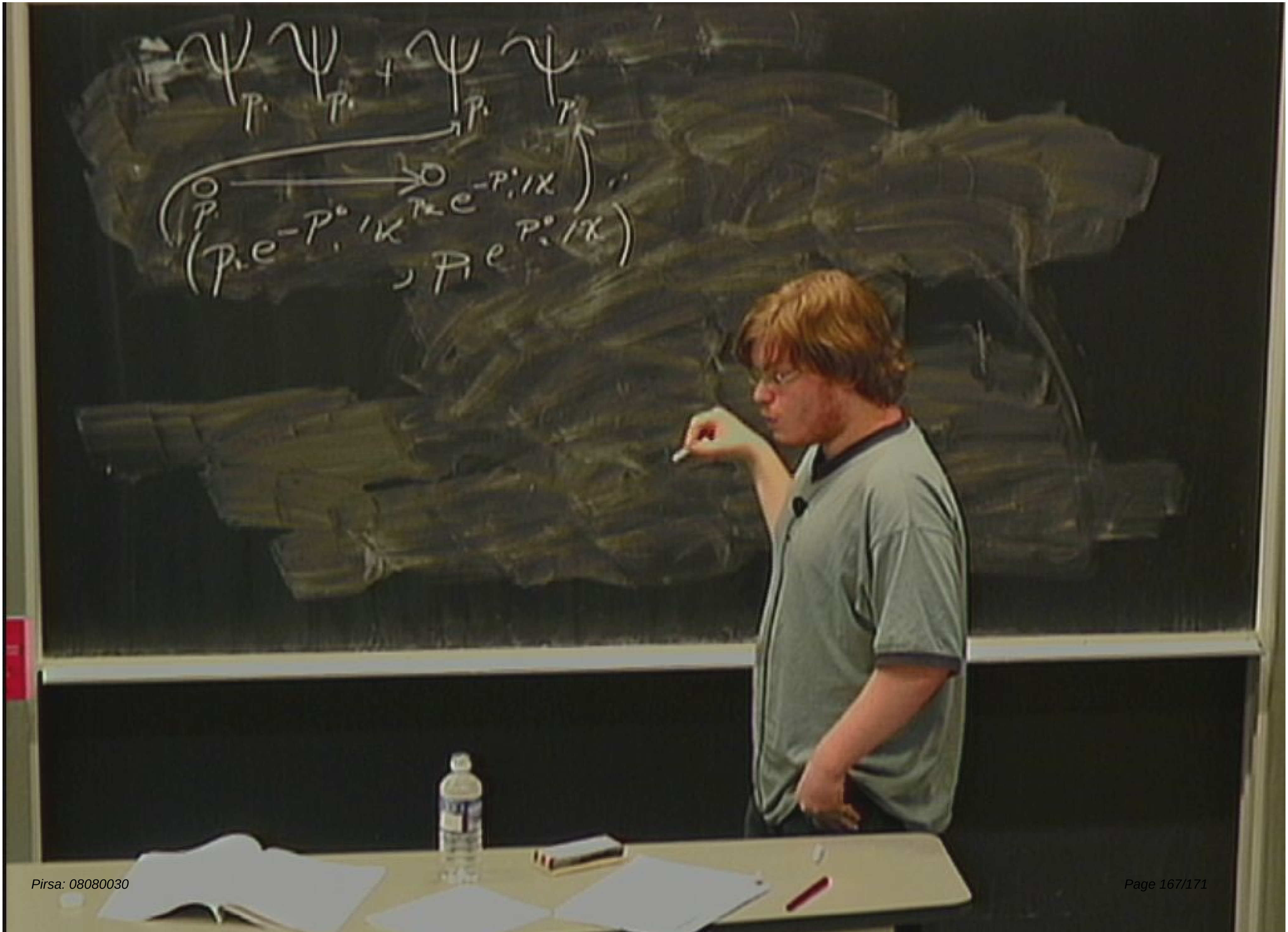


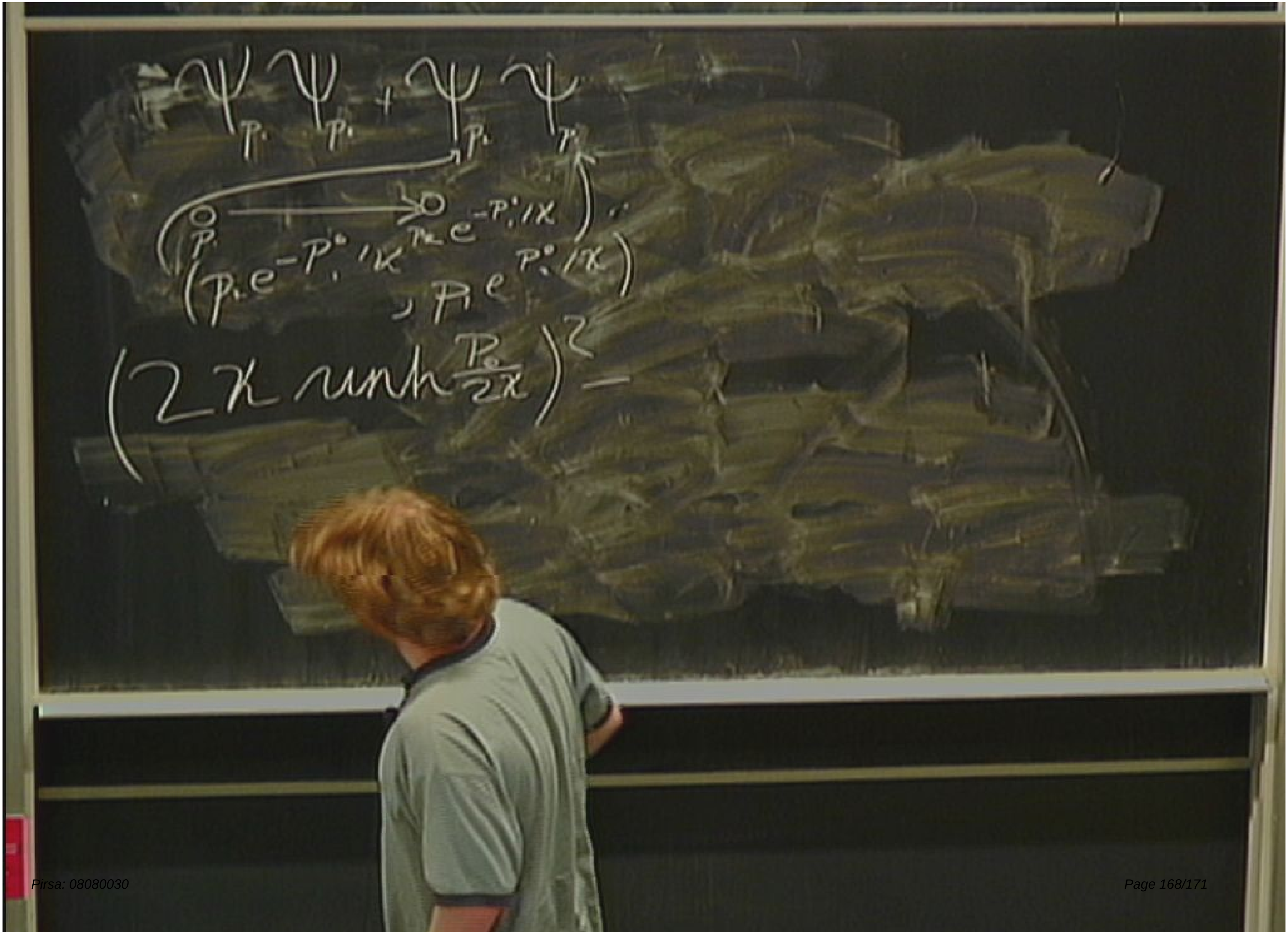


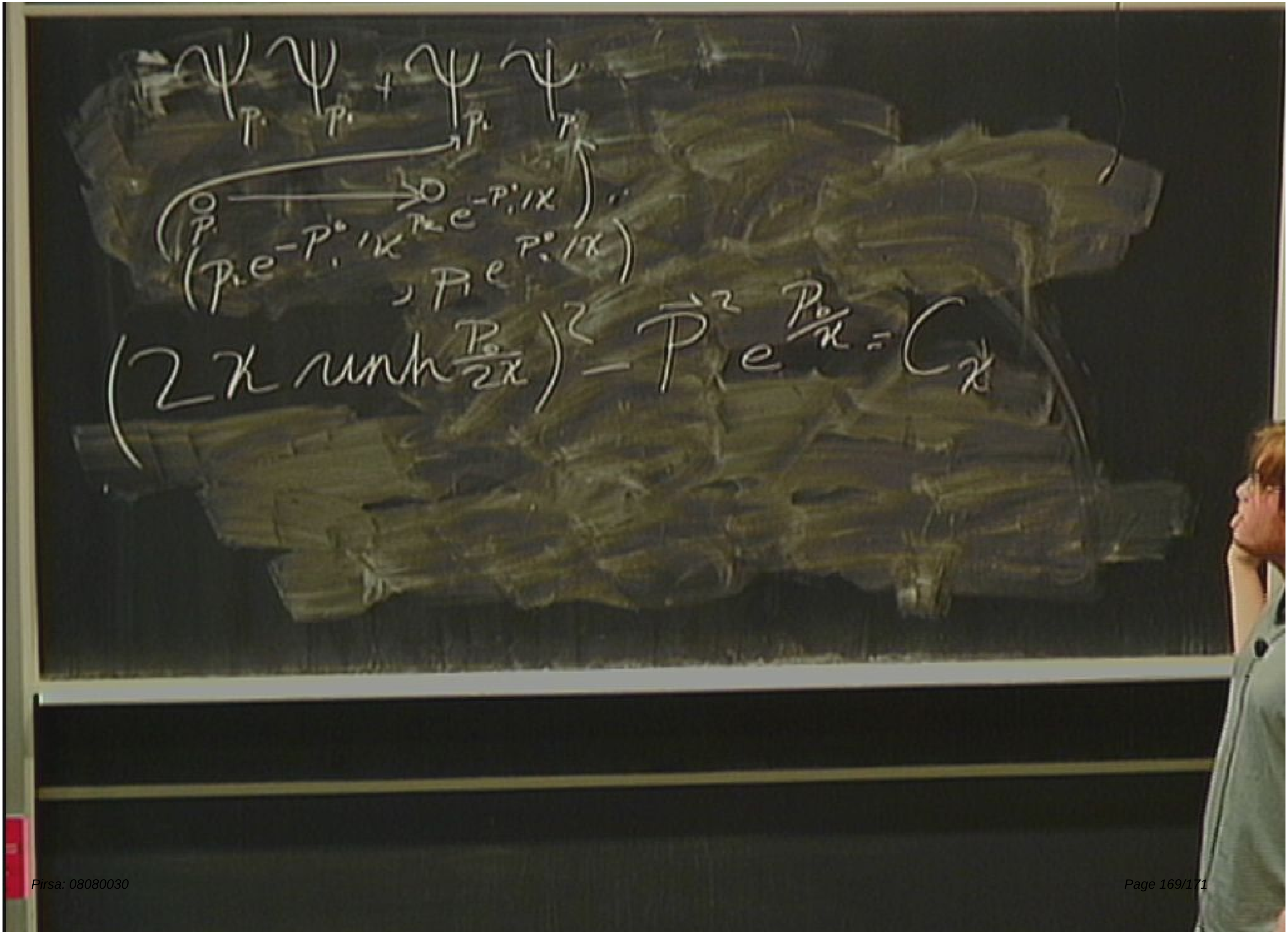


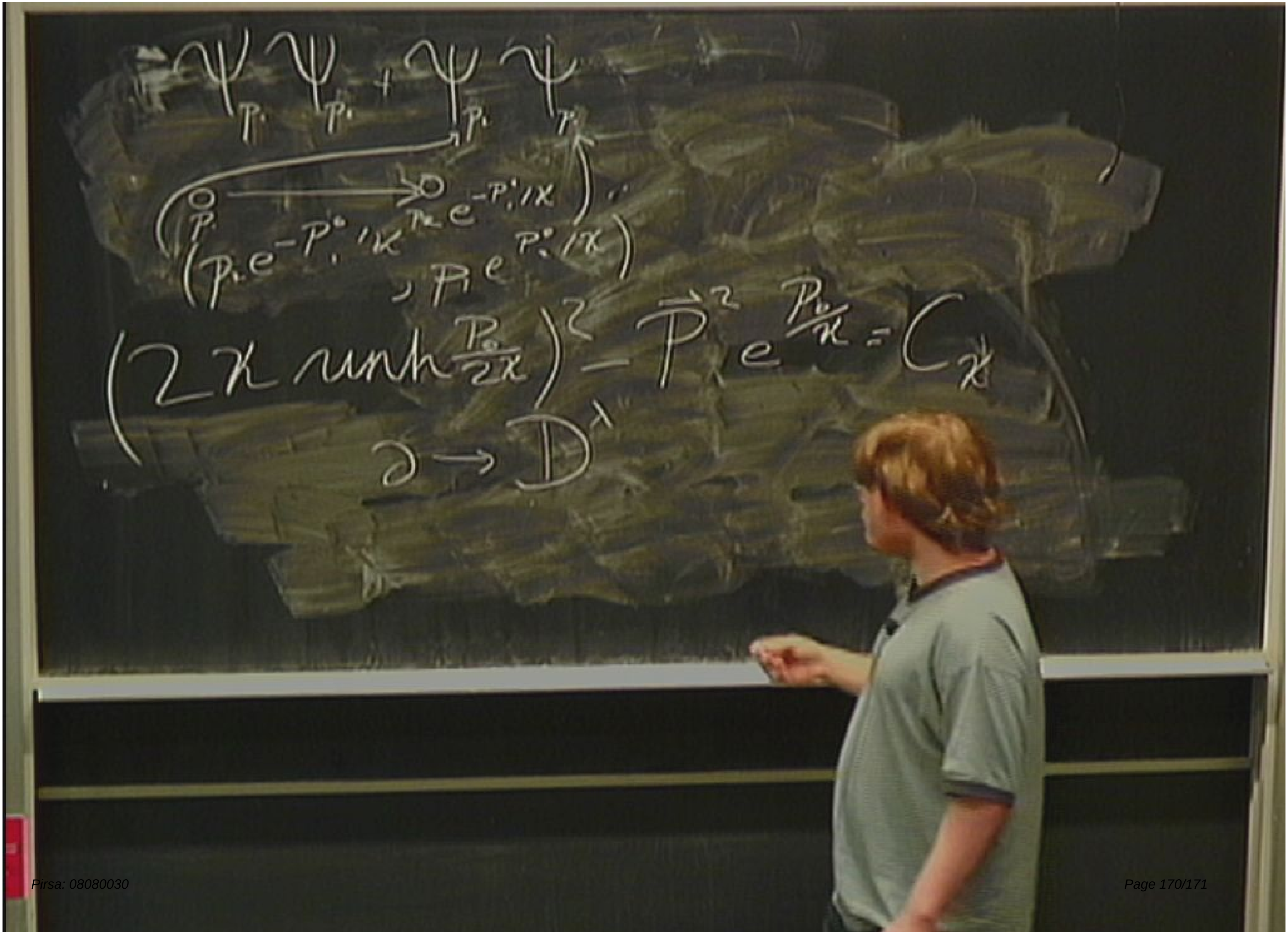


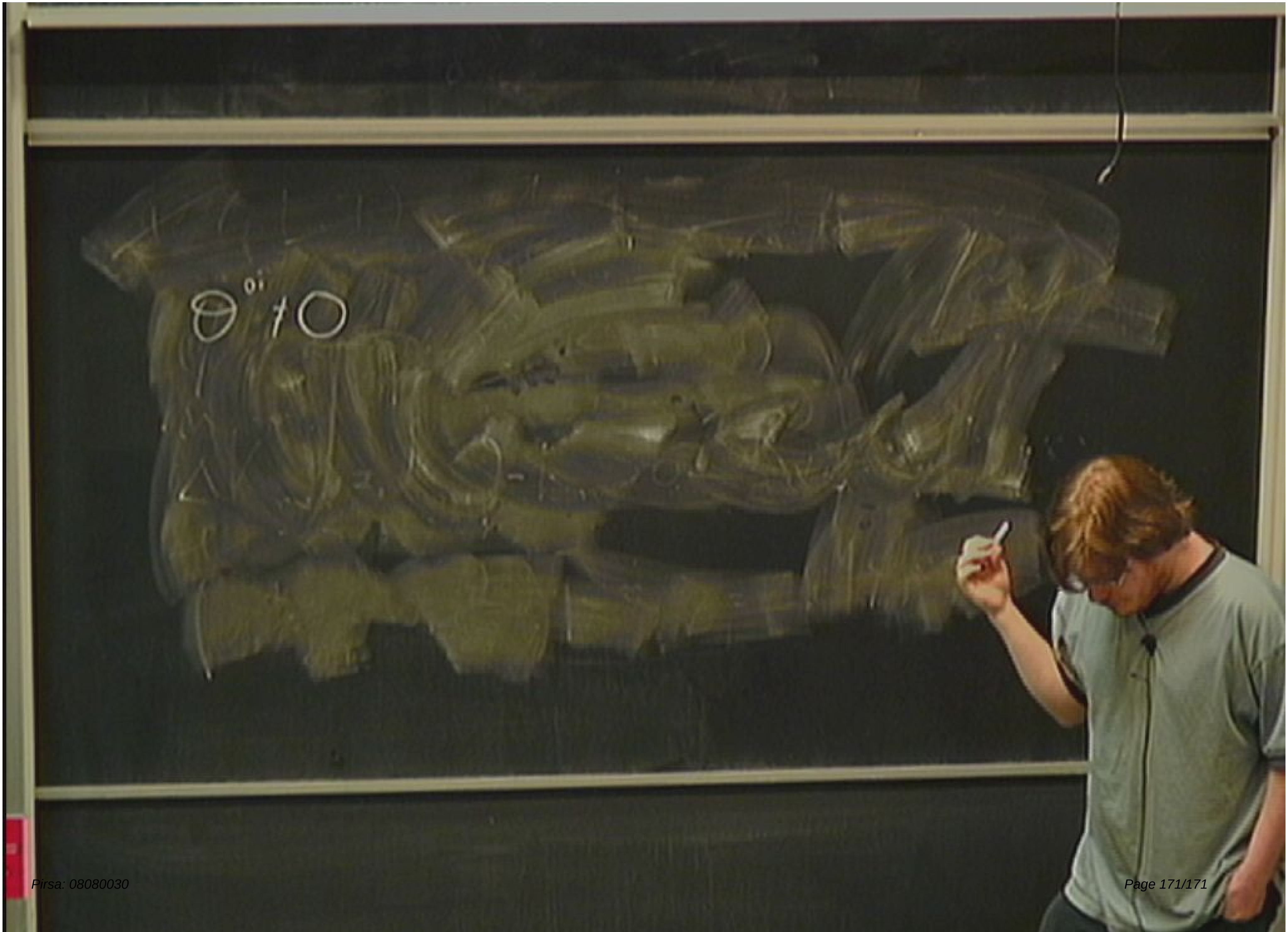







(p1 e-p2°/κ , p2 e p1°/κ)
(2κ sinh P0/2κ)2 - P2 e P0/κ = Cκ


$(2\kappa \sinh \frac{P_0}{2\kappa})^2 - \vec{P}^2 e^{P_0/\kappa} = C_\kappa$
$\partial \to D$


$\theta^{0i} \neq 0$