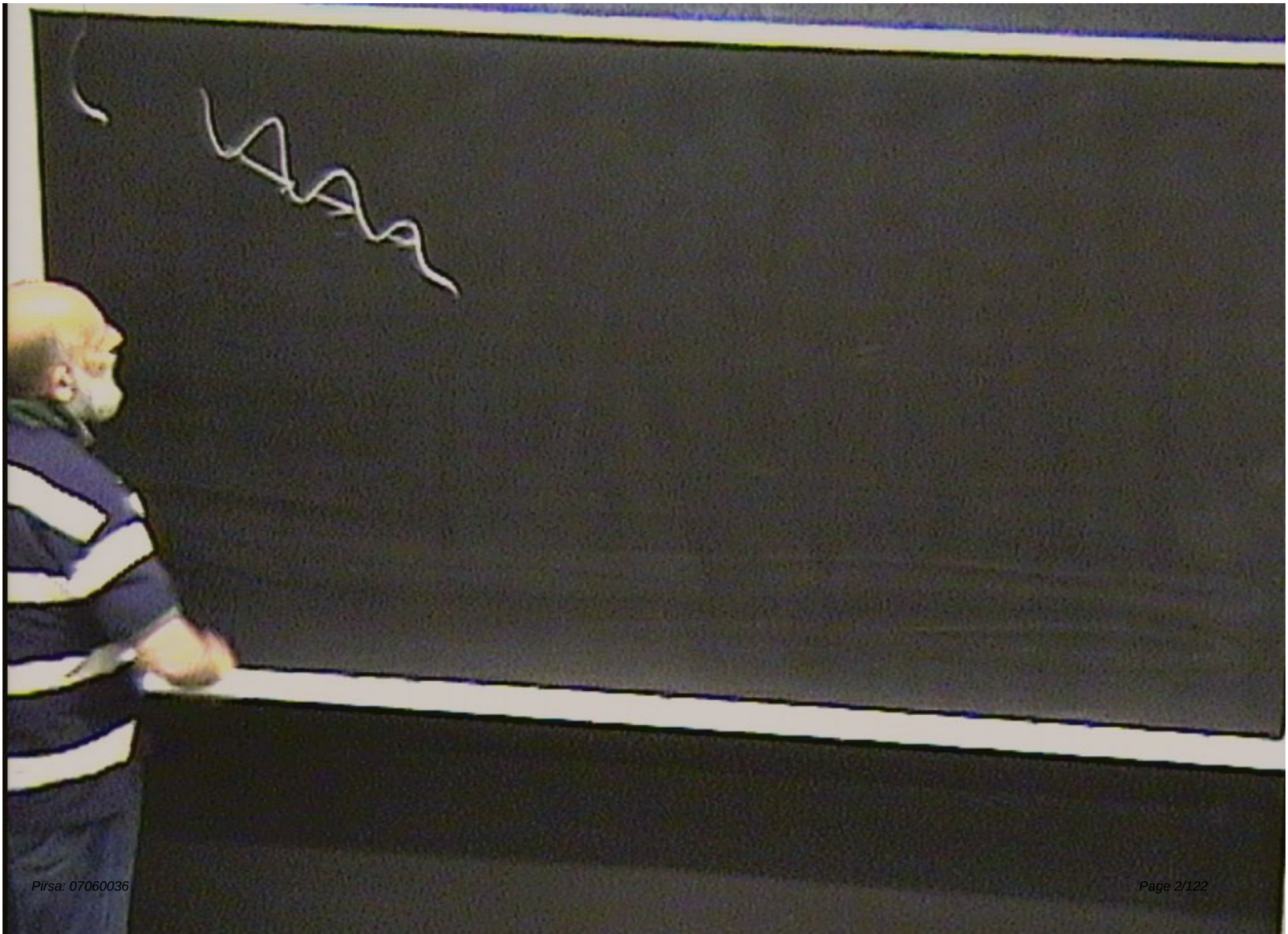
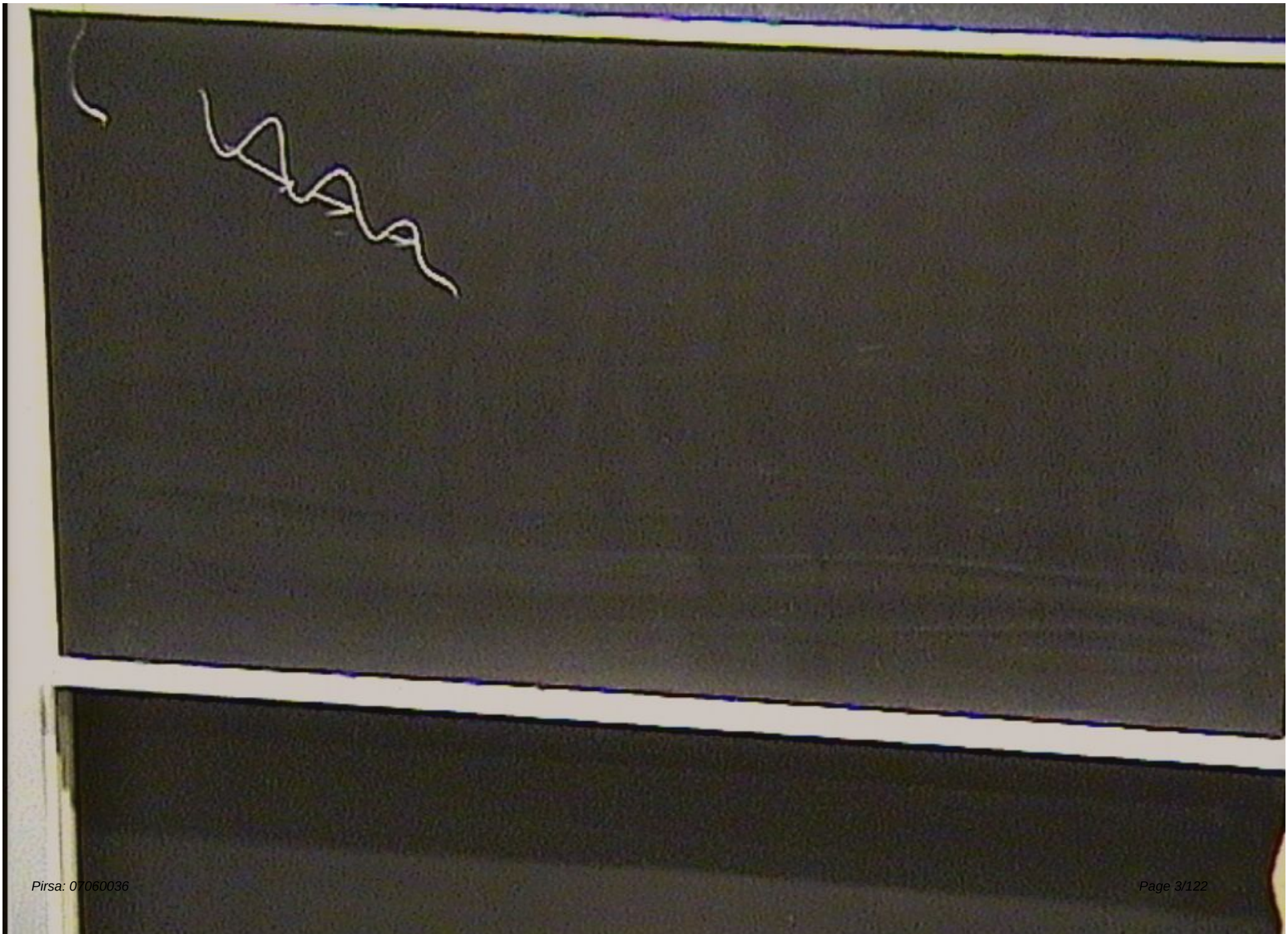
Title: Black Holes & Holography - Class 8

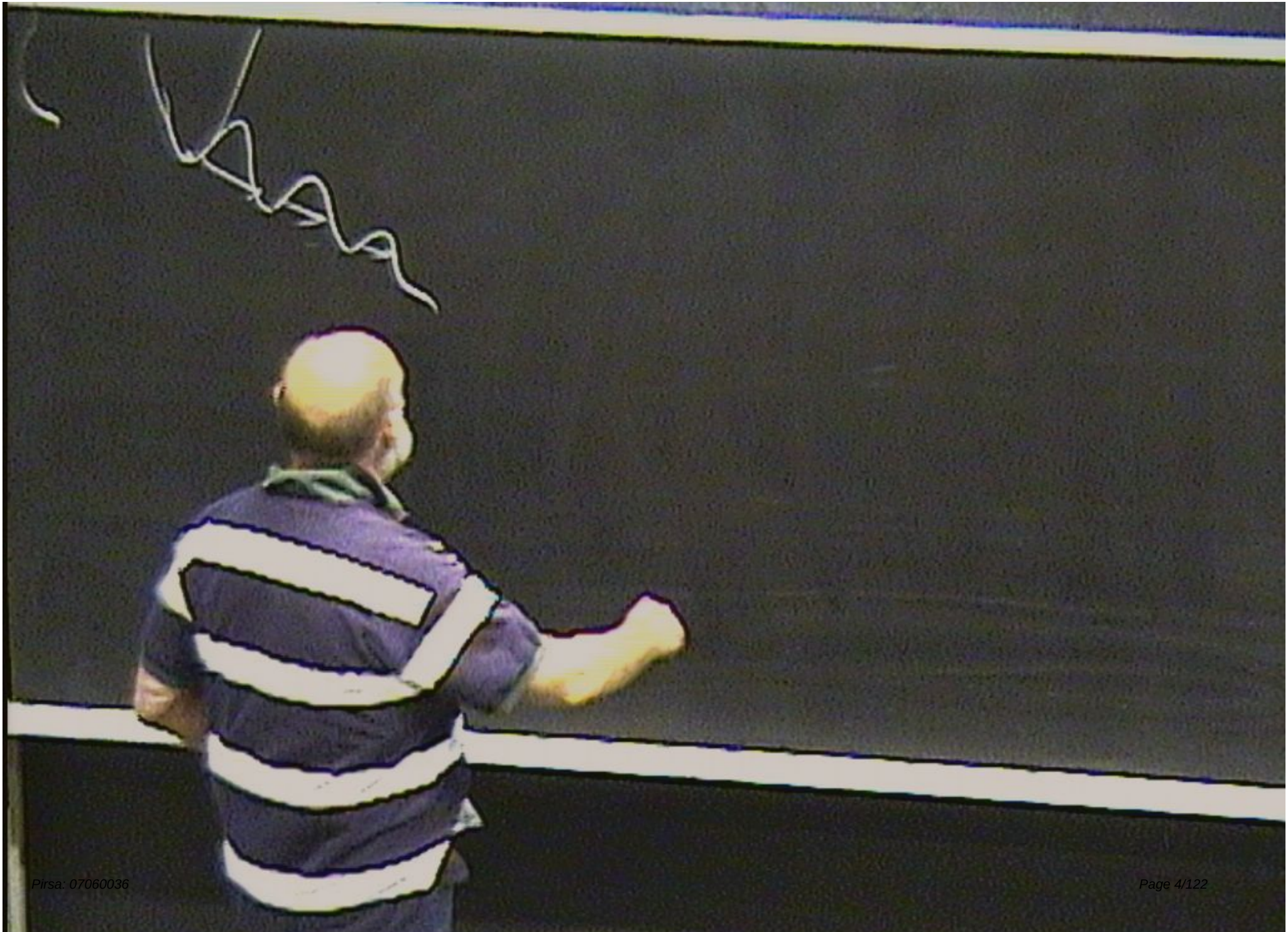
Date: Jun 12, 2007 02:00 PM

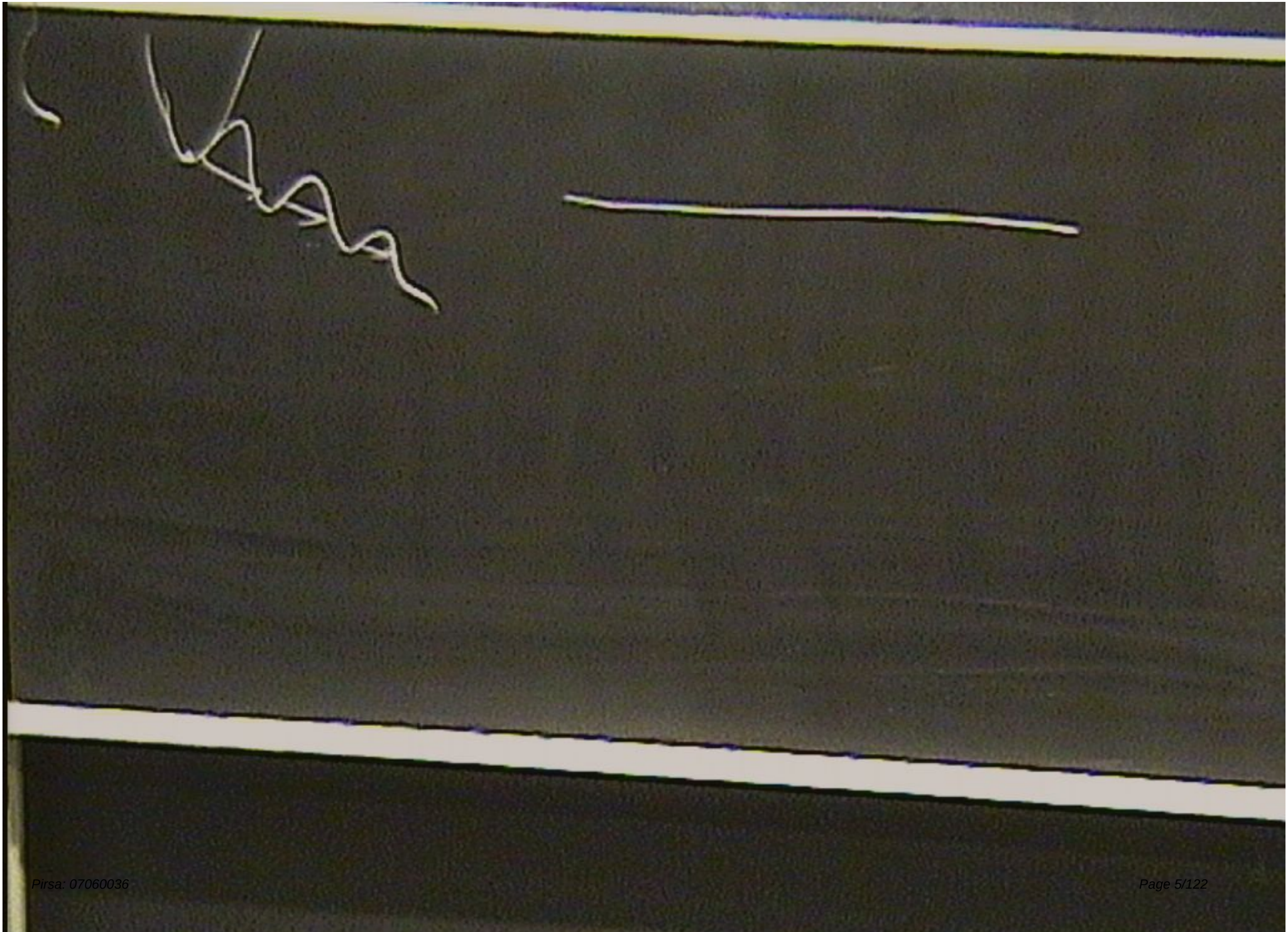
URL: http://pirsa.org/07060036

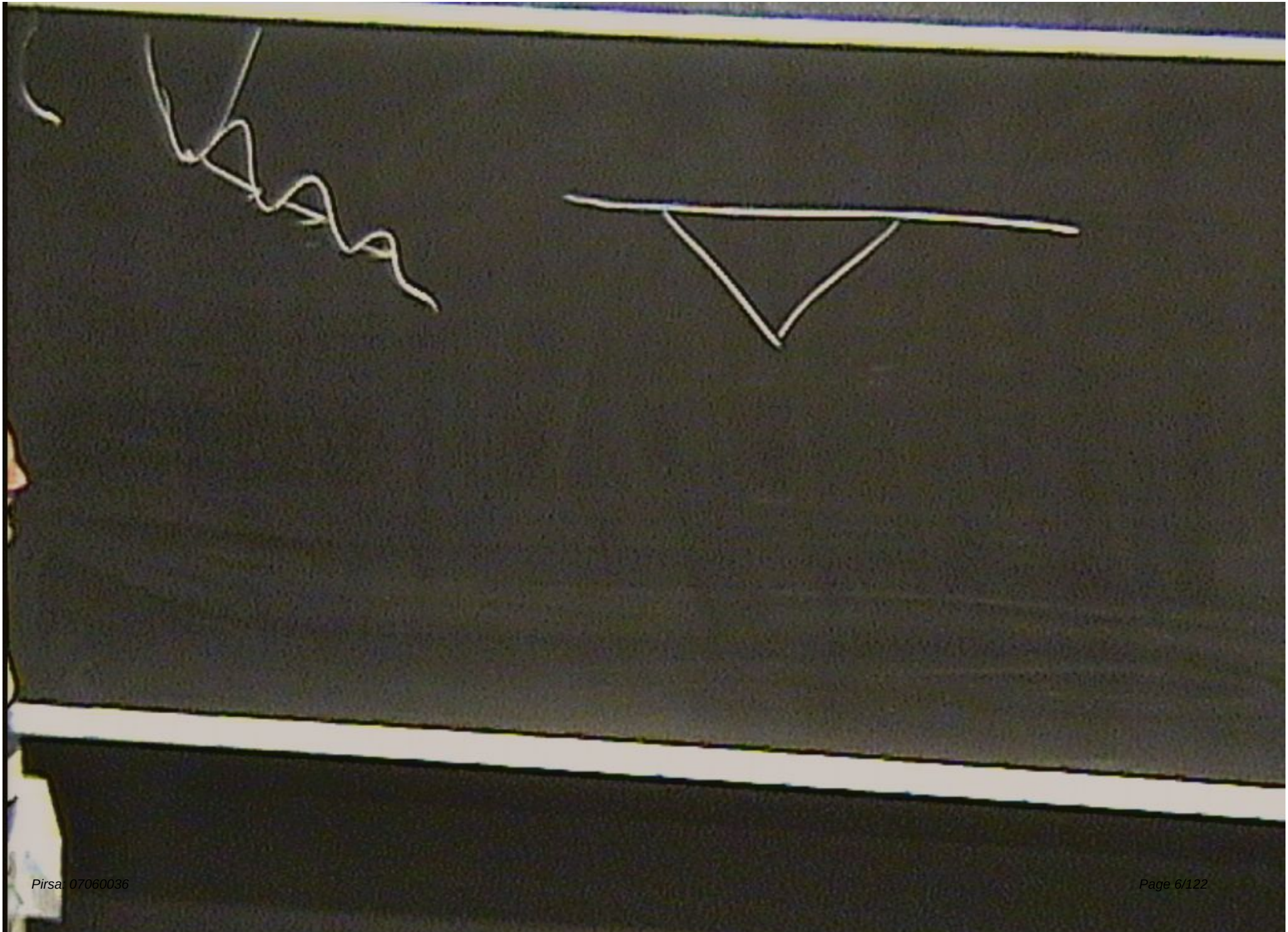
Abstract:

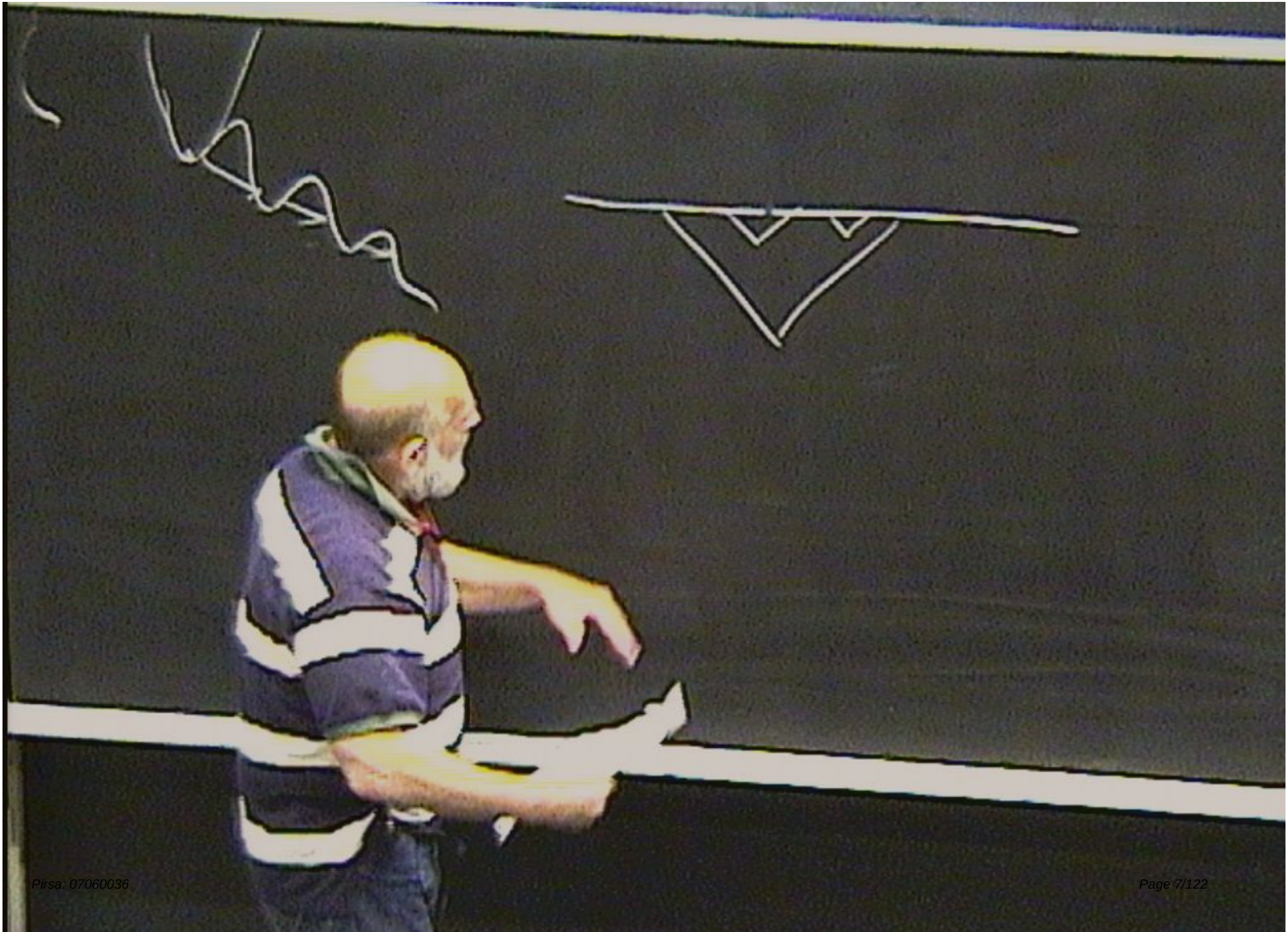


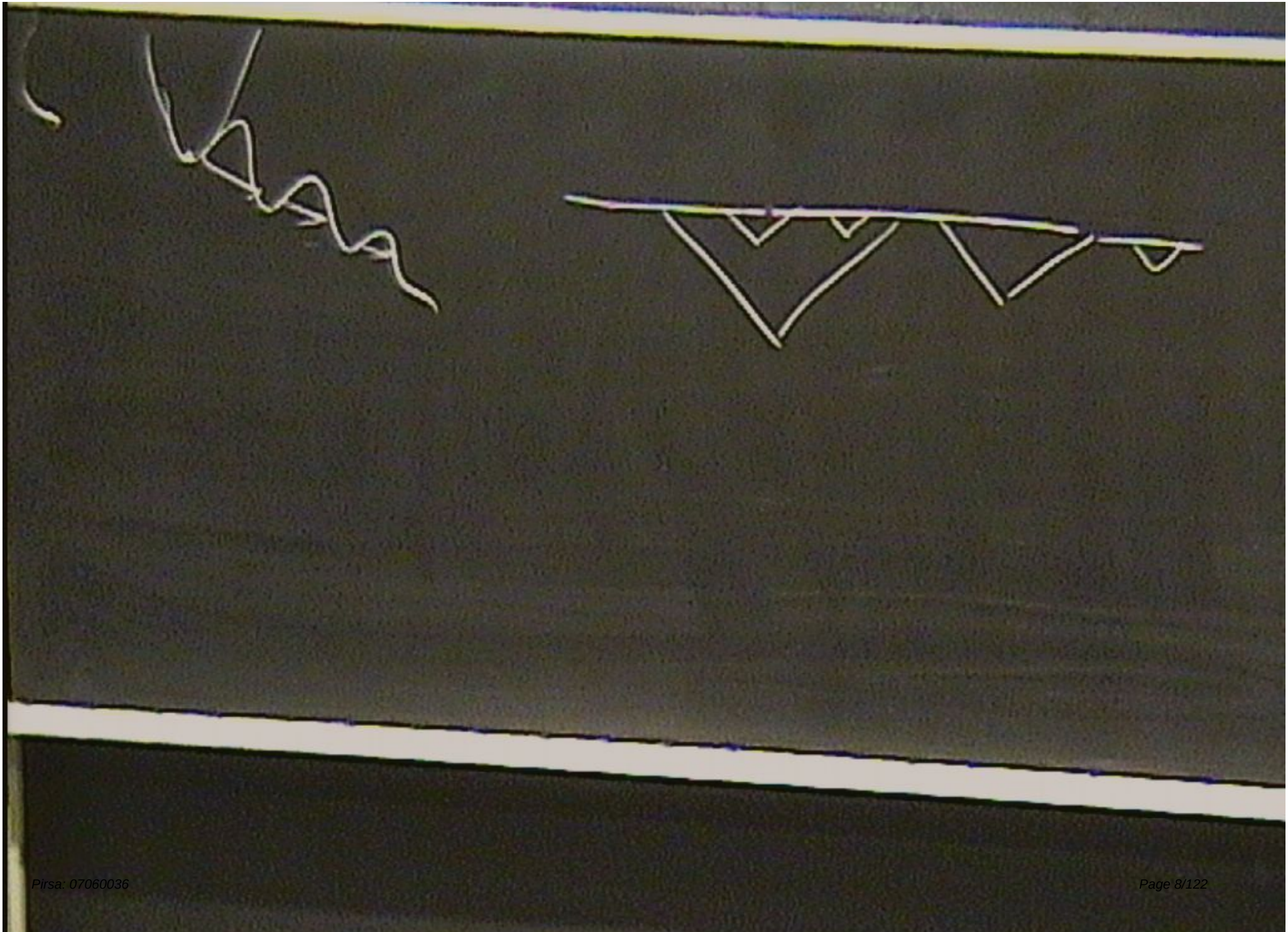


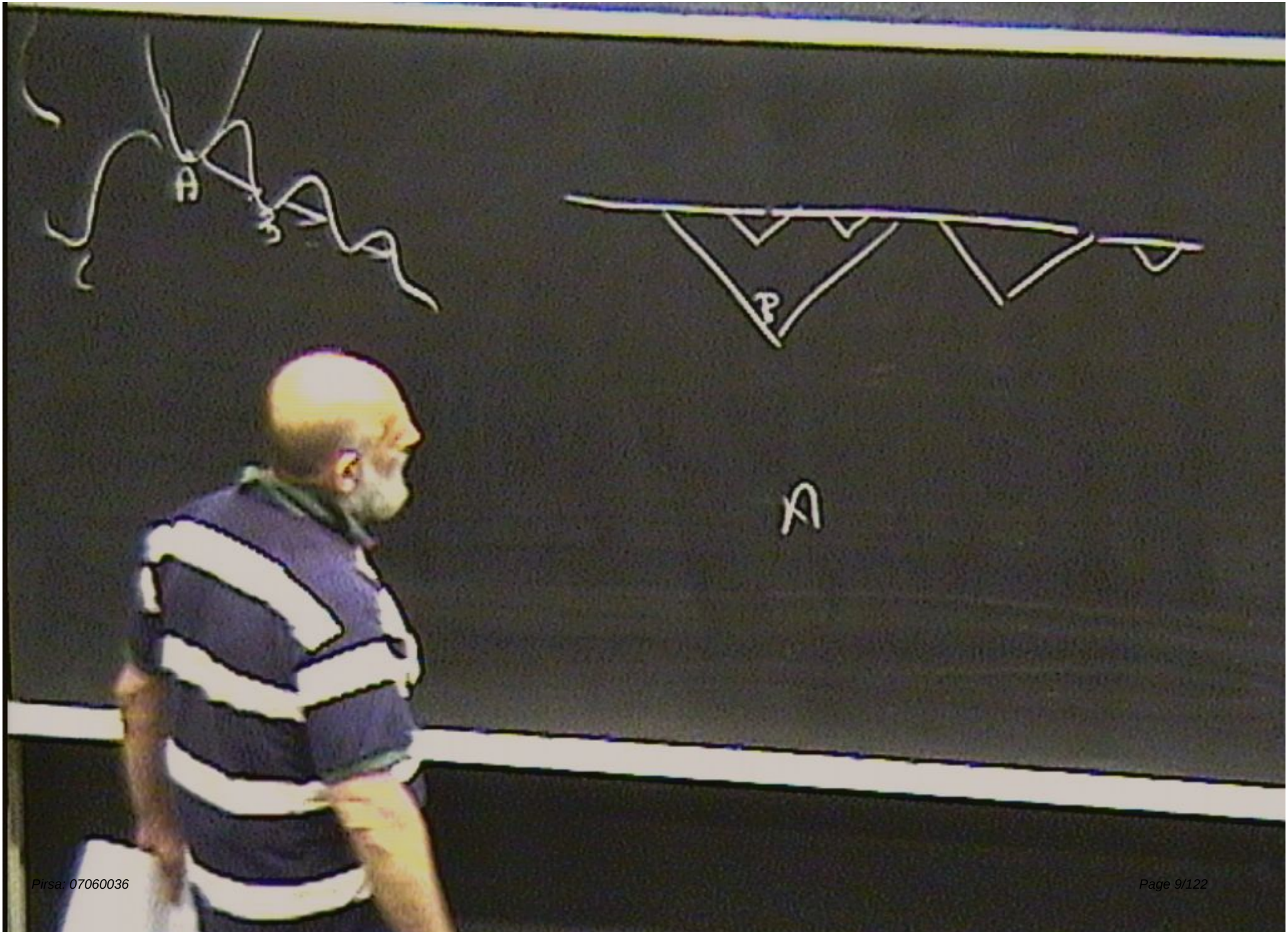


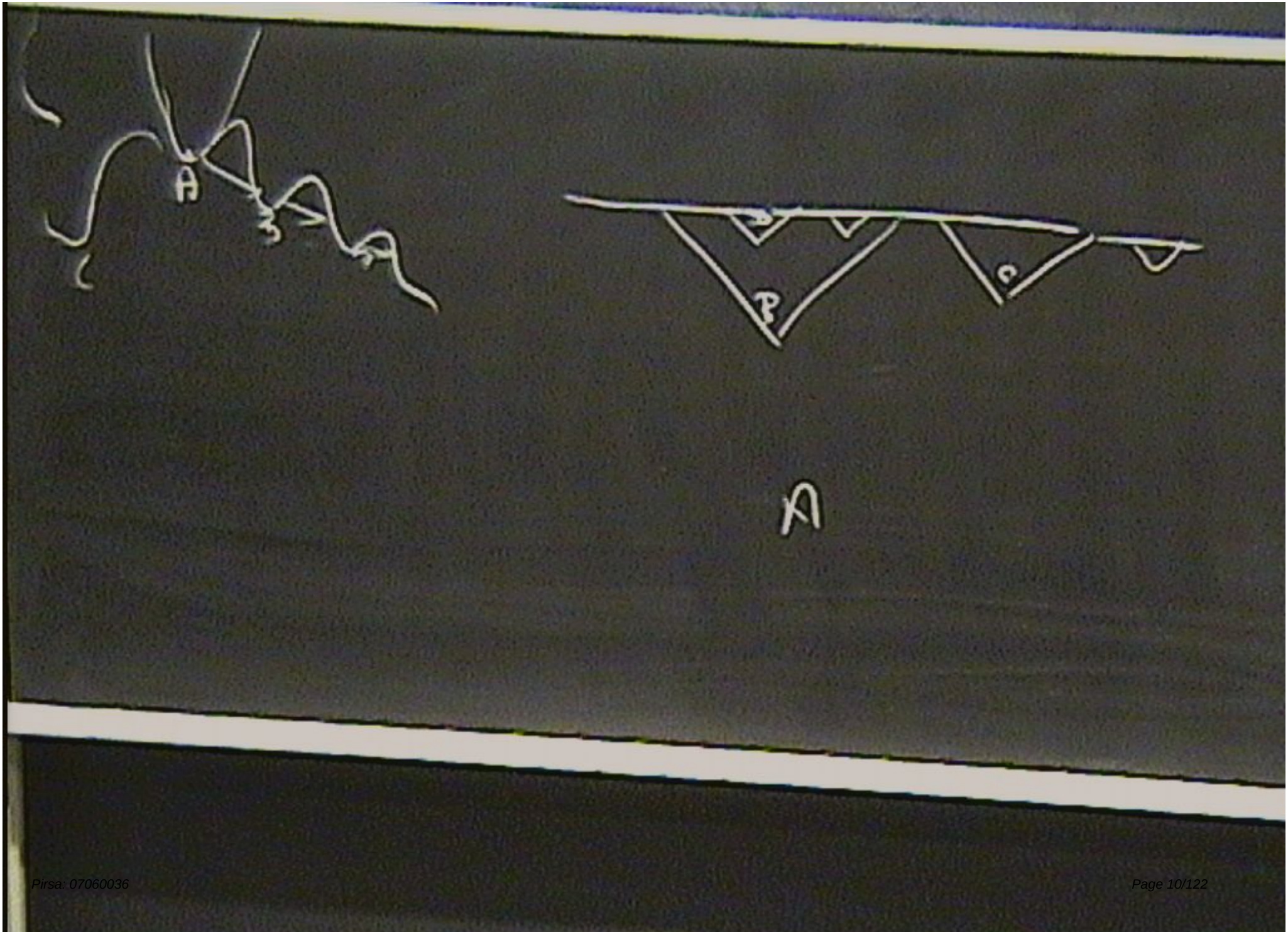


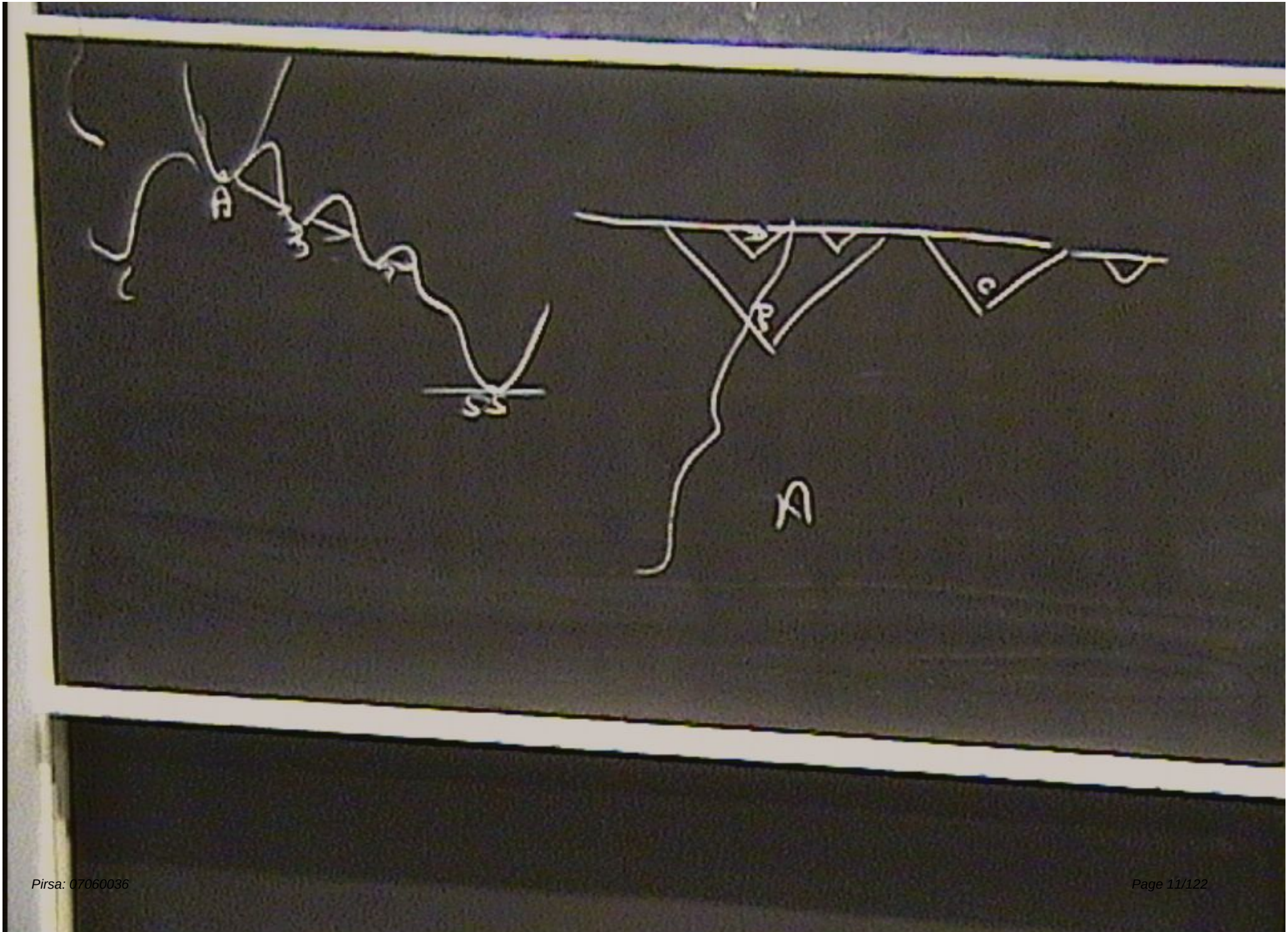


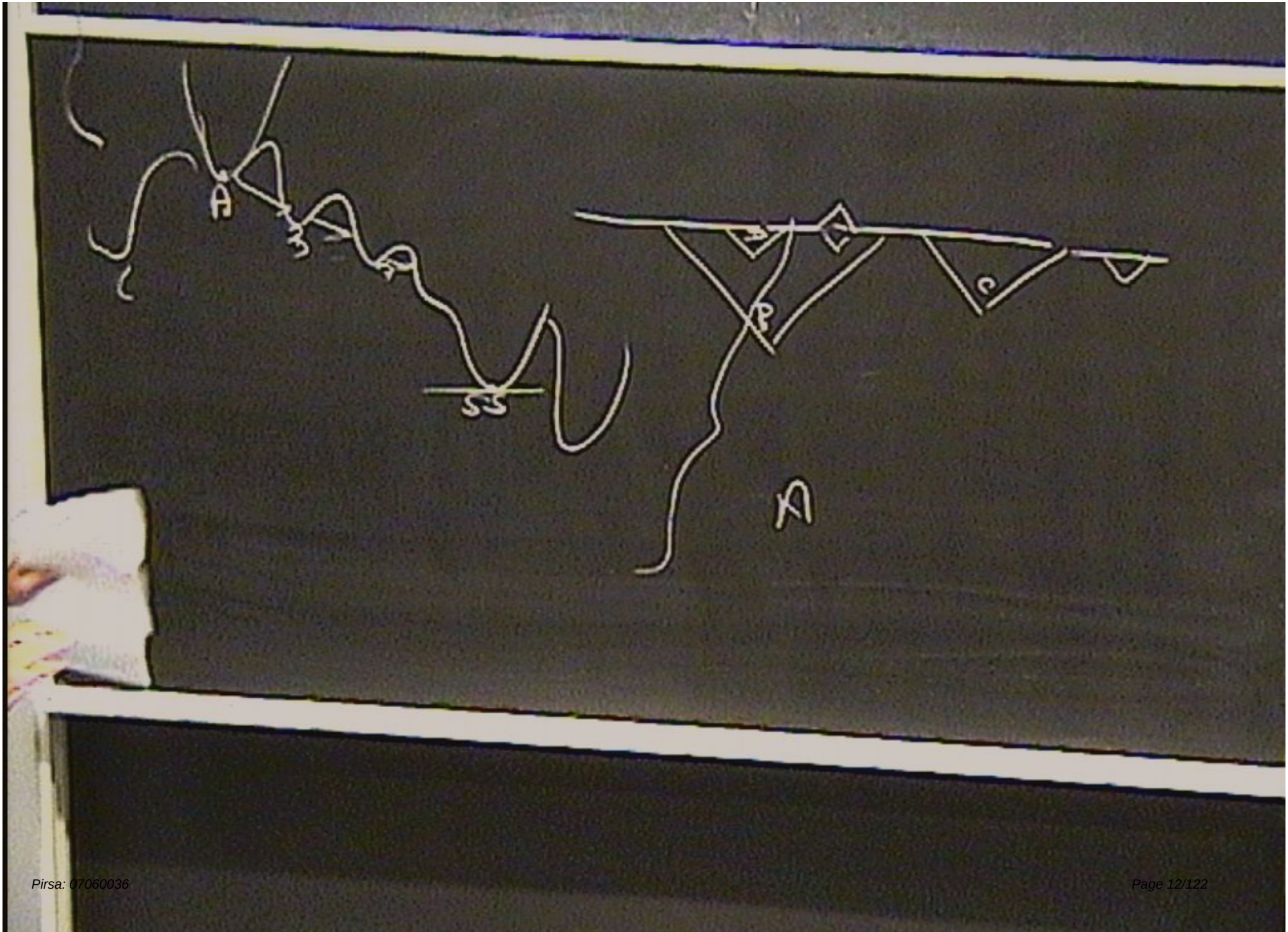


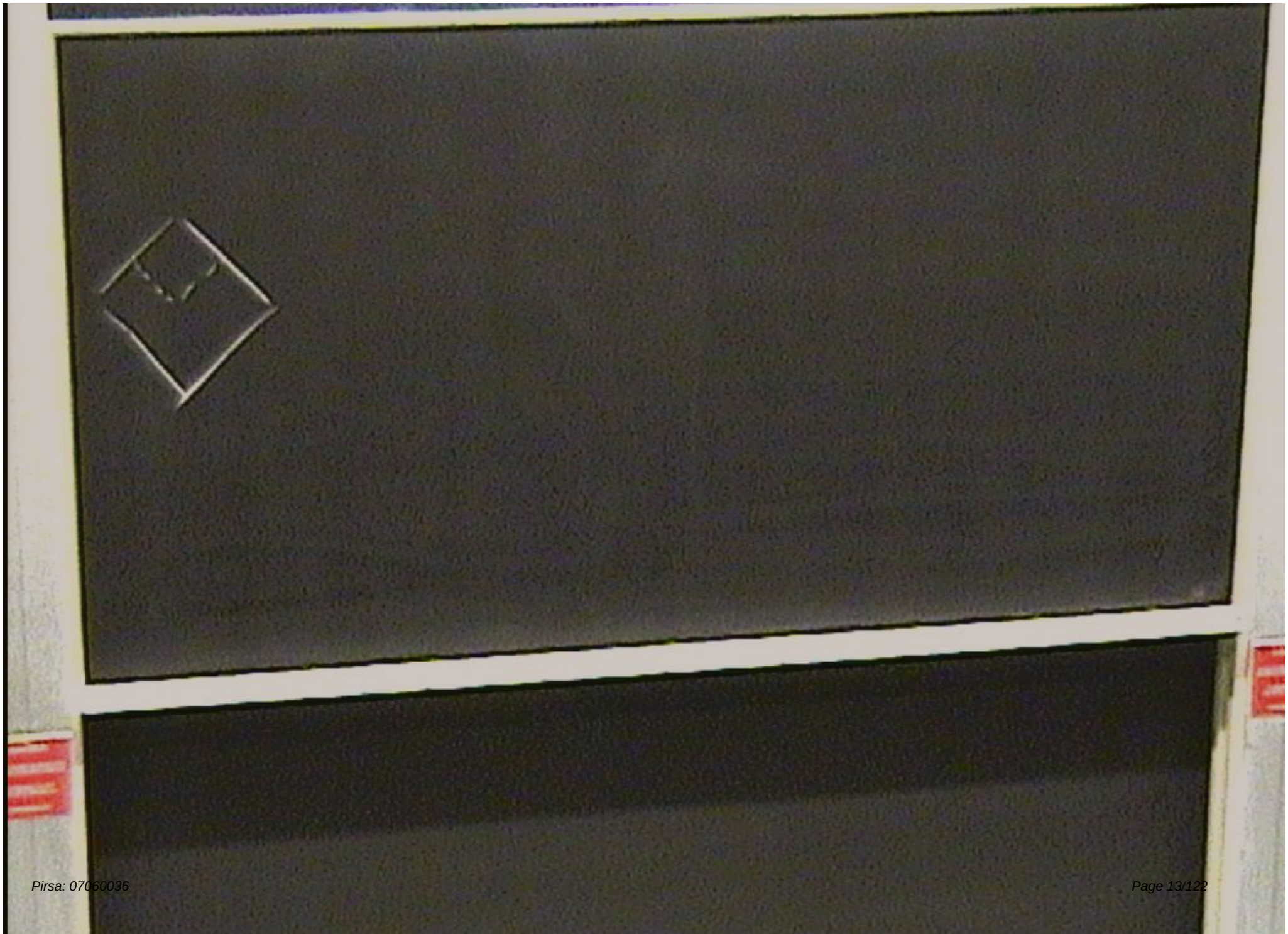


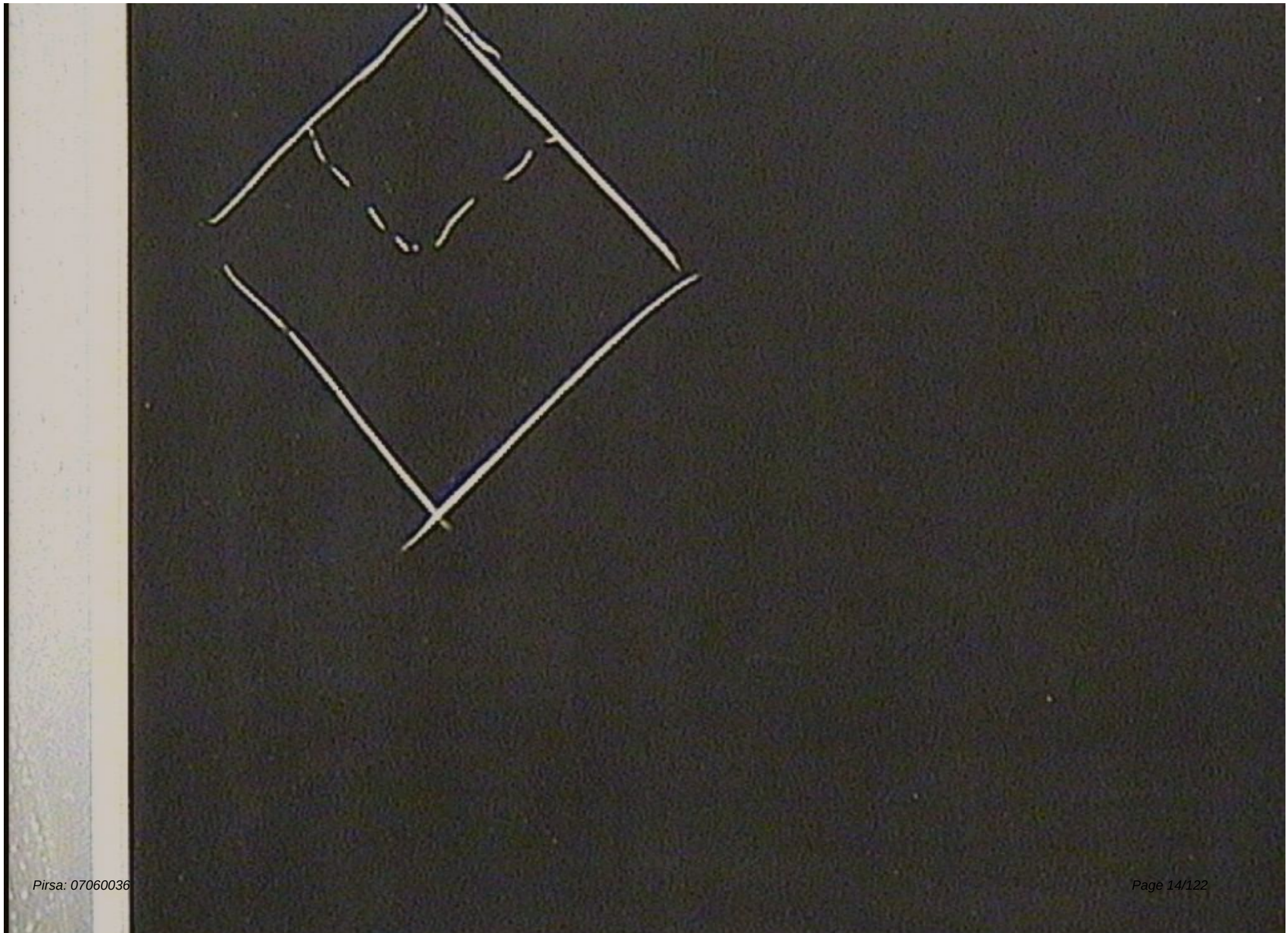

A
B
A

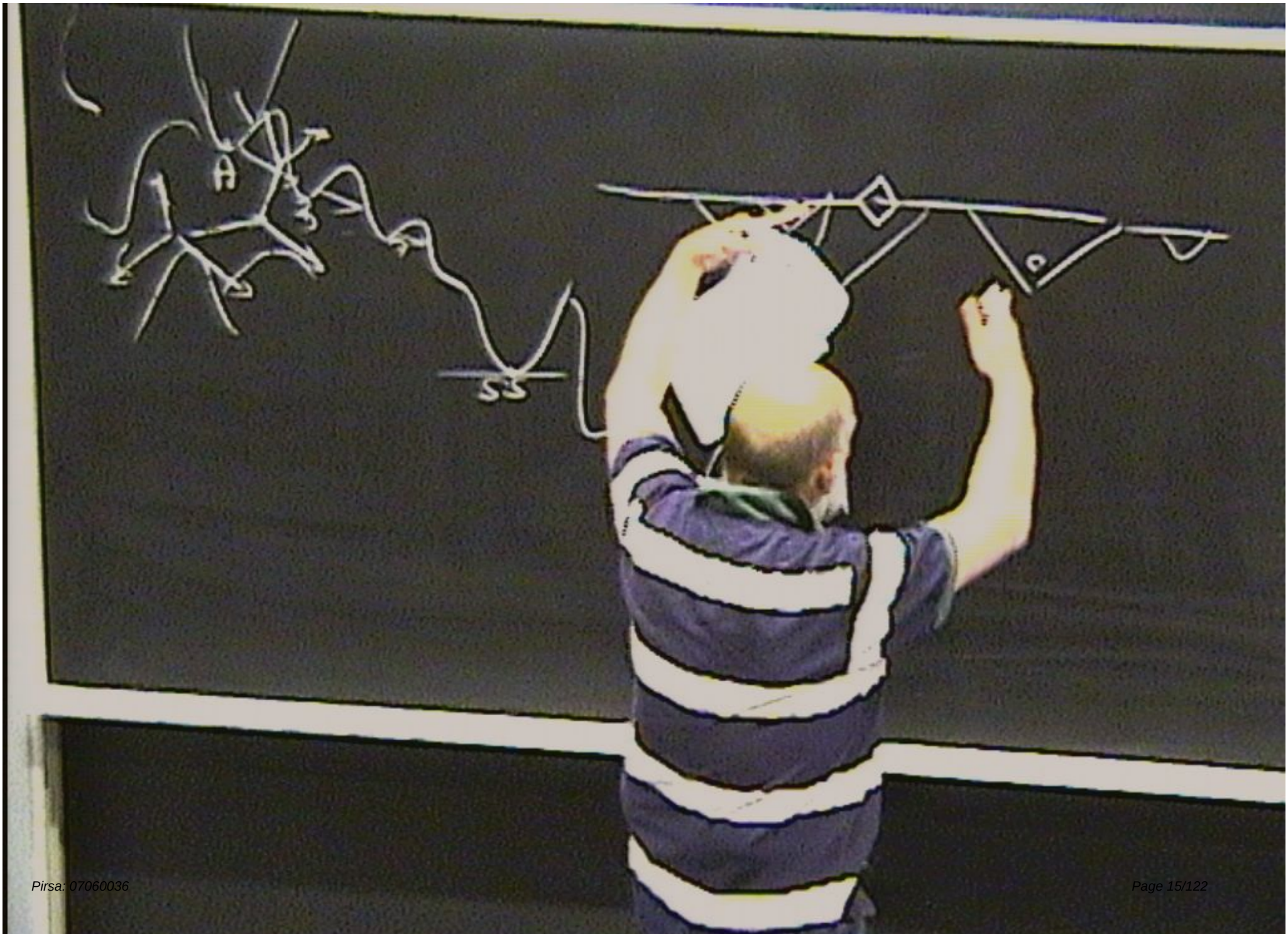

A
B
C
A

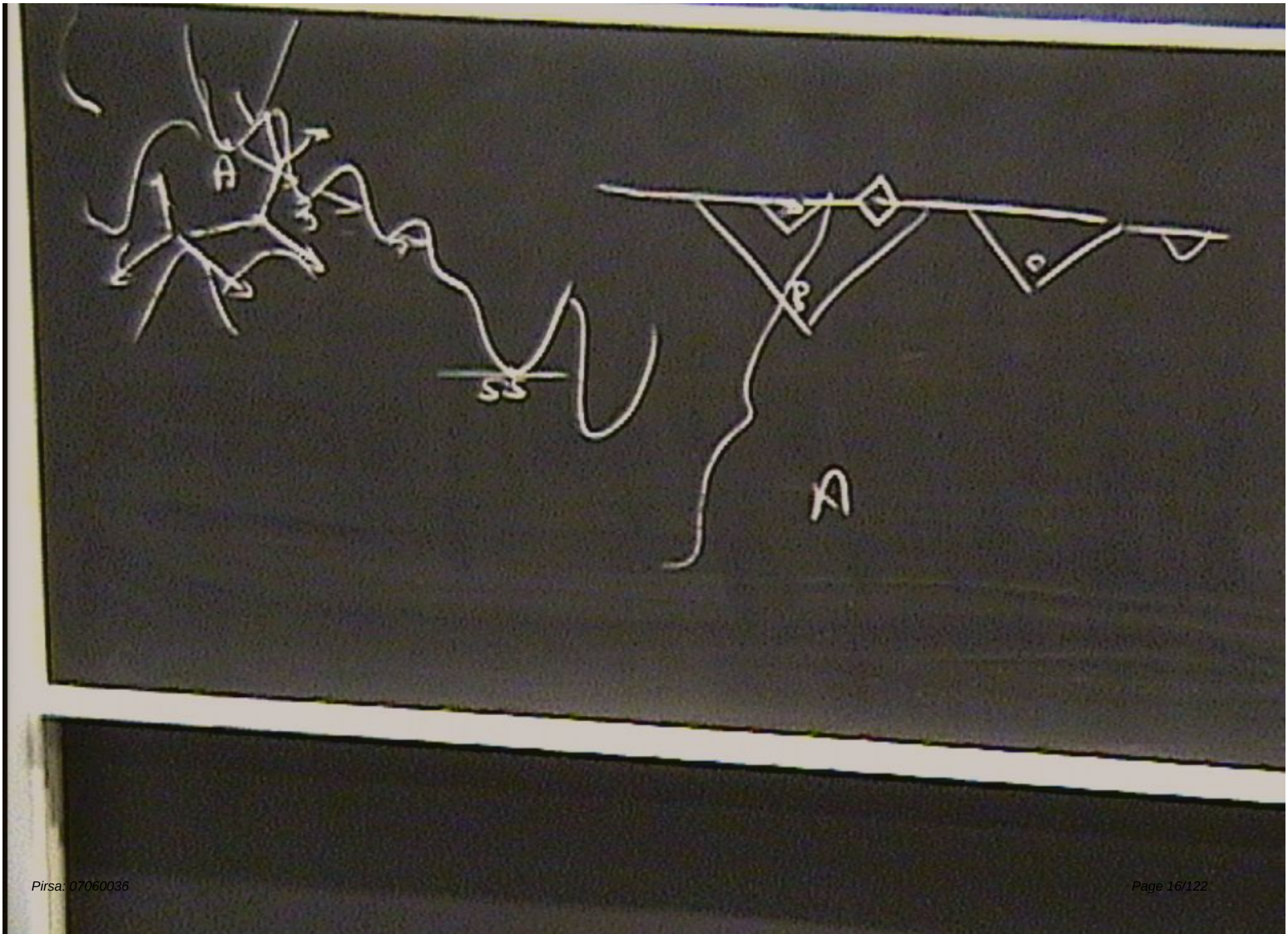

A
B
C
A

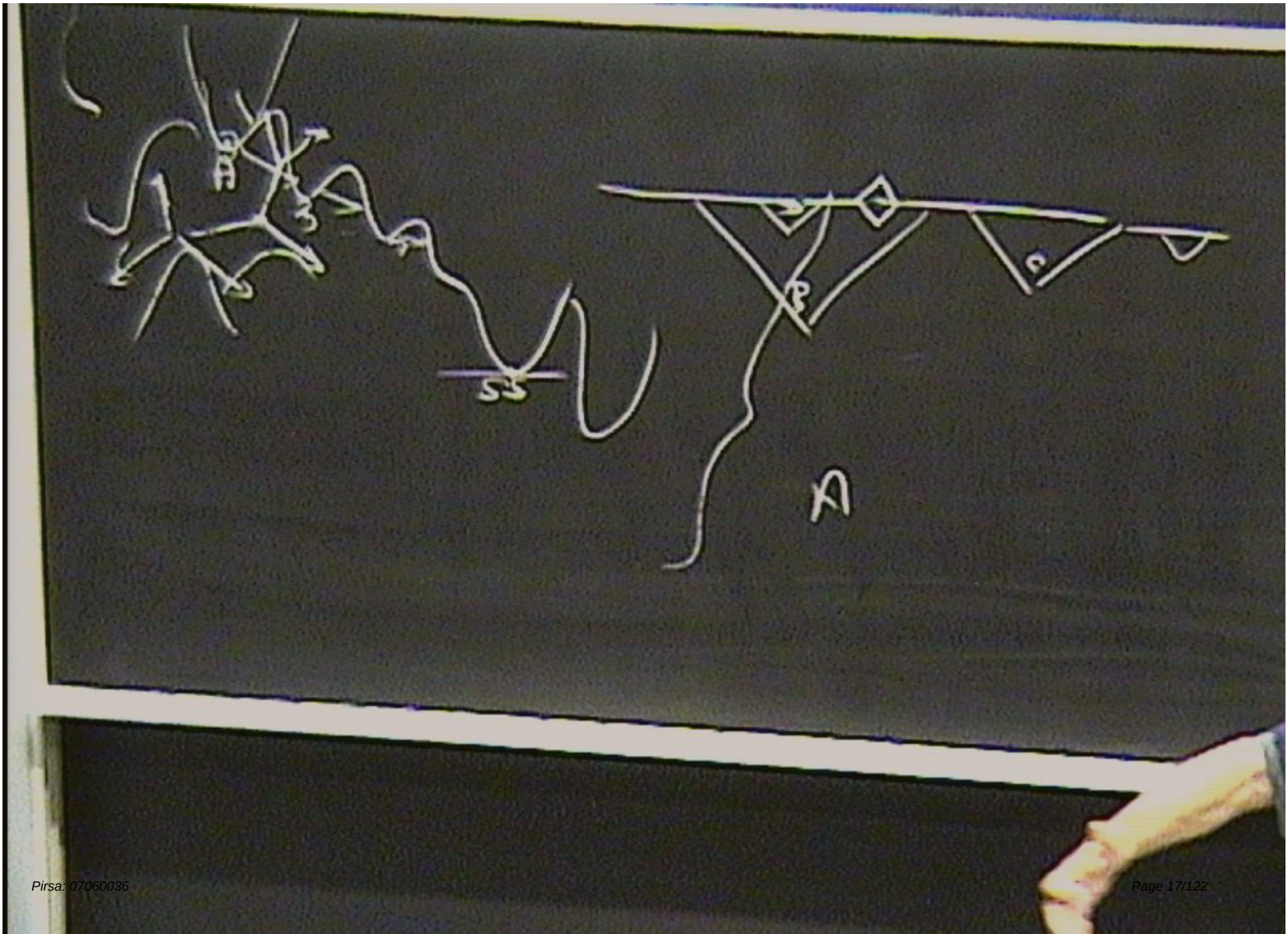

A
B
C
P
A1

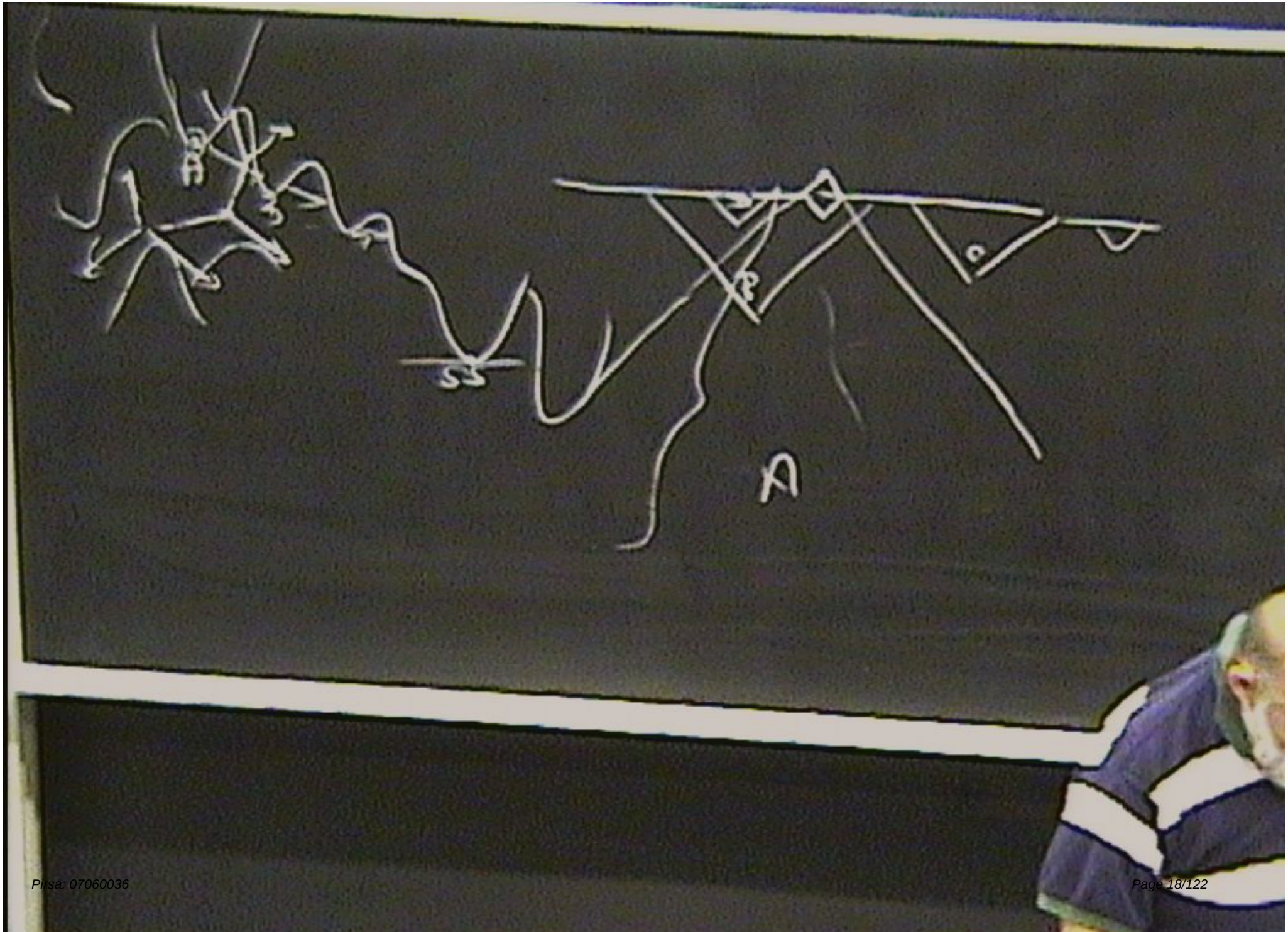







A
S
S
A


S3
A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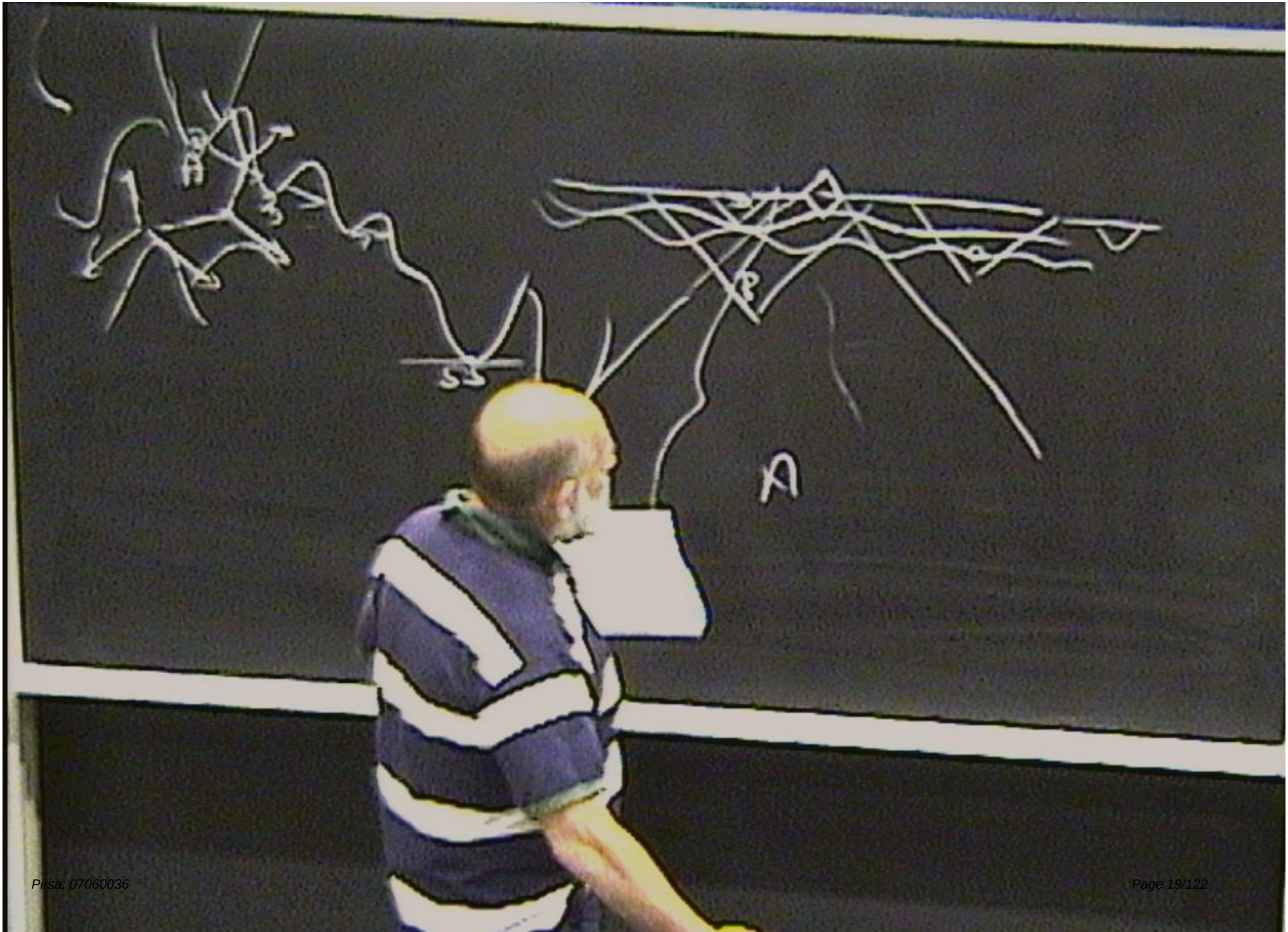

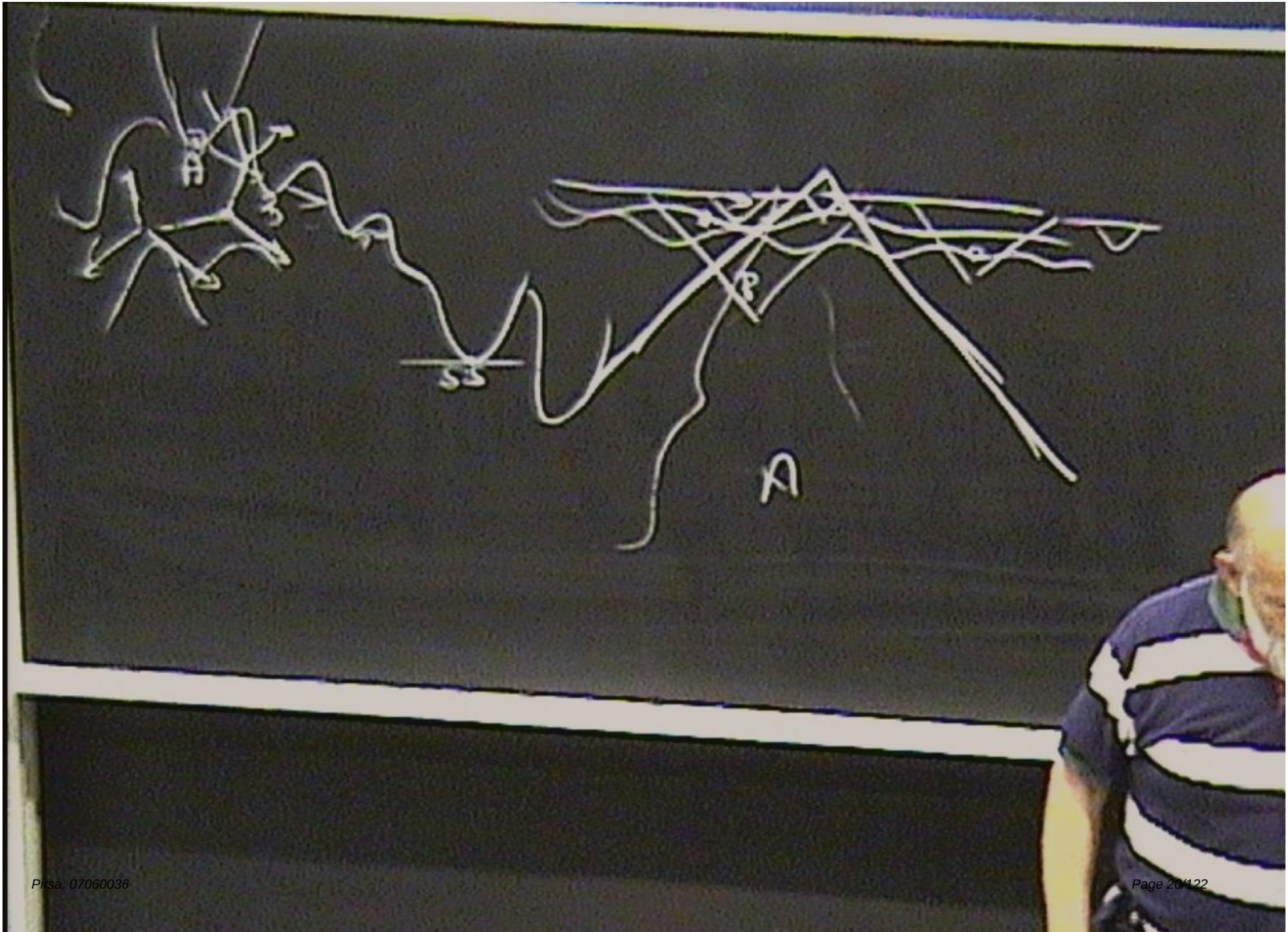

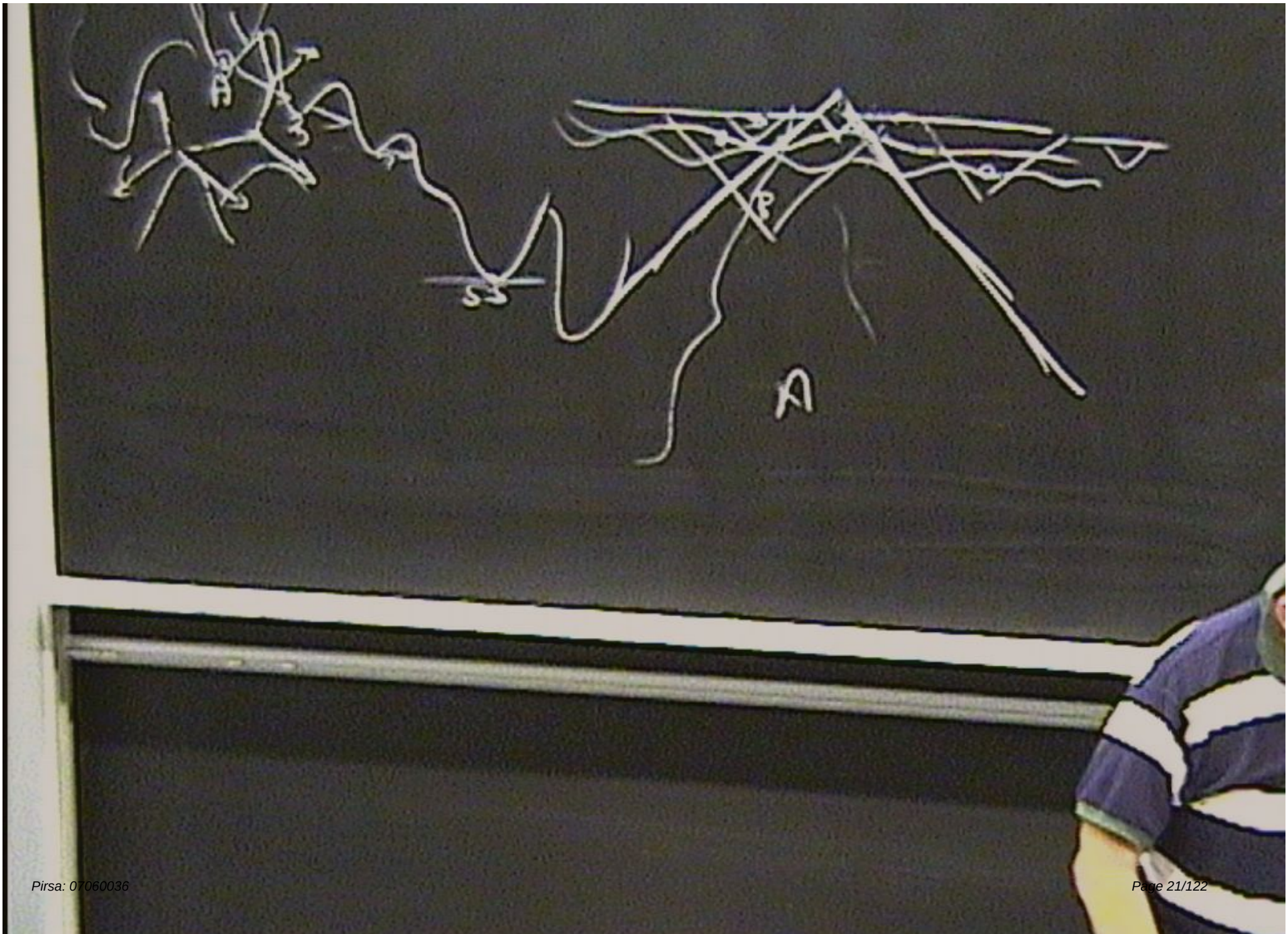
A
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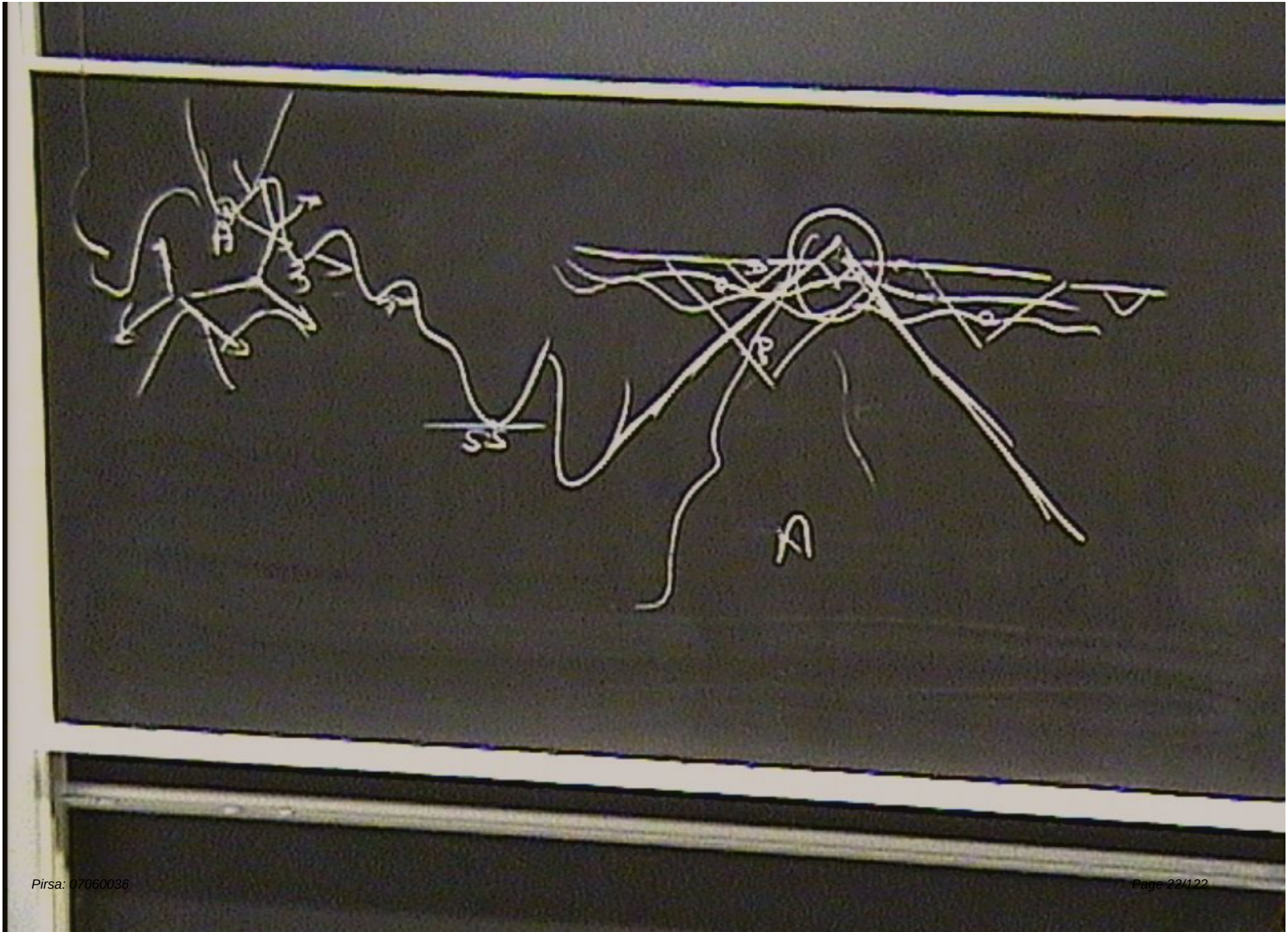
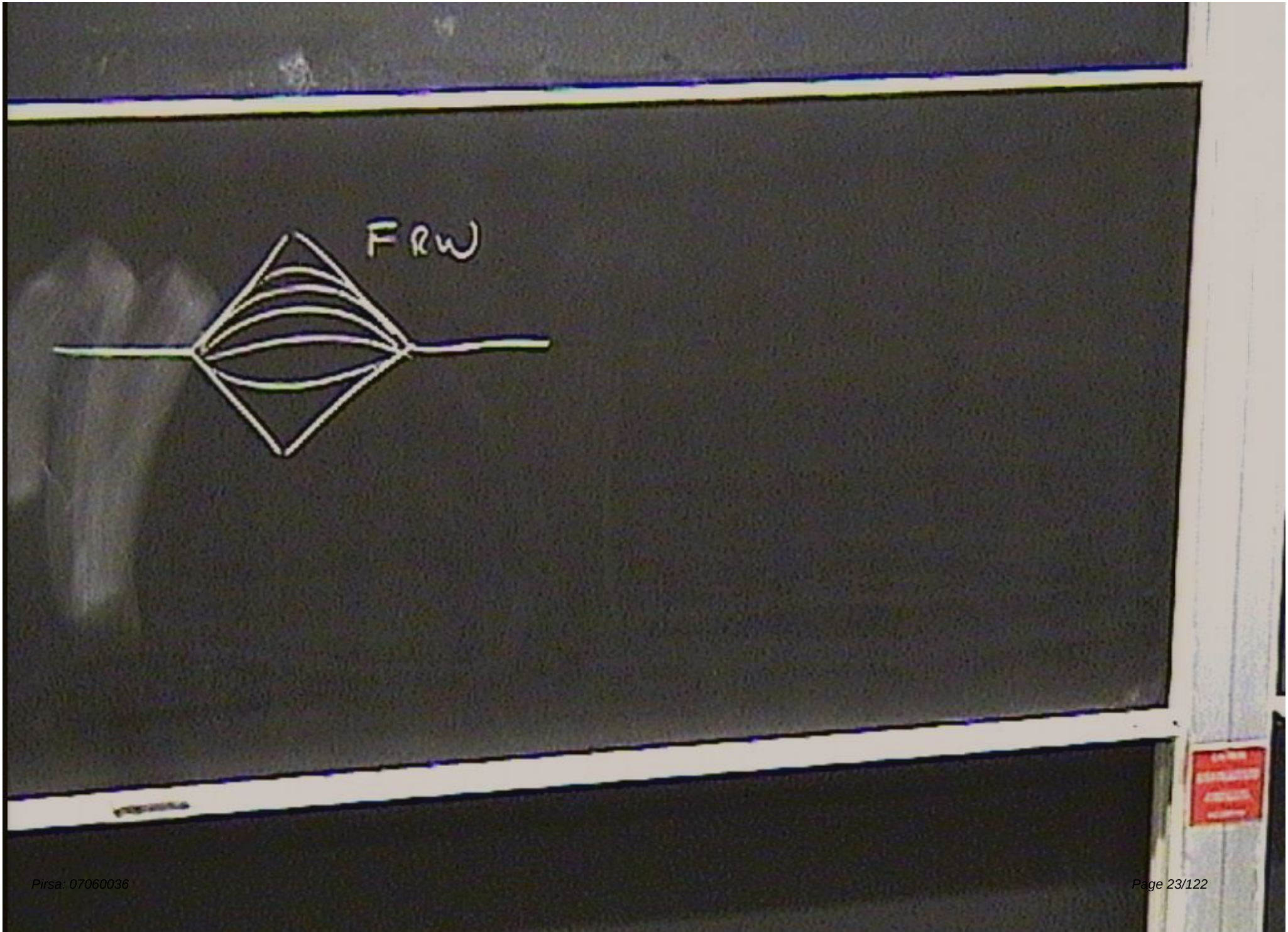
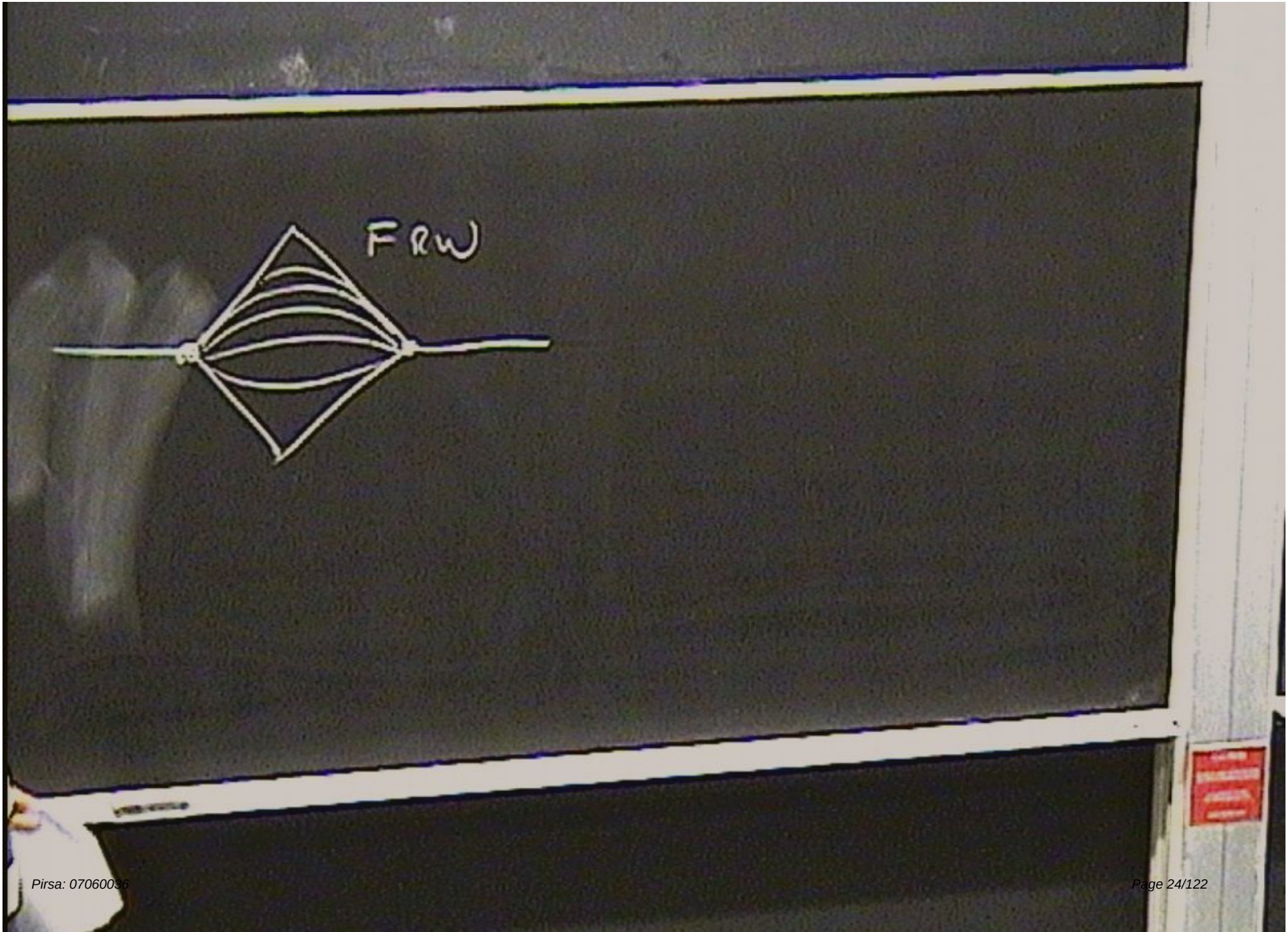



FRW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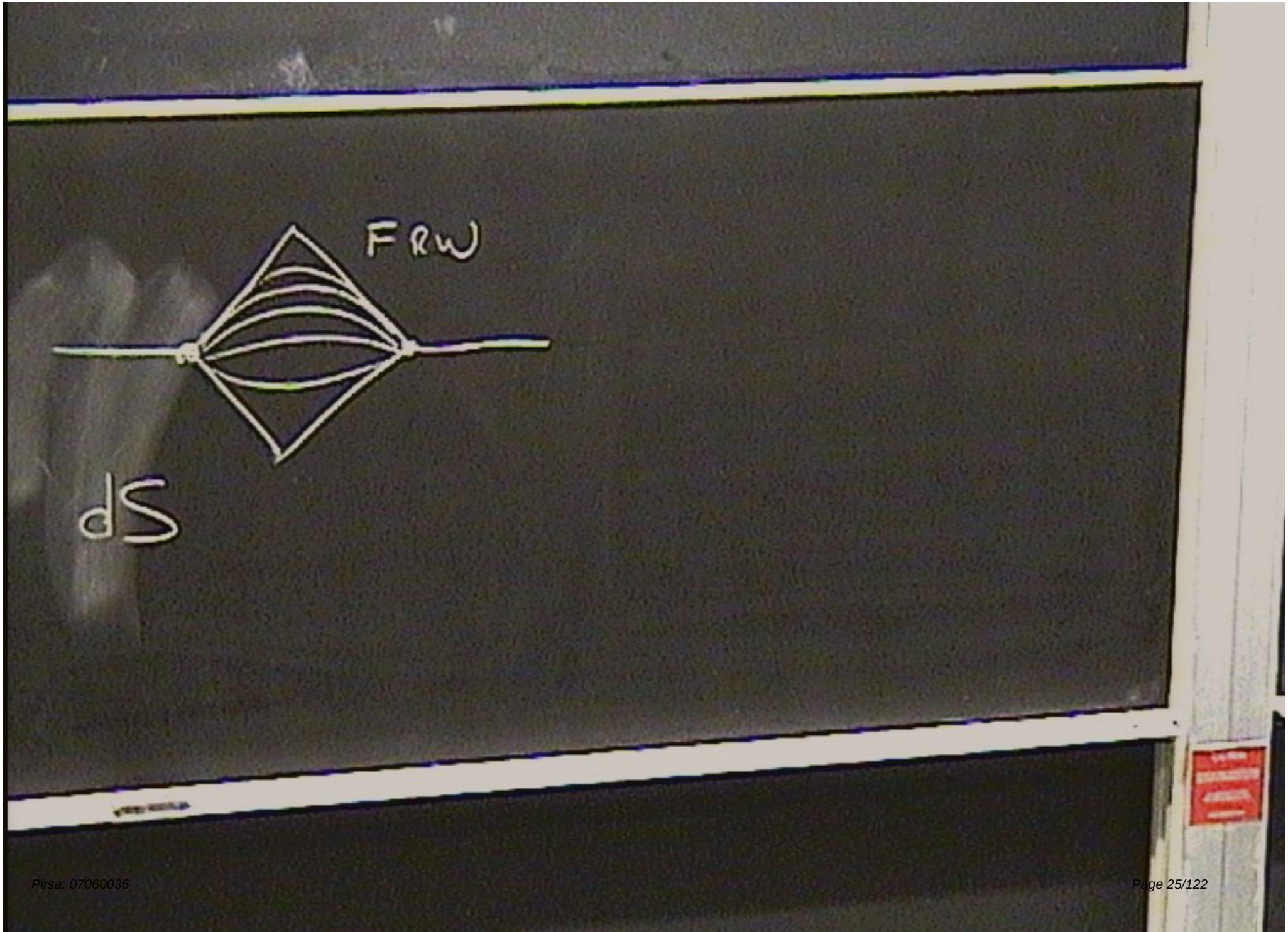
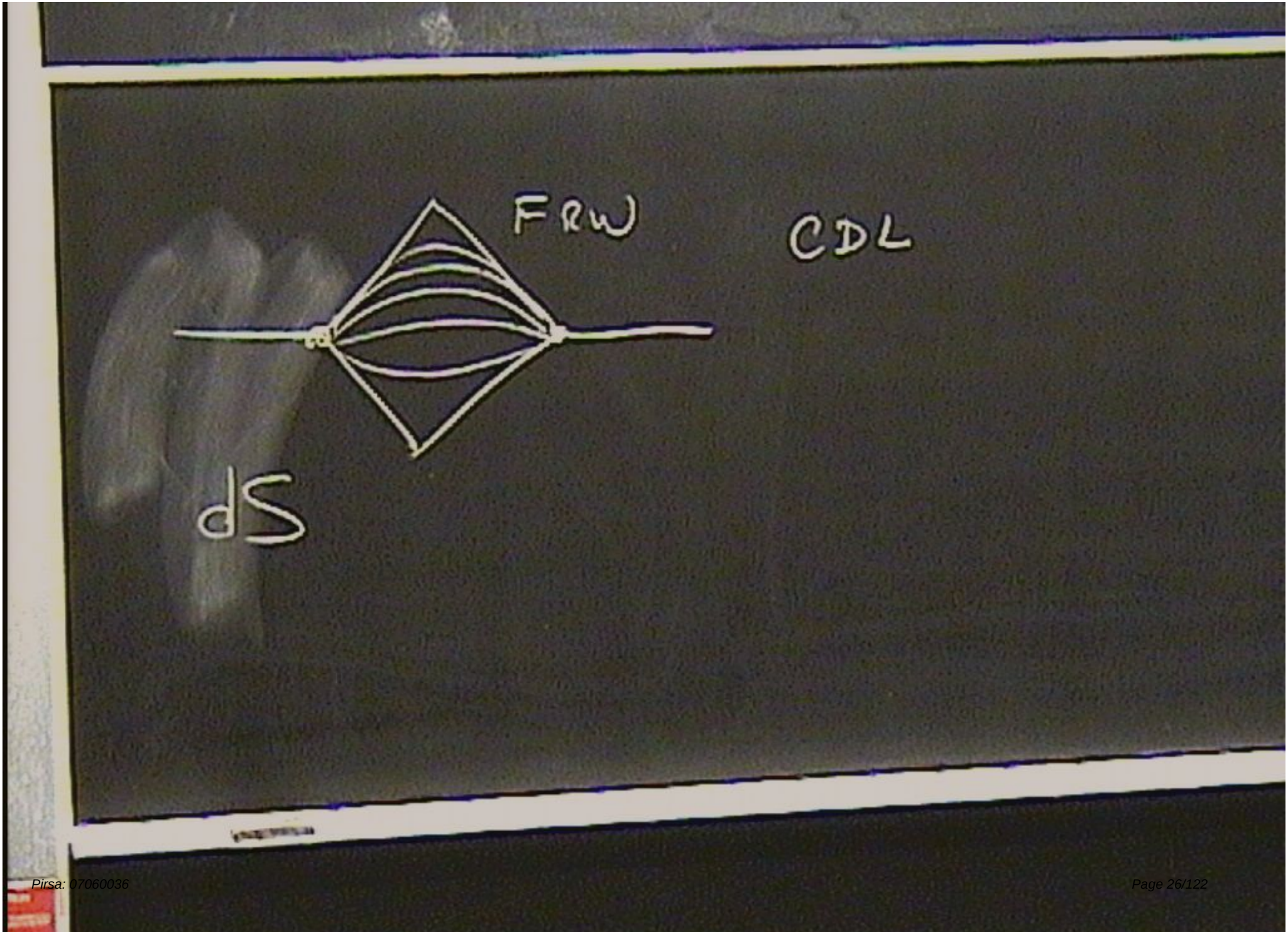
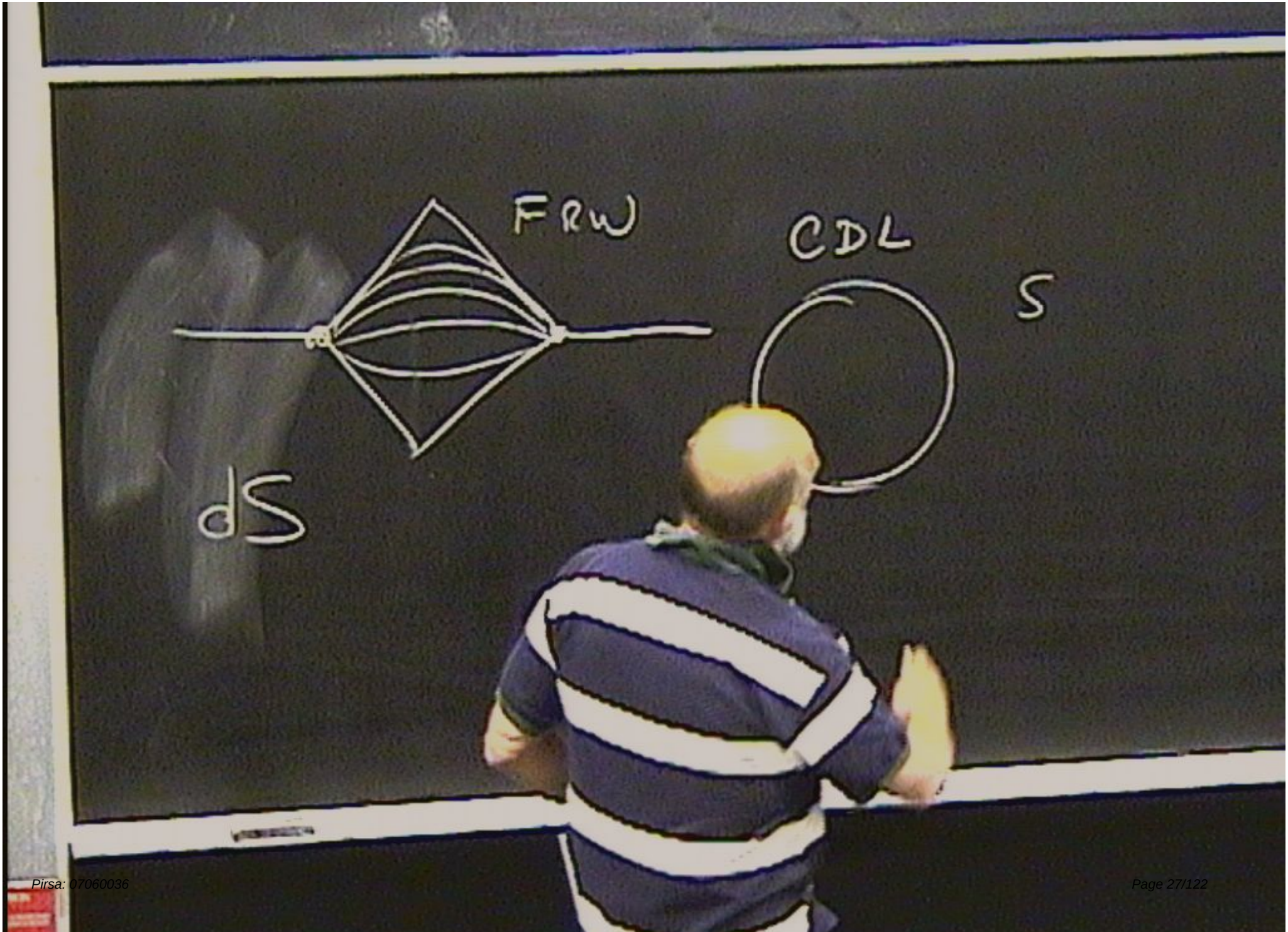
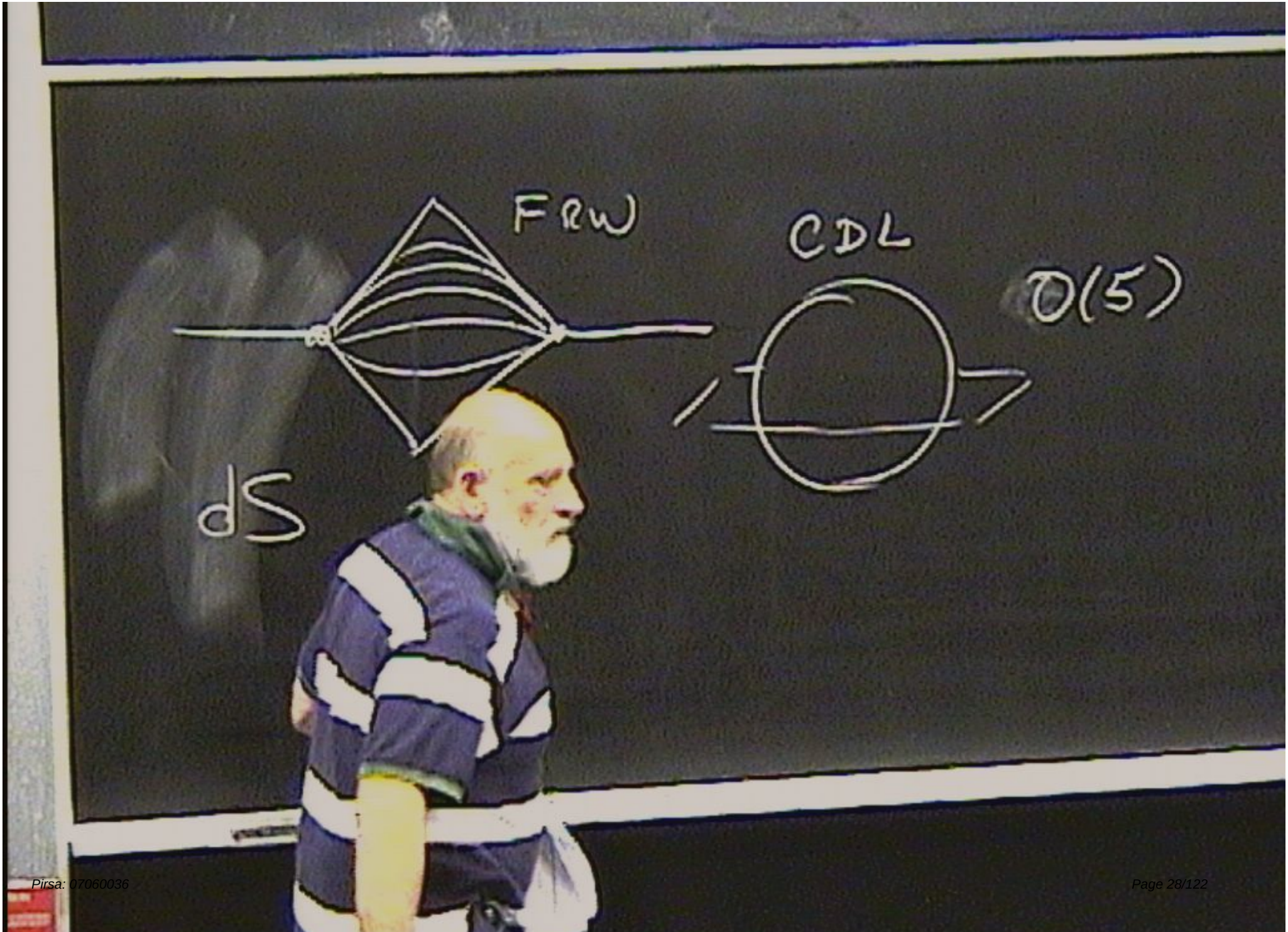
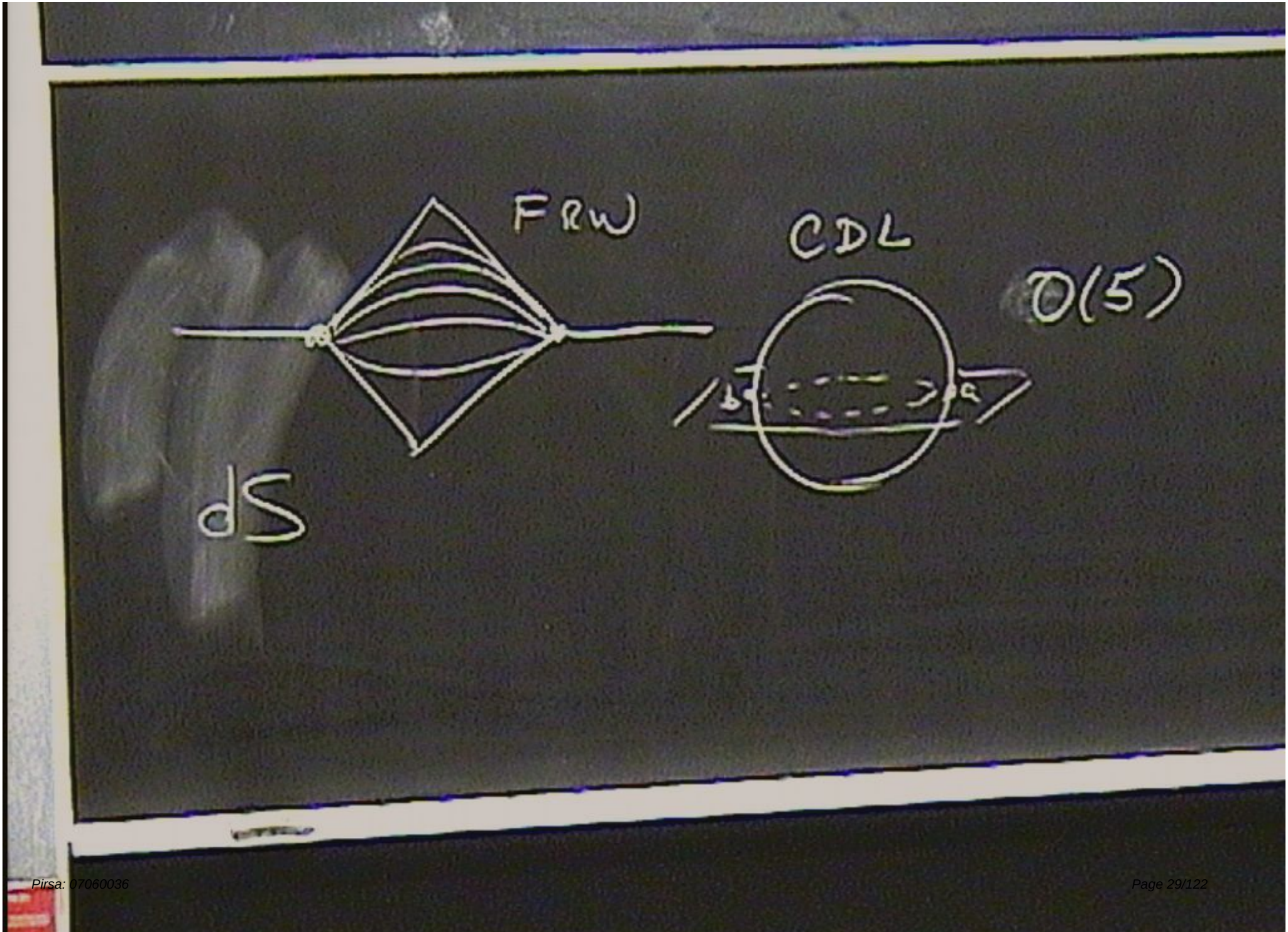
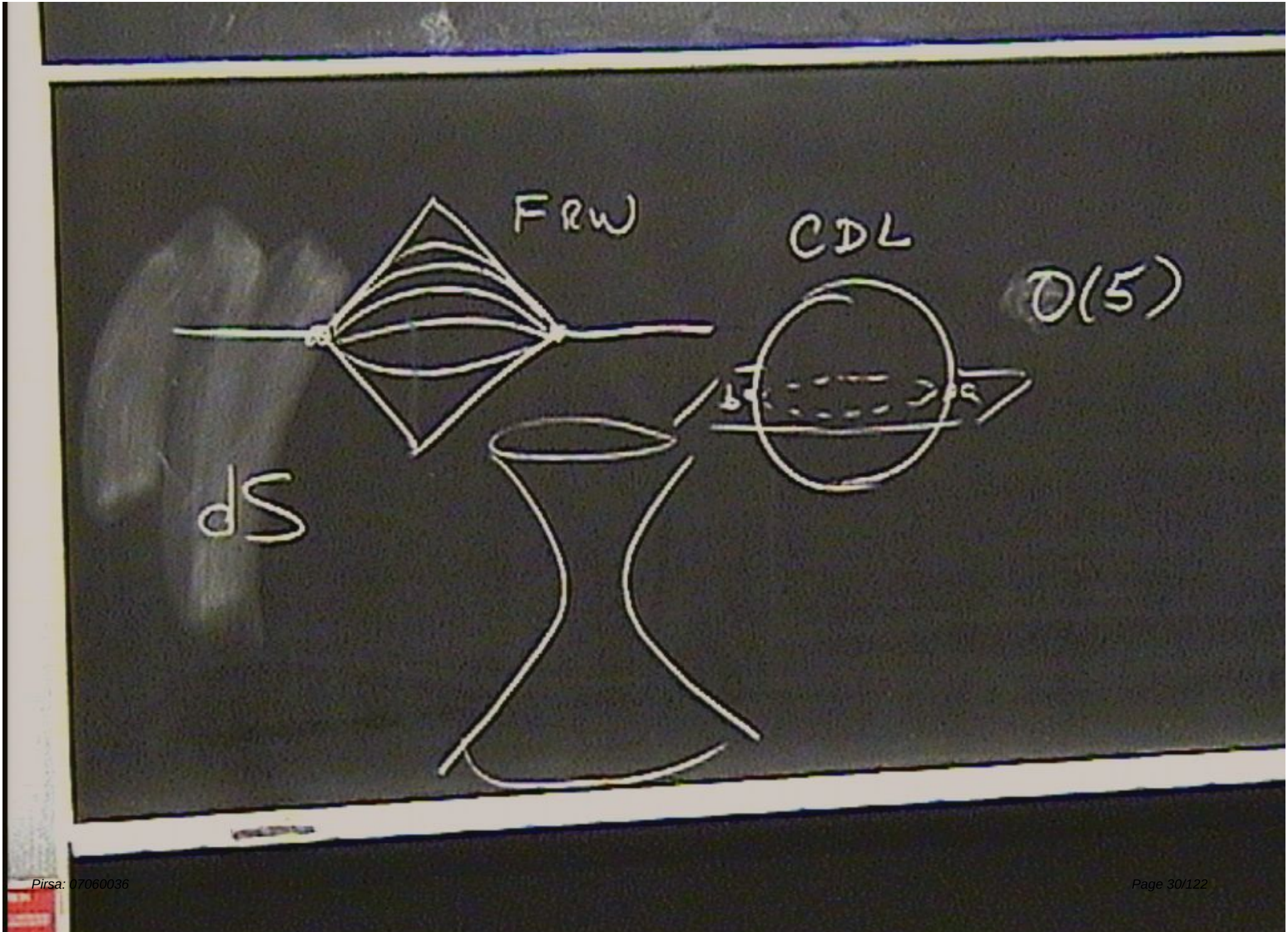

FRW
dS

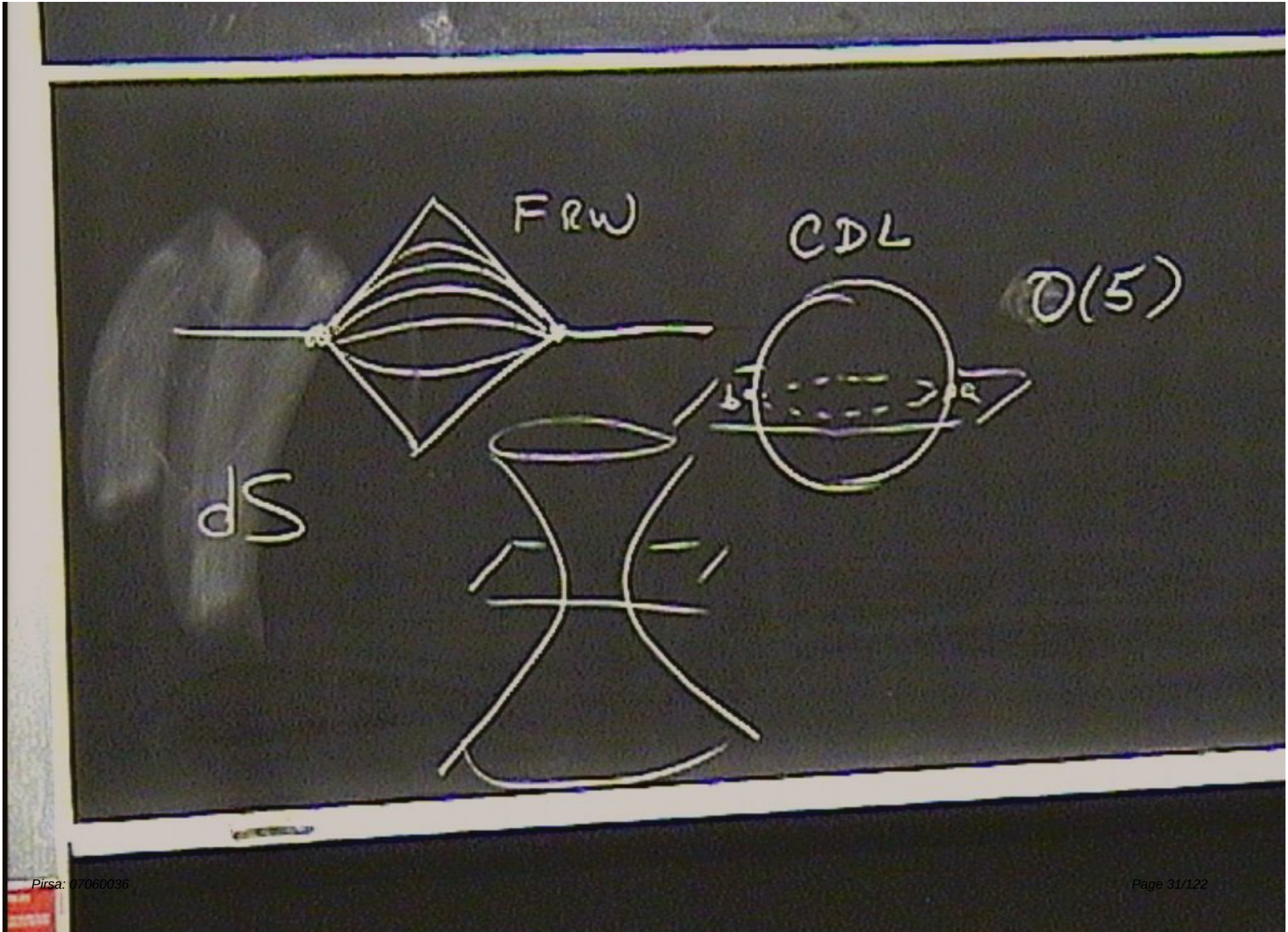

FRW
CDL
dS

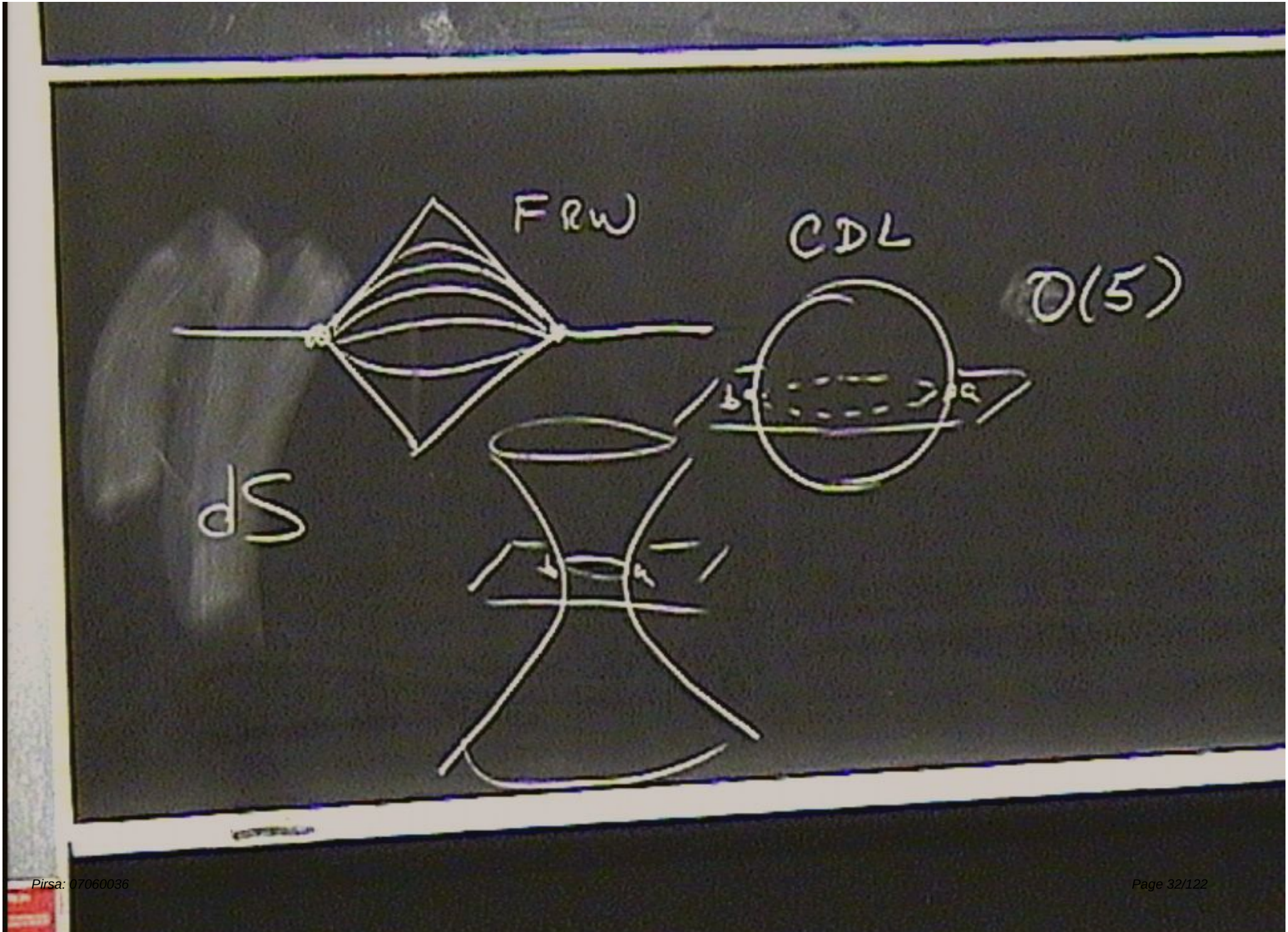

FRW
CDL
S
dS

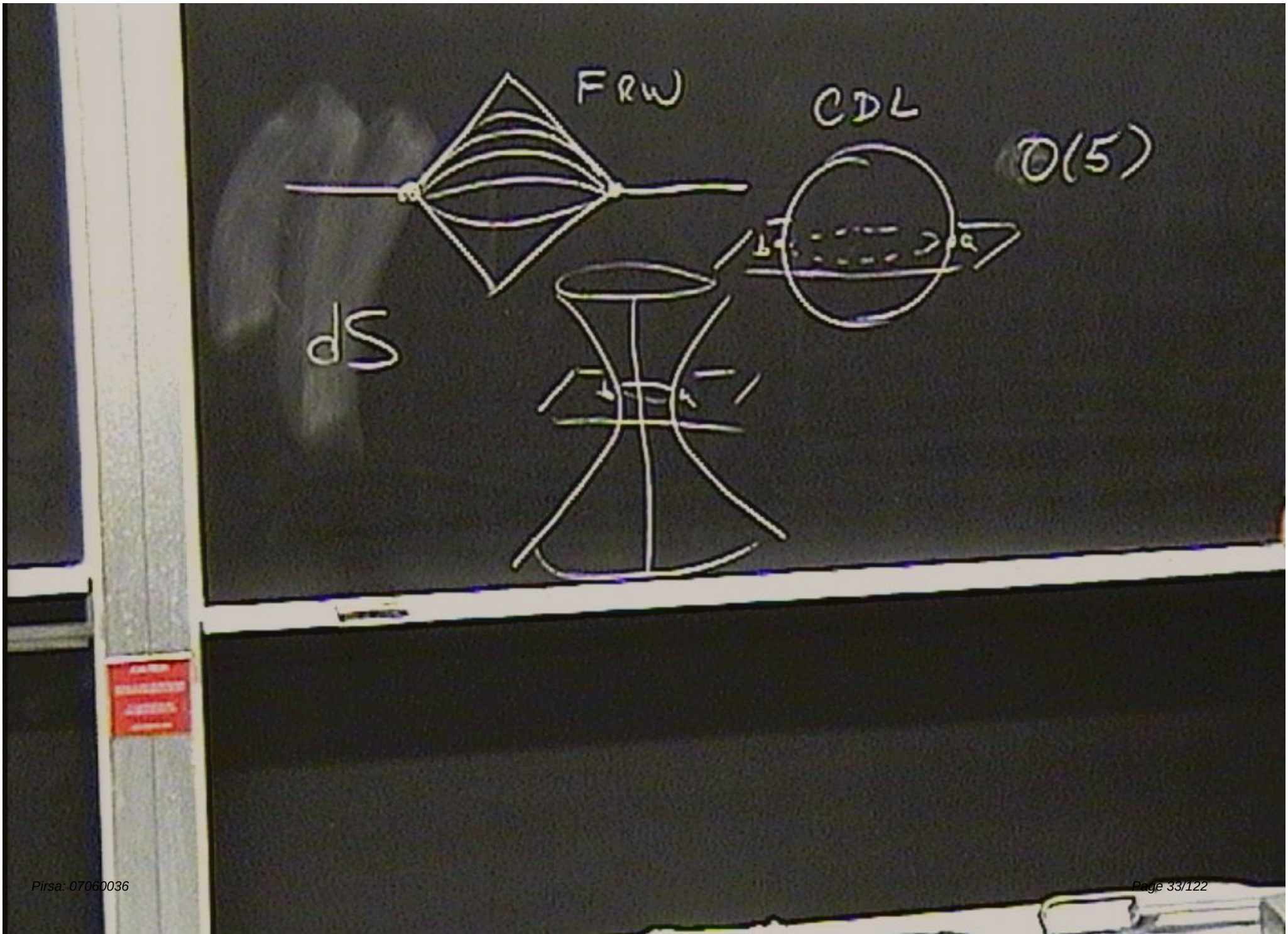

FRW
CDL
O(5)
dS

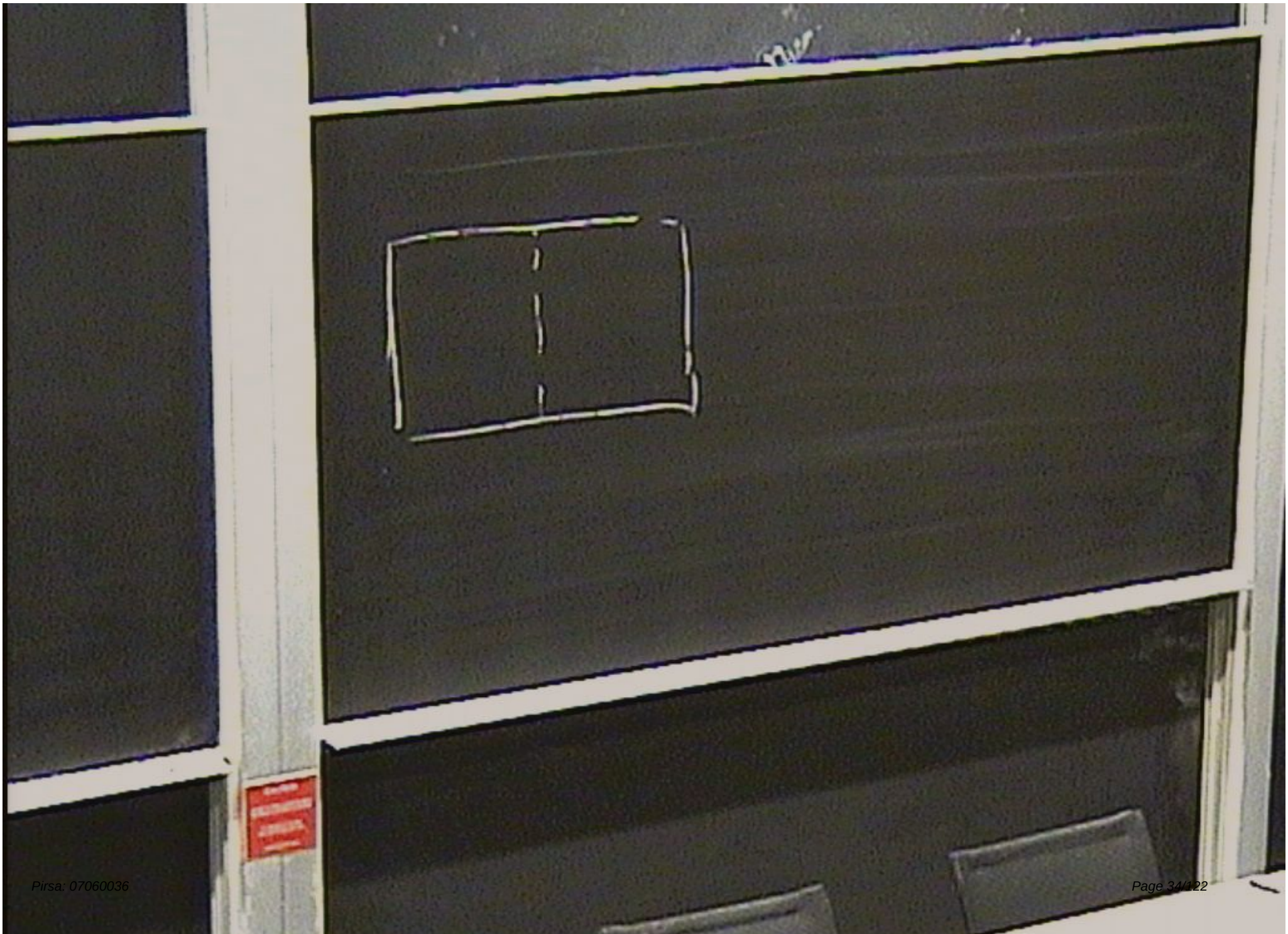

FRW
CDL
O(5)
dS

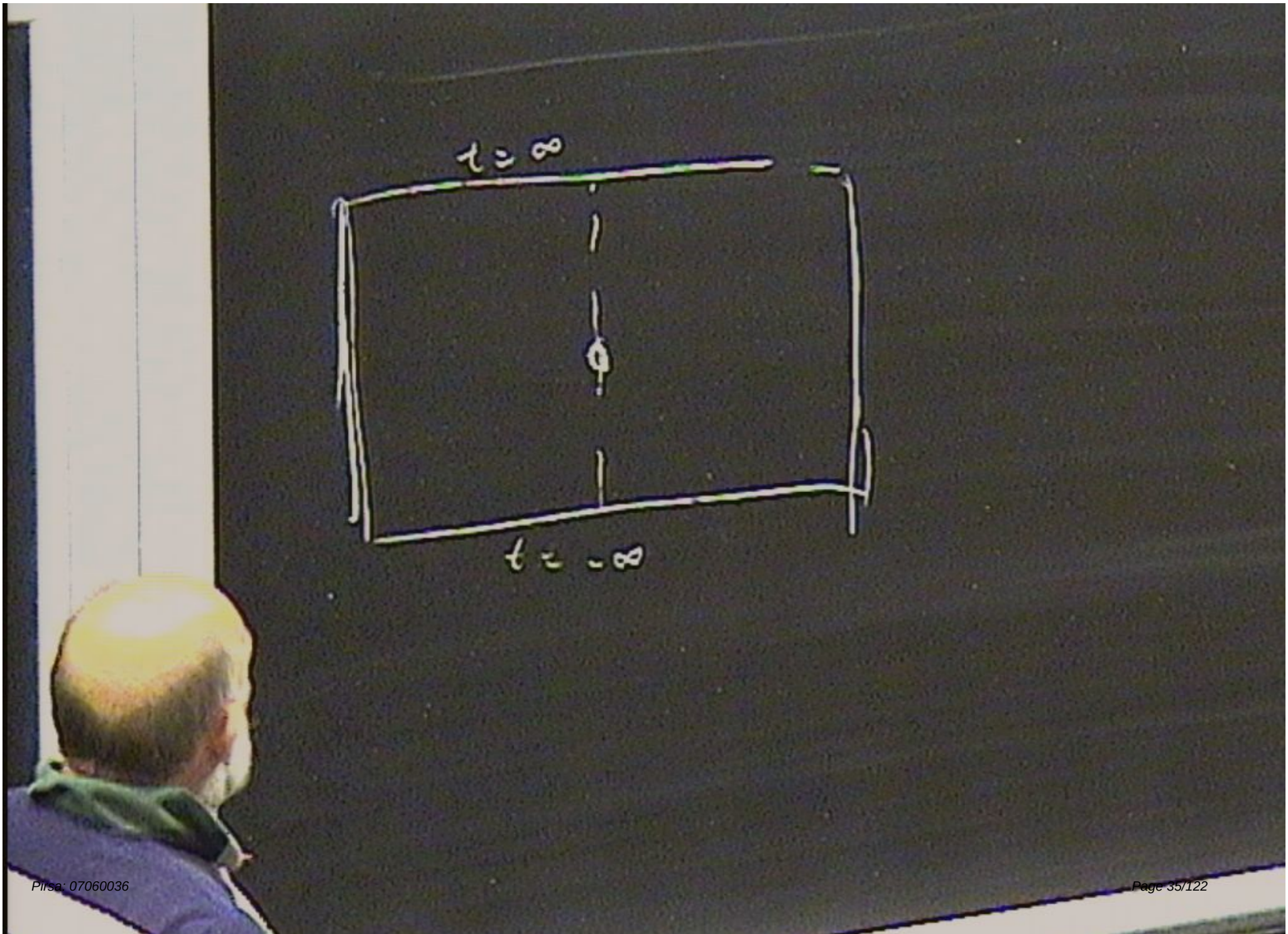

FRW
CDL
O(5)
dS

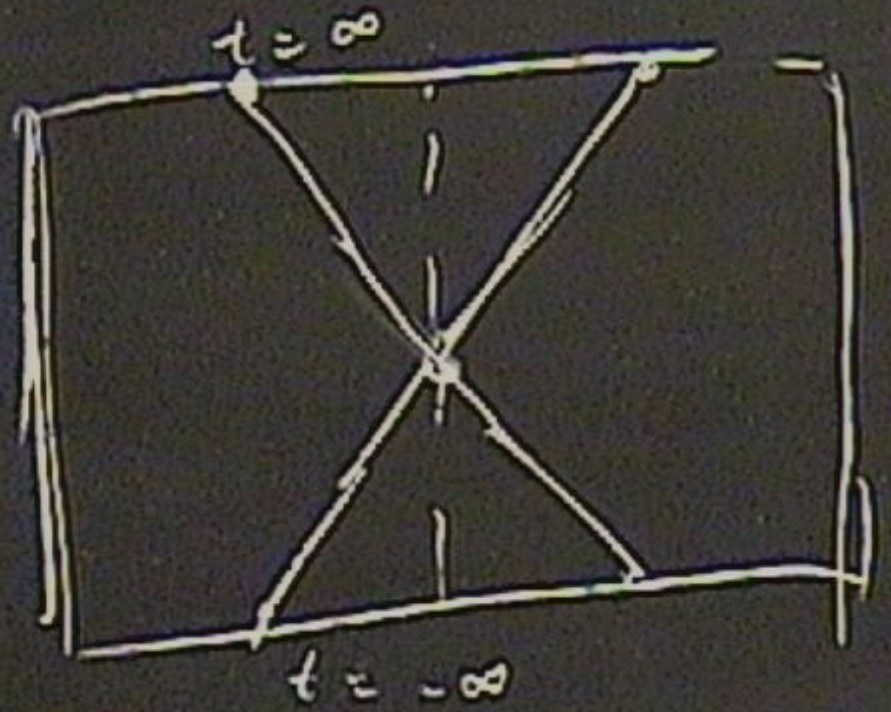

FRW
CDL
O(5)
dS

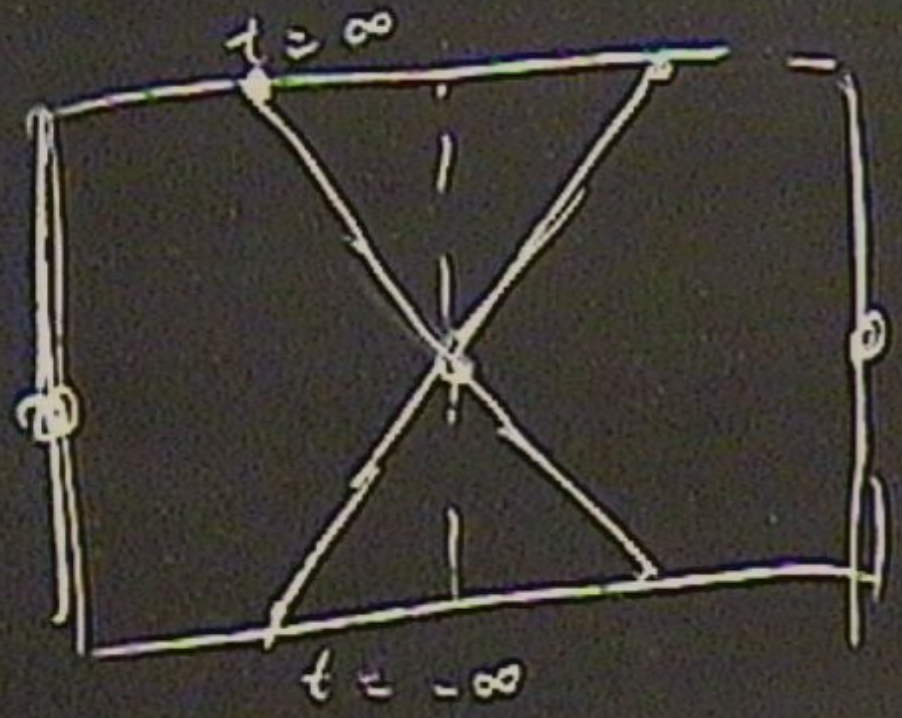

FRW
CDL
O(5)
dS


FRW
CDL
O(5)
dS




t = ∞
1
φ
1
t = -∞


t = ∞
I
I
t = -∞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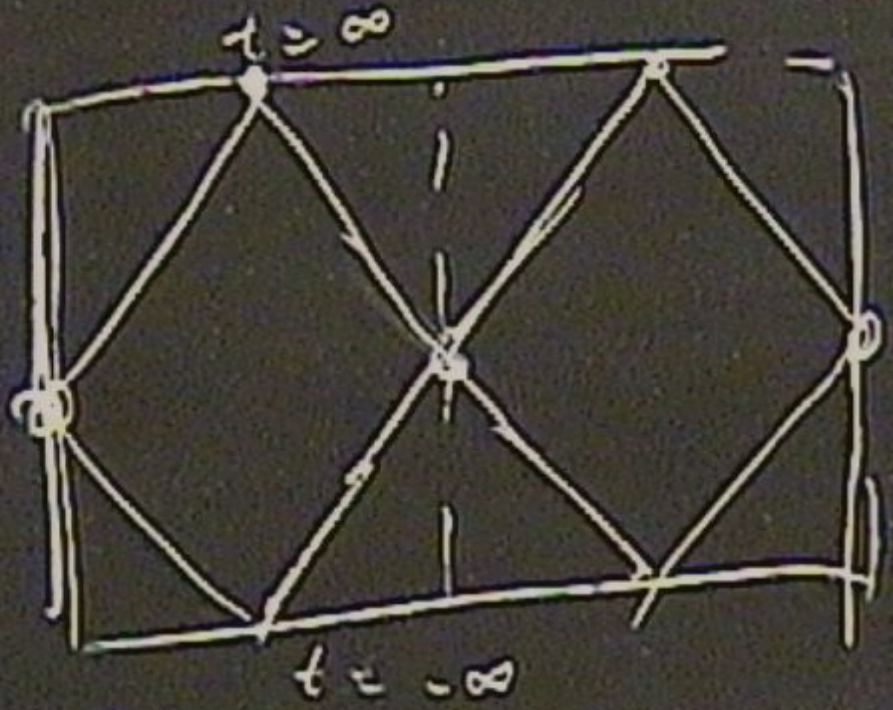
t = -∞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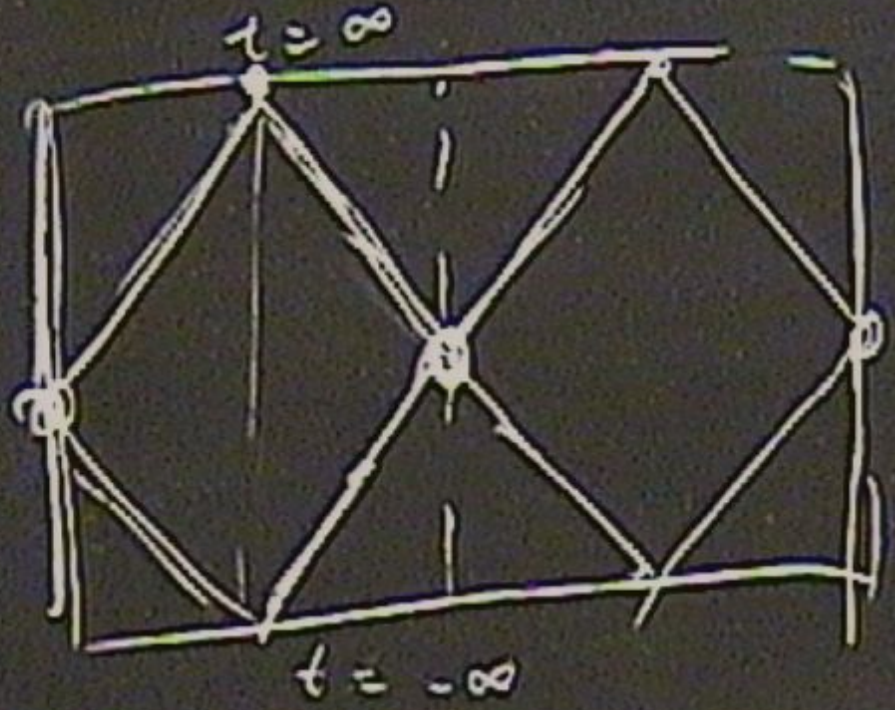
t = -∞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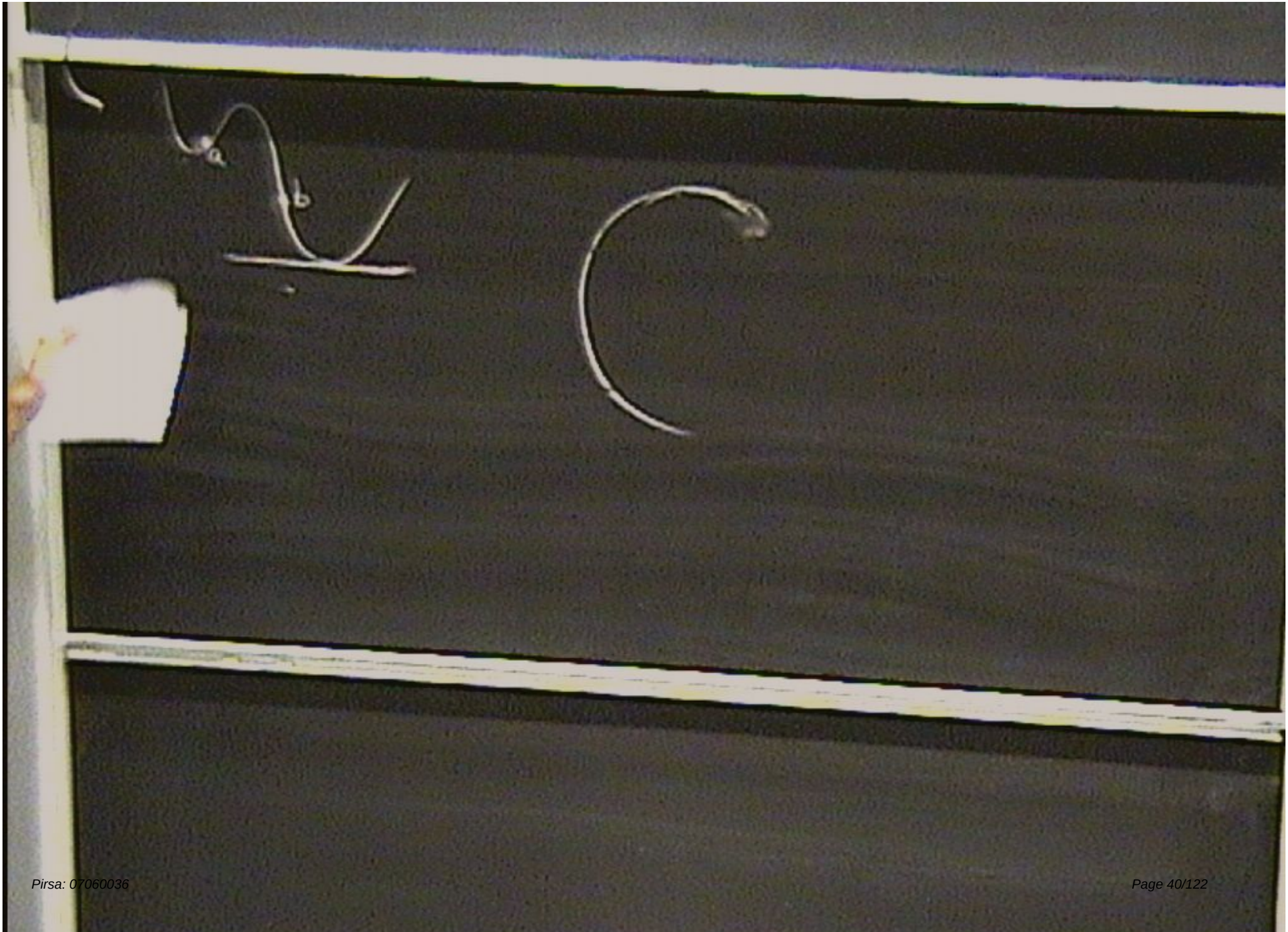
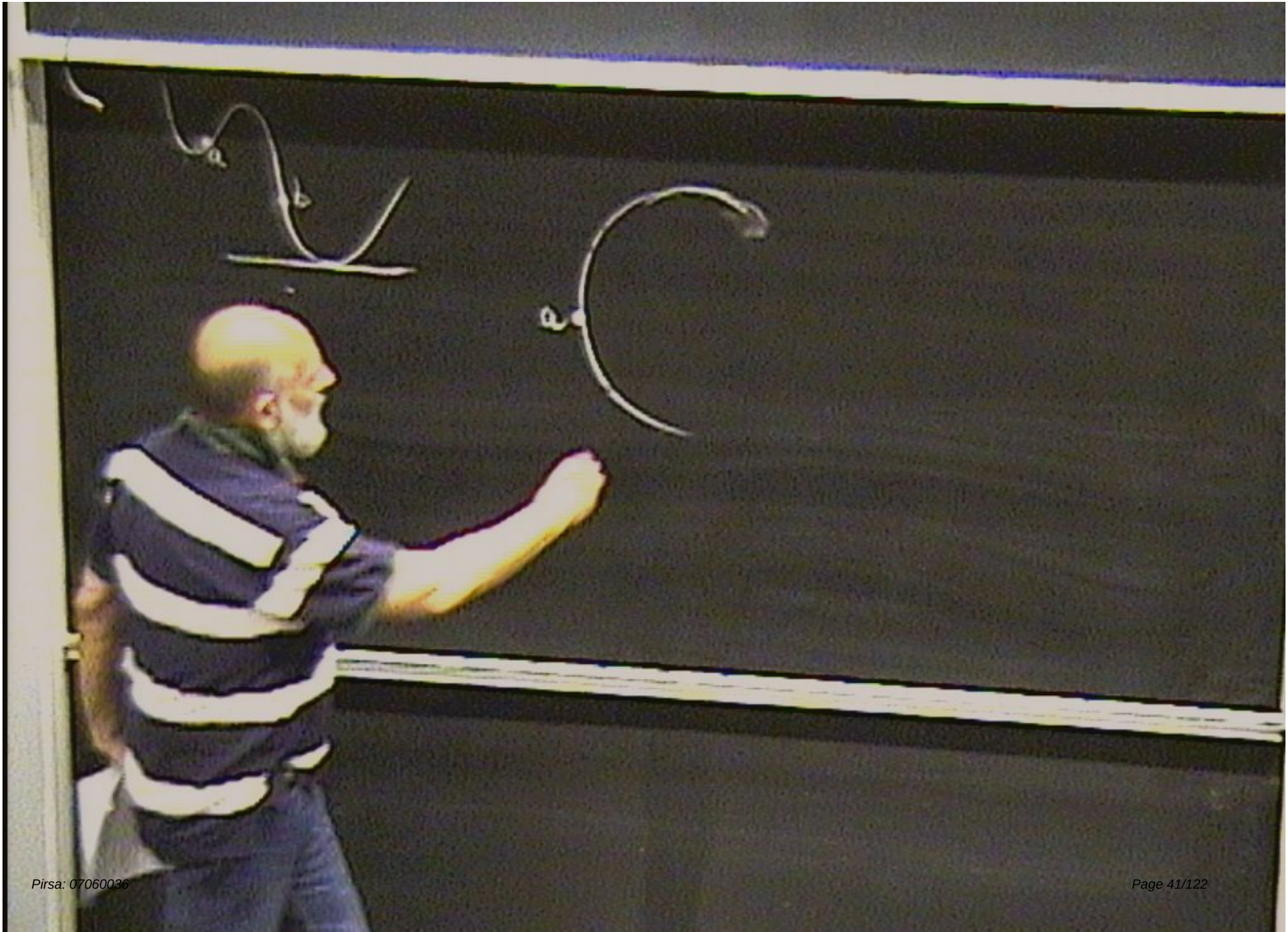
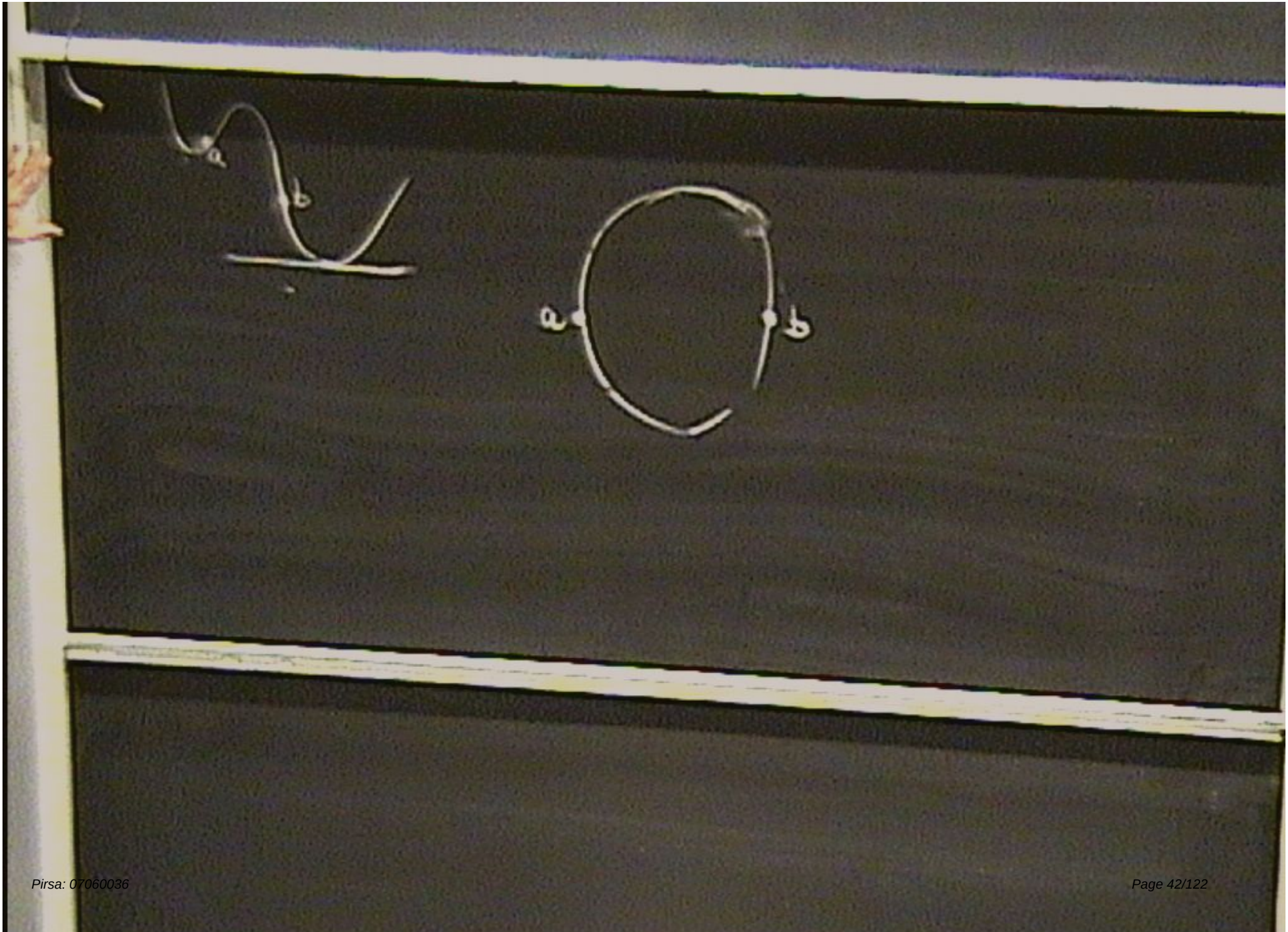
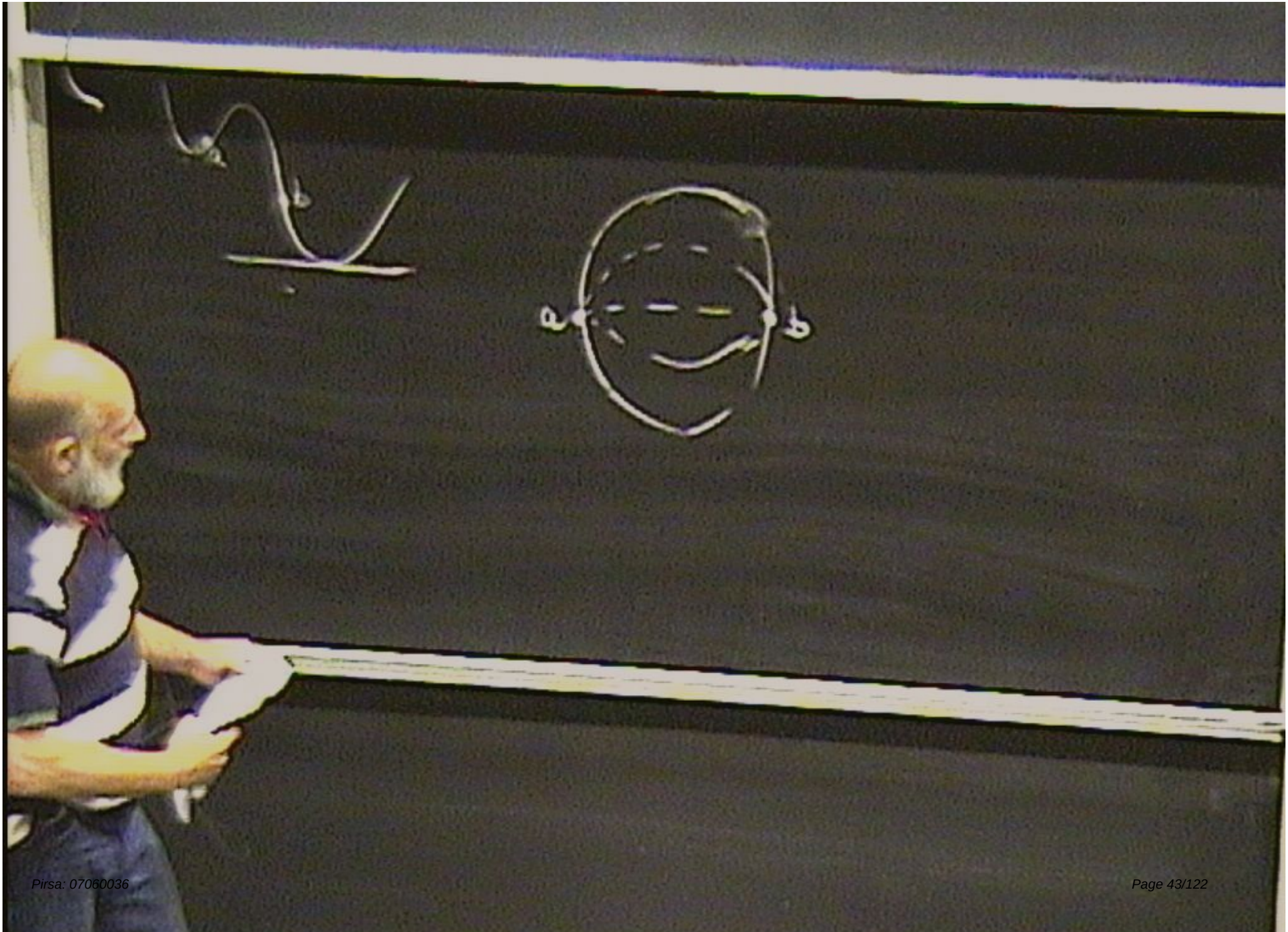
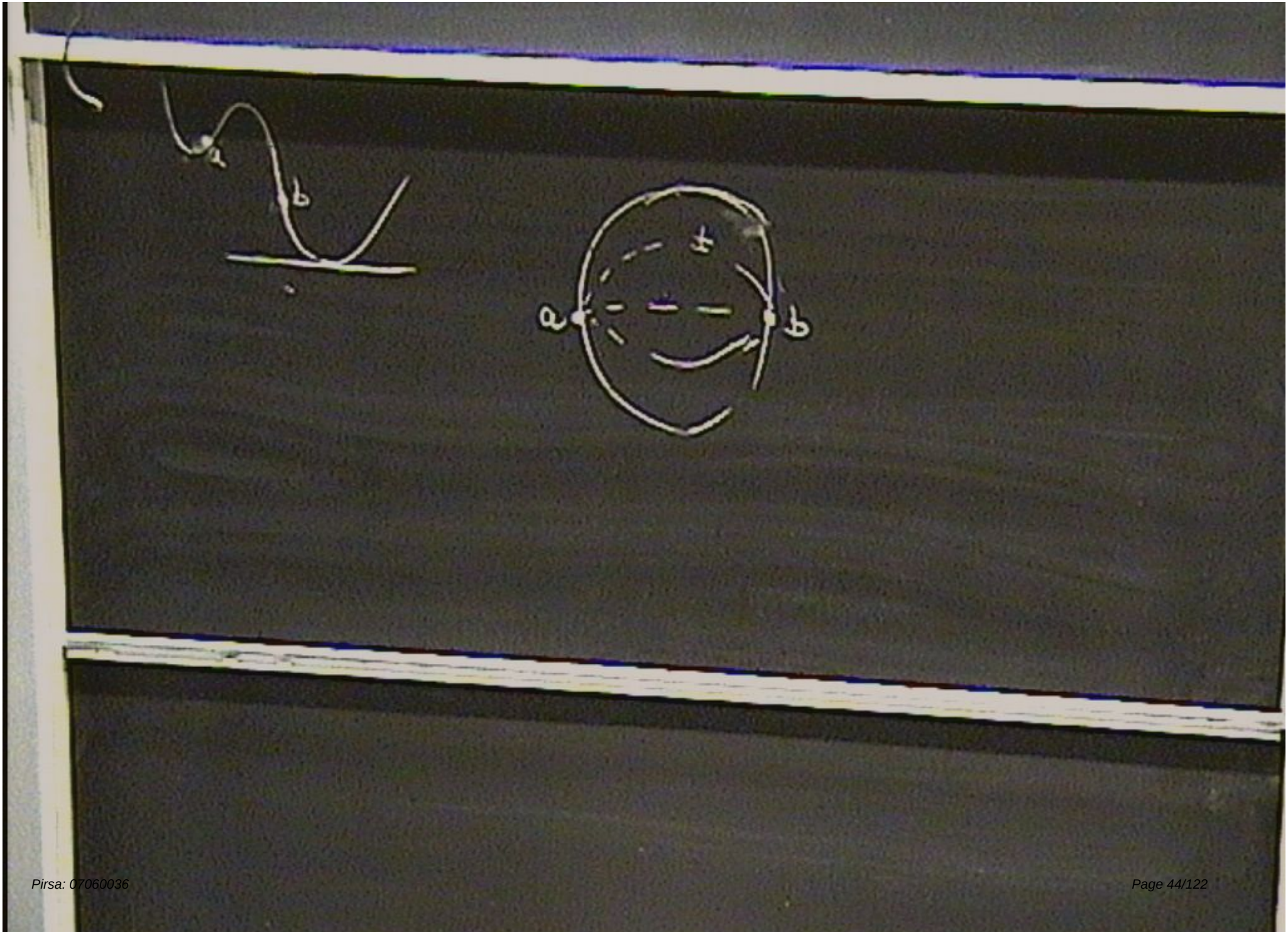
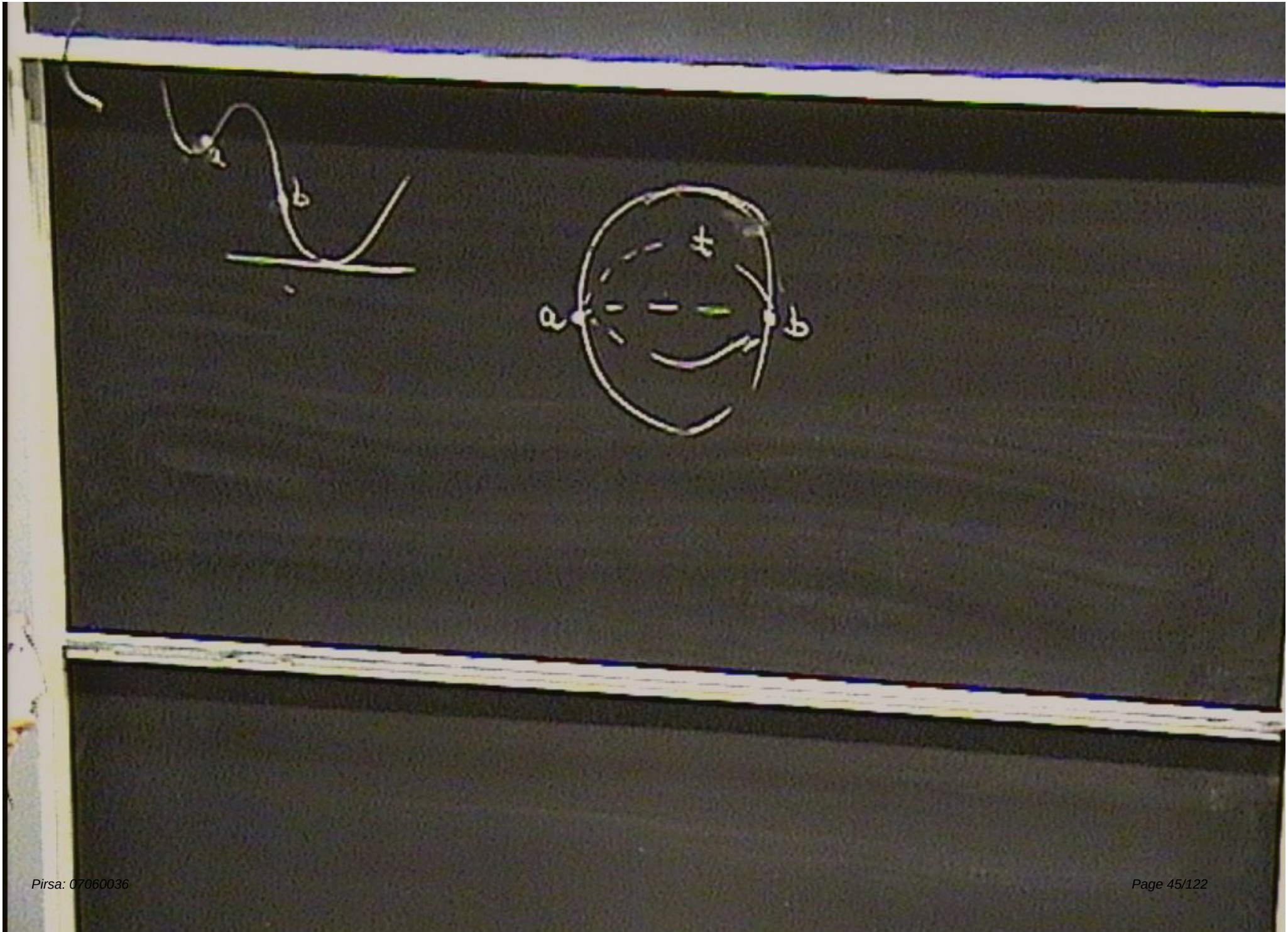

a
b

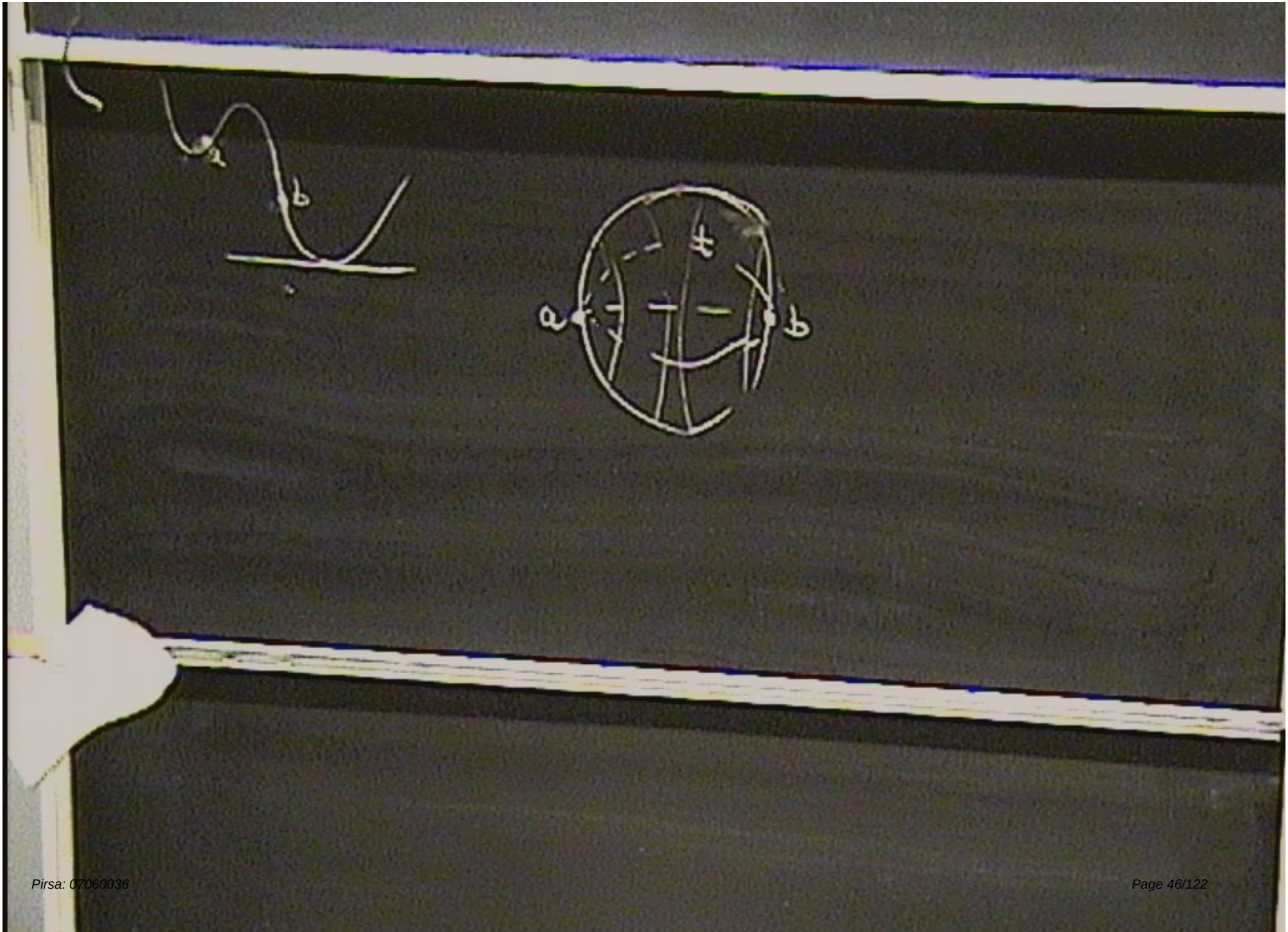


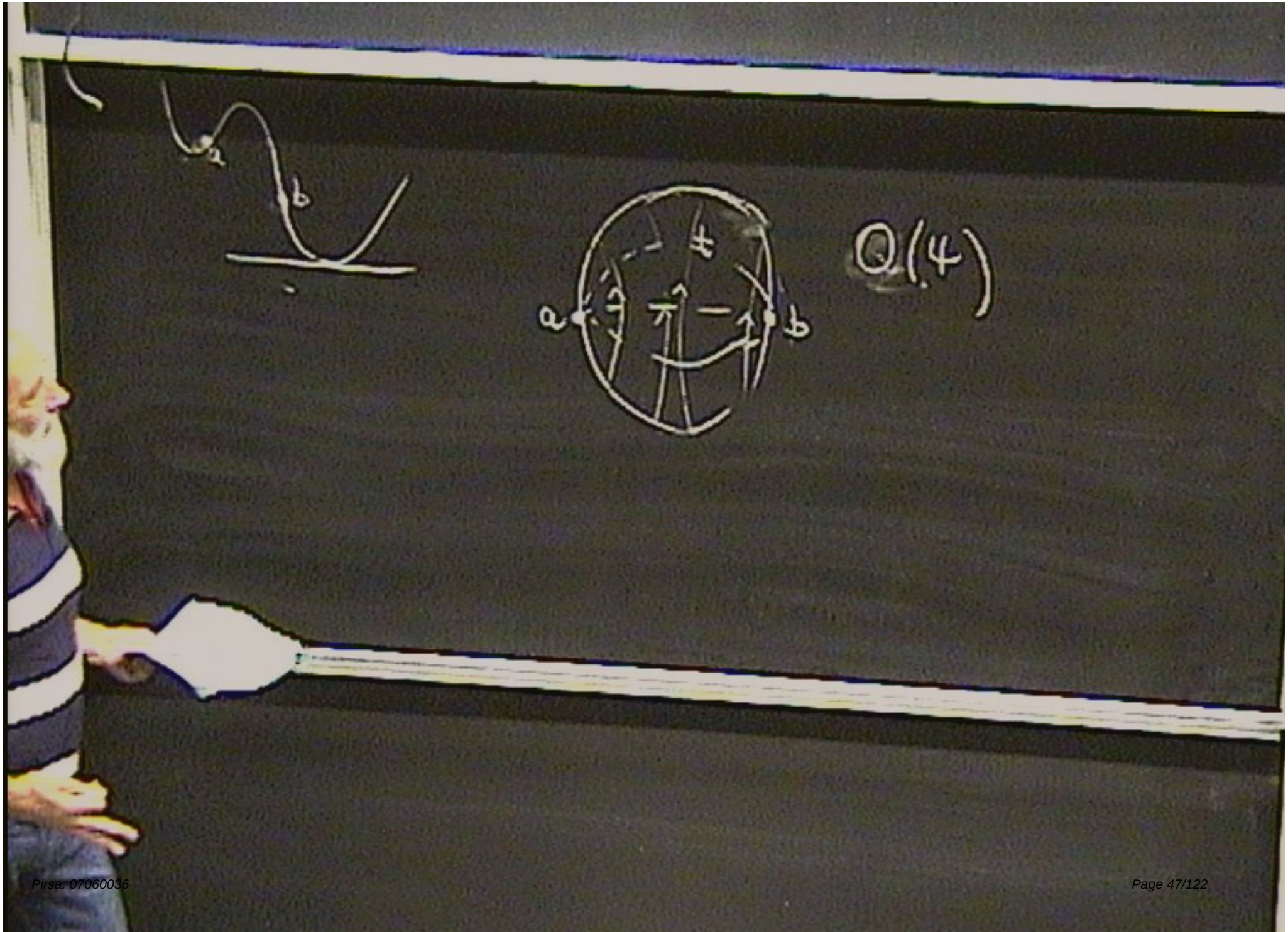

a
b
a
b

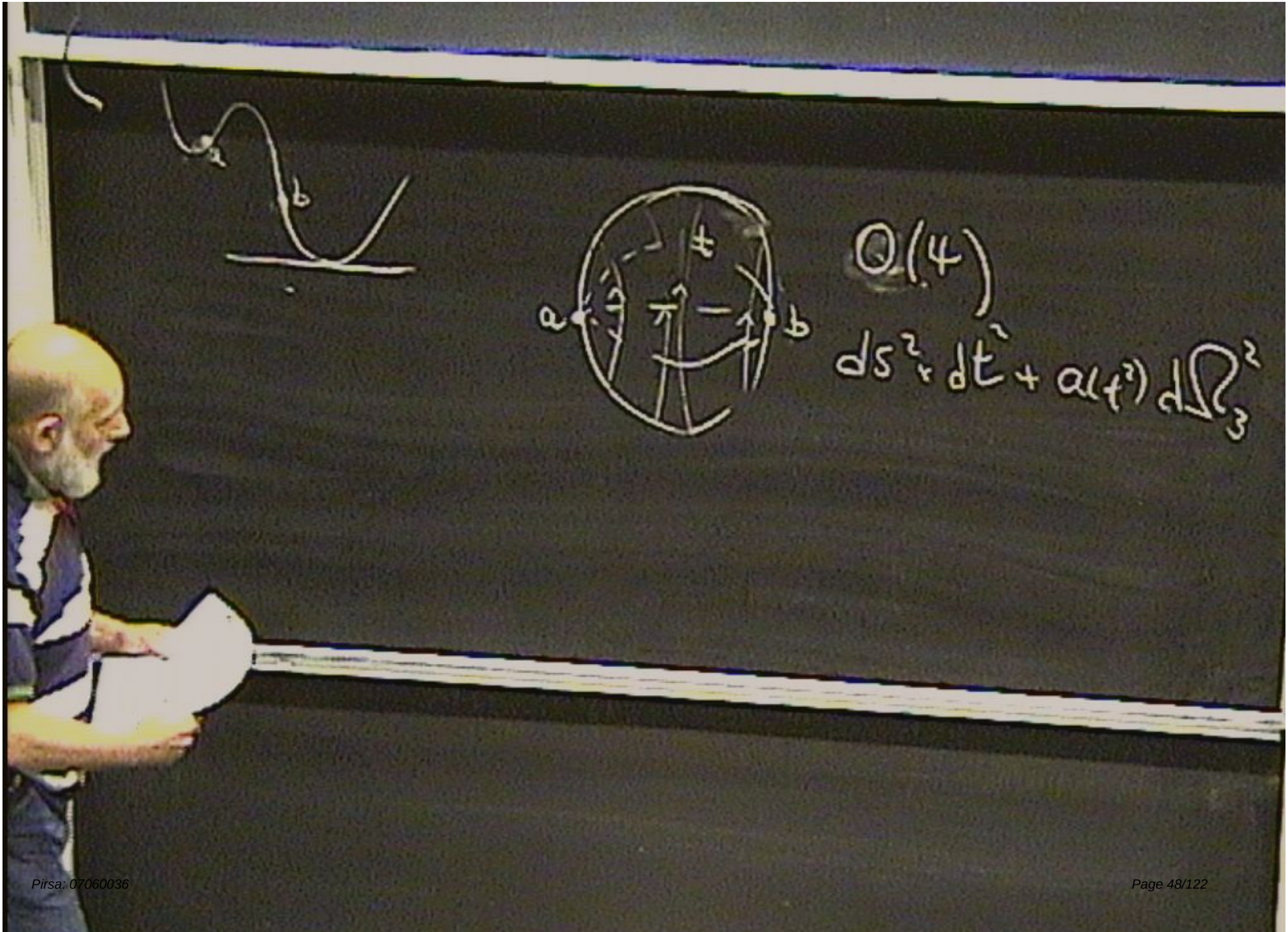


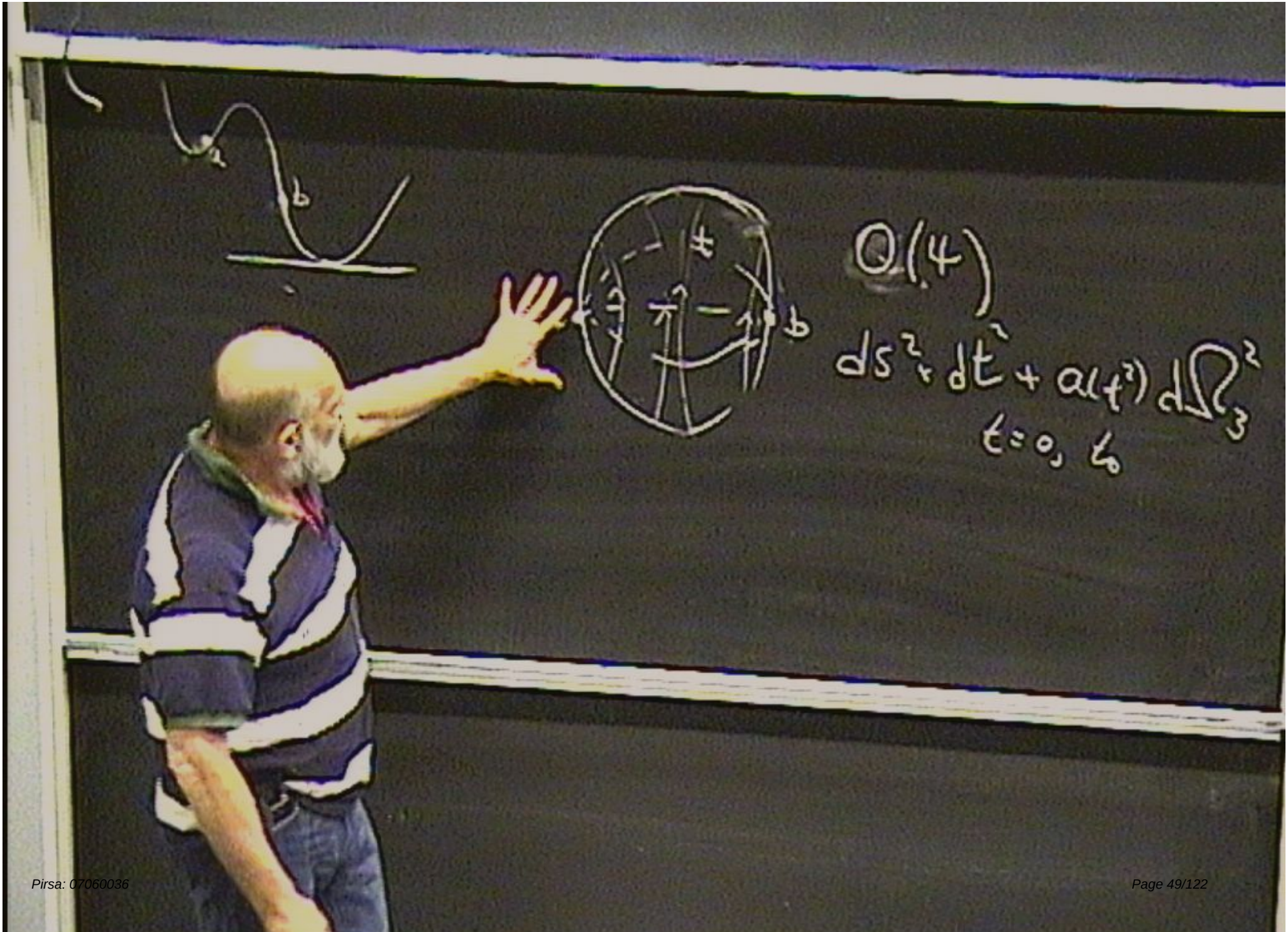

a
b
a
b

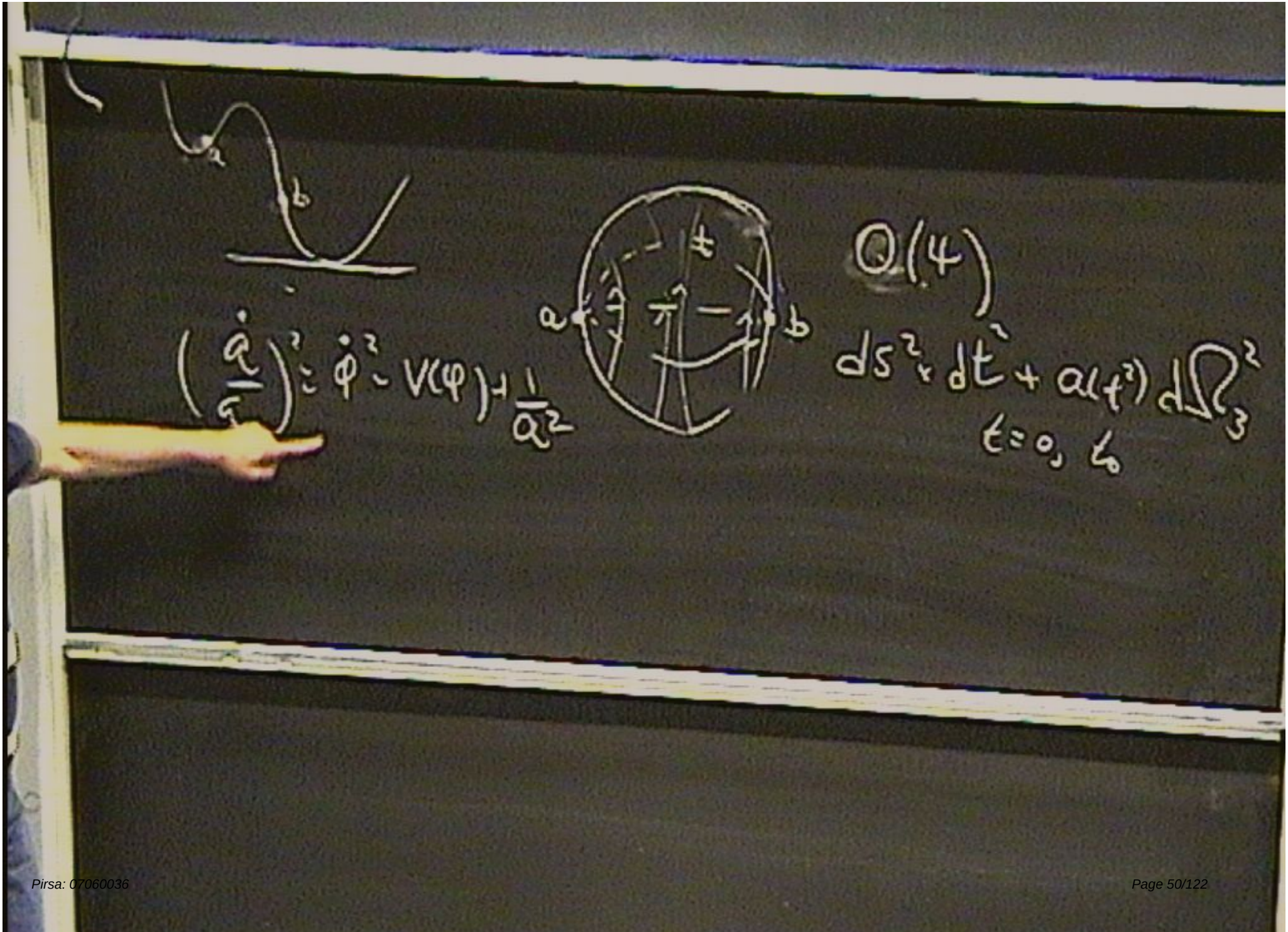

a
b
a
b

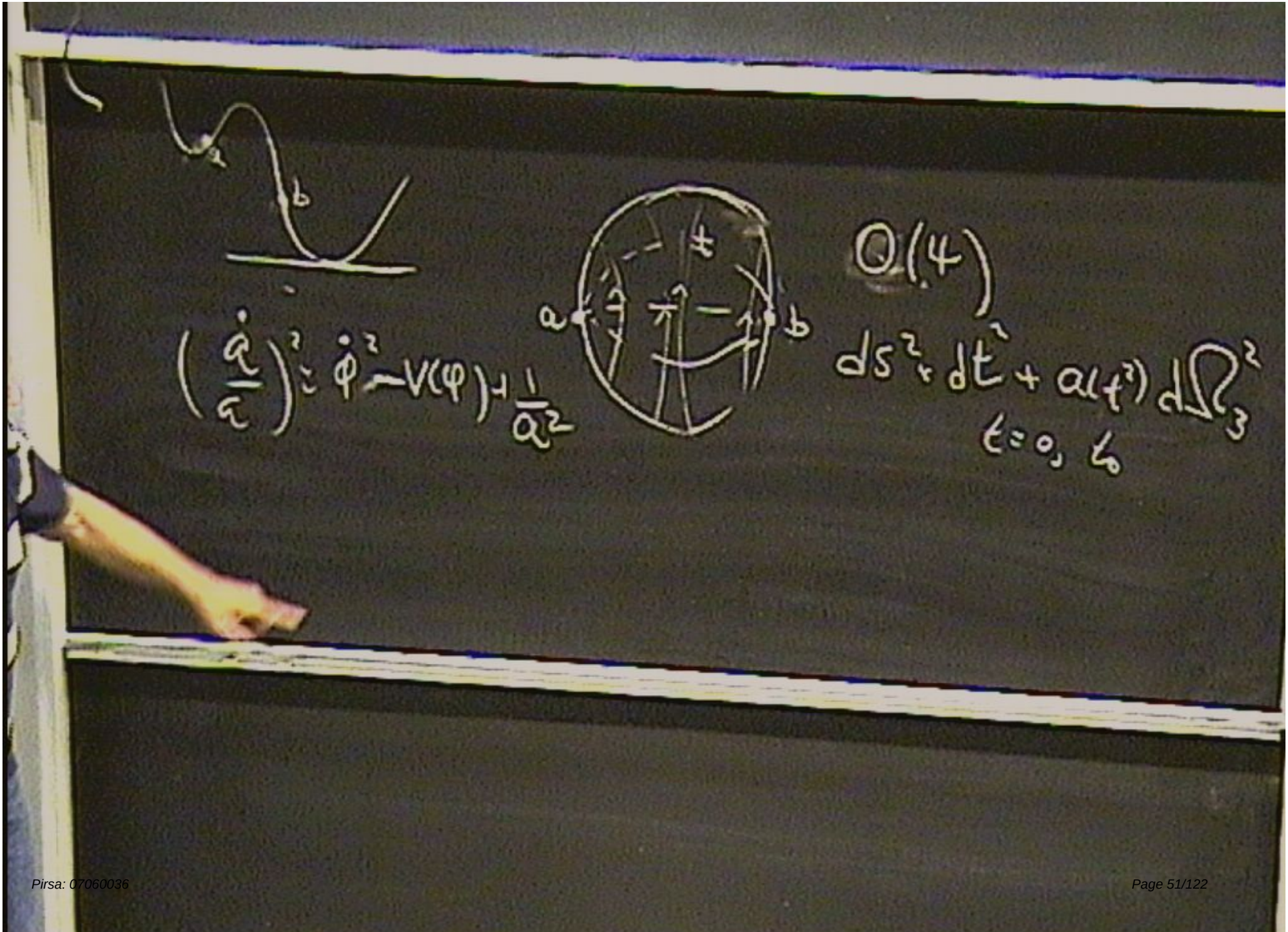

a
b
a
b

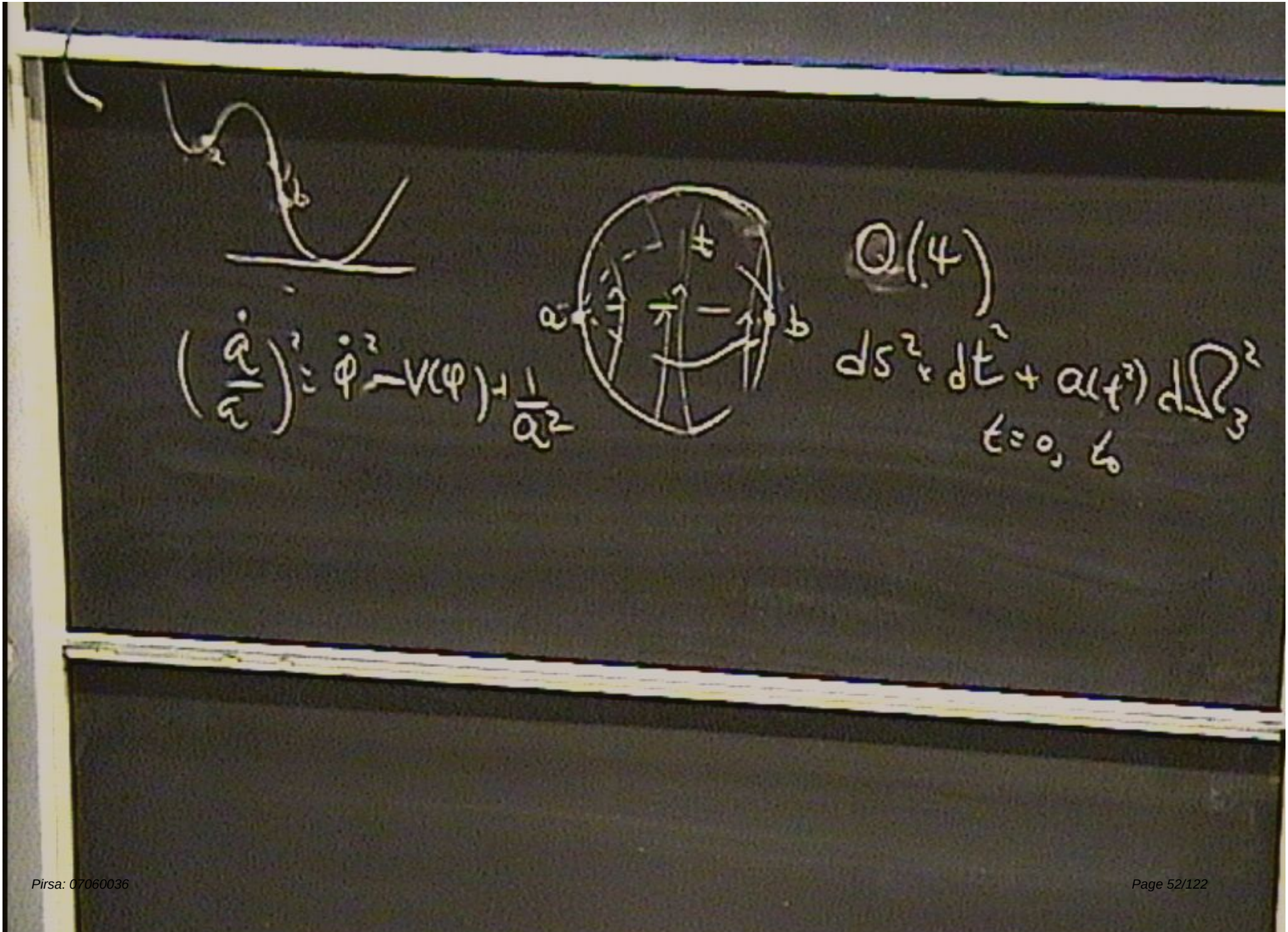

a
b
a
b
Q(4)


a
b
t
a
b
O(4)
$ds^2 = dt^2 + a(t^2) d\Omega_3^2$


O(4)
$ds^2 = dt^2 + a(t^2) d\Omega_3^2$
$t = 0, t_0$


a
b
$\left(\frac{\dot{a}}{a}\right)^2 \sim \dot{\phi}^2 \sim V(\varphi) + \frac{1}{a^2}$
a
b
O(4)
$ds^2 \sim dt^2 + a(t^2)\, d\Omega_3^2$
$t = 0, t_0$


a
b
t
a
b
O(4)
$\left(\frac{\dot{a}}{a}\right)^2 = \dot{\phi}^2 - V(\phi) + \frac{1}{a^2}$
$ds^2 = dt^2 + a(t^2)\, d\Omega_3^2$
$t = 0, t_0$


$\left(\frac{\dot{a}}{a}\right)^2 = \dot{\phi}^2 - V(\phi) + \frac{1}{a^2}$
a
b
$Q(4)$
$ds^2 = dt^2 + a(t^2)\, d\Omega_3^2$
$t = 0, t_0$

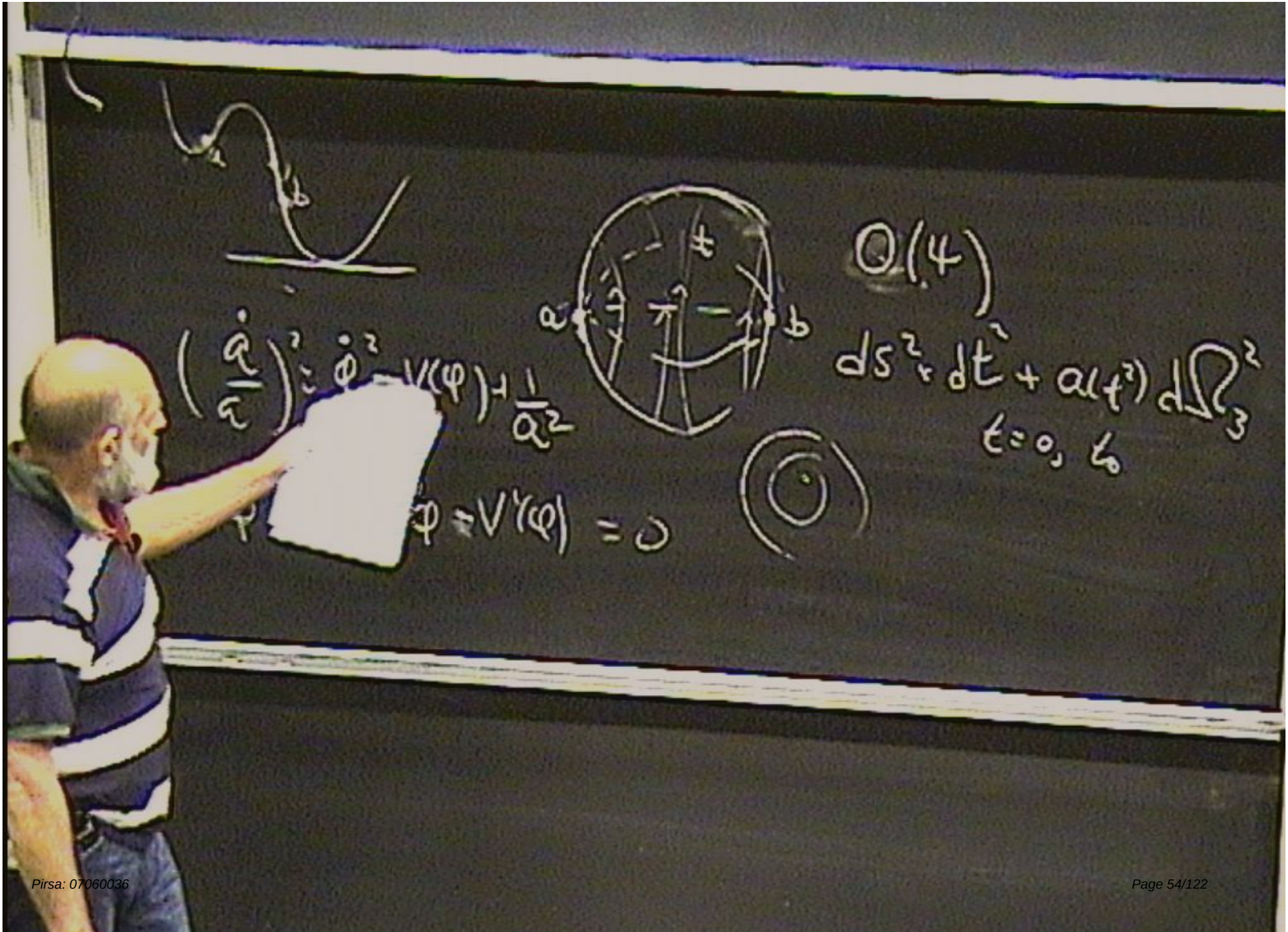
$$\left(\frac{\dot{a}}{a}\right)^2 = \dot{\phi}^2 - V(\phi) + \frac{1}{a^2}$$

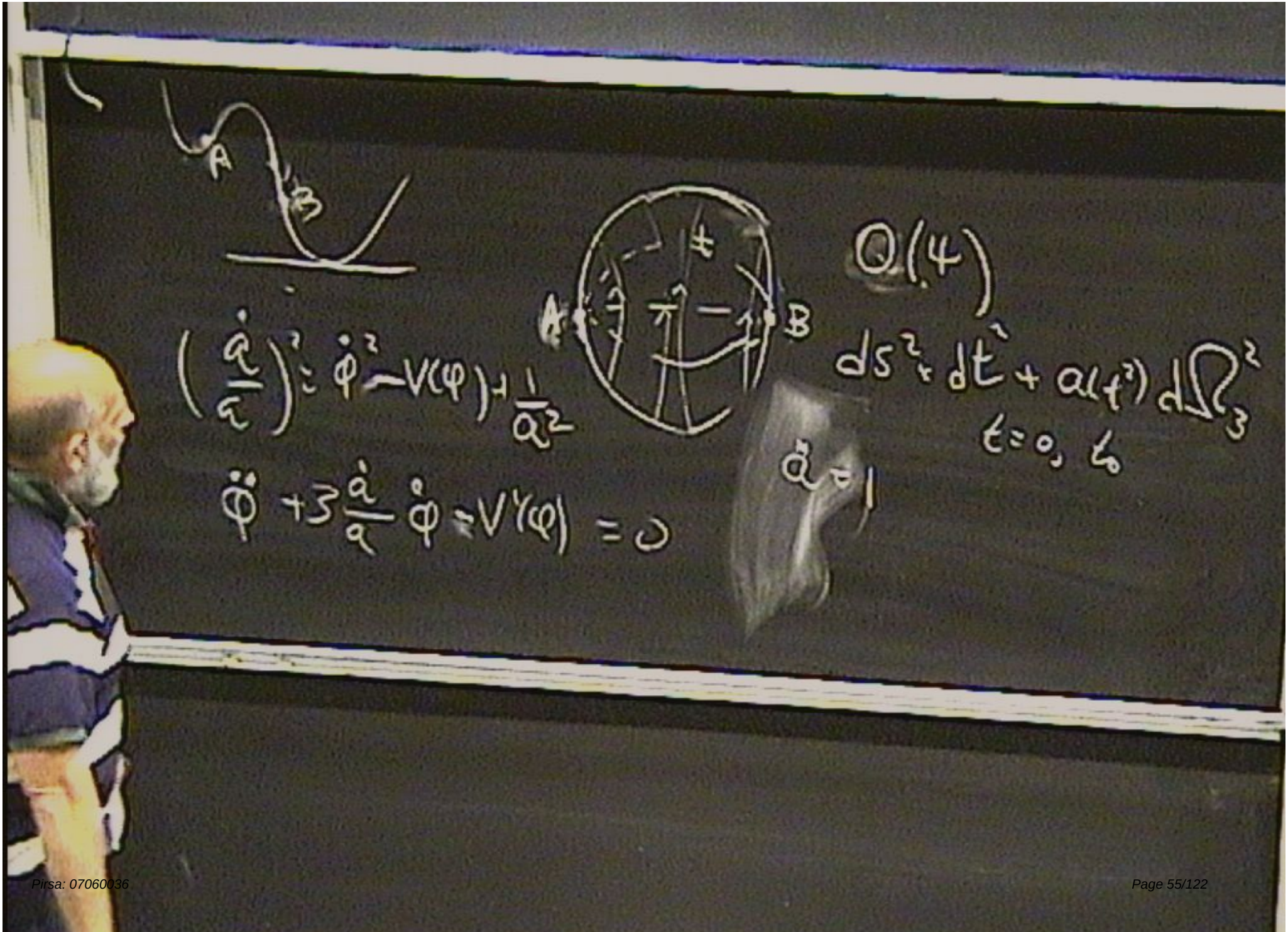
$$\ddot{\phi} + 3\frac{\dot{a}}{a}\dot{\phi} = -V'(\phi)$$

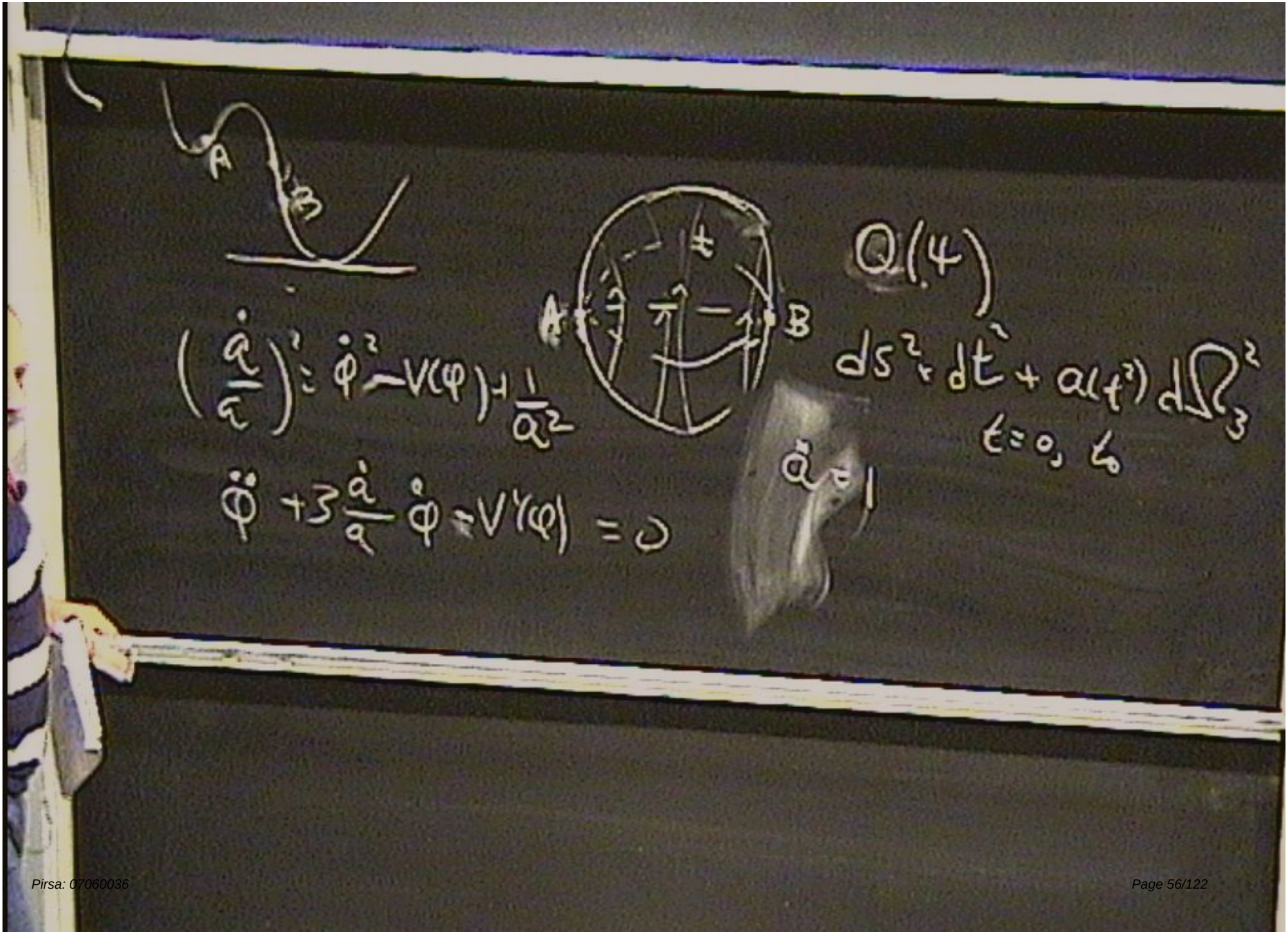
$Q(4)$

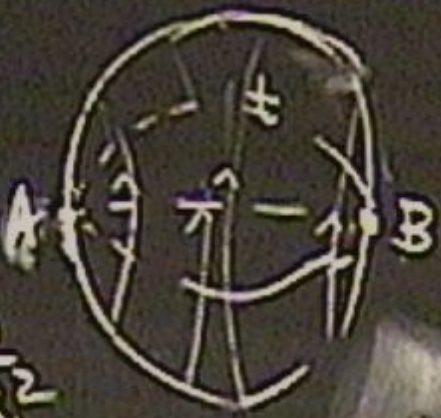
$$ds^2 = dt^2 + a(t^2)\, d\Omega_3^2$$

$t = 0, 4$


O(4)
a
b
$\left(\frac{\dot{a}}{a}\right)^2 + \dot{\phi}^2 - V(\phi) + \frac{1}{a^2}$
$ds^2 = dt^2 + a(t^2) d\Omega_3^2$
$t = 0, t_0$
$\ddot{\phi} + V'(\phi) = 0$


A
B
A
B
O(4)
$\left(\frac{\dot{a}}{a}\right)^2 = \dot{\phi}^2 - V(\phi) + \frac{1}{a^2}$
$ds^2 = dt^2 + a(t^2)\, d\Omega_3^2$
$t = 0, \infty$
$a = 1$
$\ddot{\phi} + 3\frac{\dot{a}}{a}\dot{\phi} = V'(\phi) = 0$


A
B
A
B
Q(4)
$\left(\frac{\dot{a}}{a}\right)^2 = \dot{\phi}^2 - V(\phi) + \frac{1}{a^2}$
$ds^2 = dt^2 + a(t^2)\, d\Omega_3^2$
$t = 0, 4$
$a = 1$
$\ddot{\phi} + 3\frac{\dot{a}}{a}\dot{\phi} - V'(\phi) = 0$



O(4)

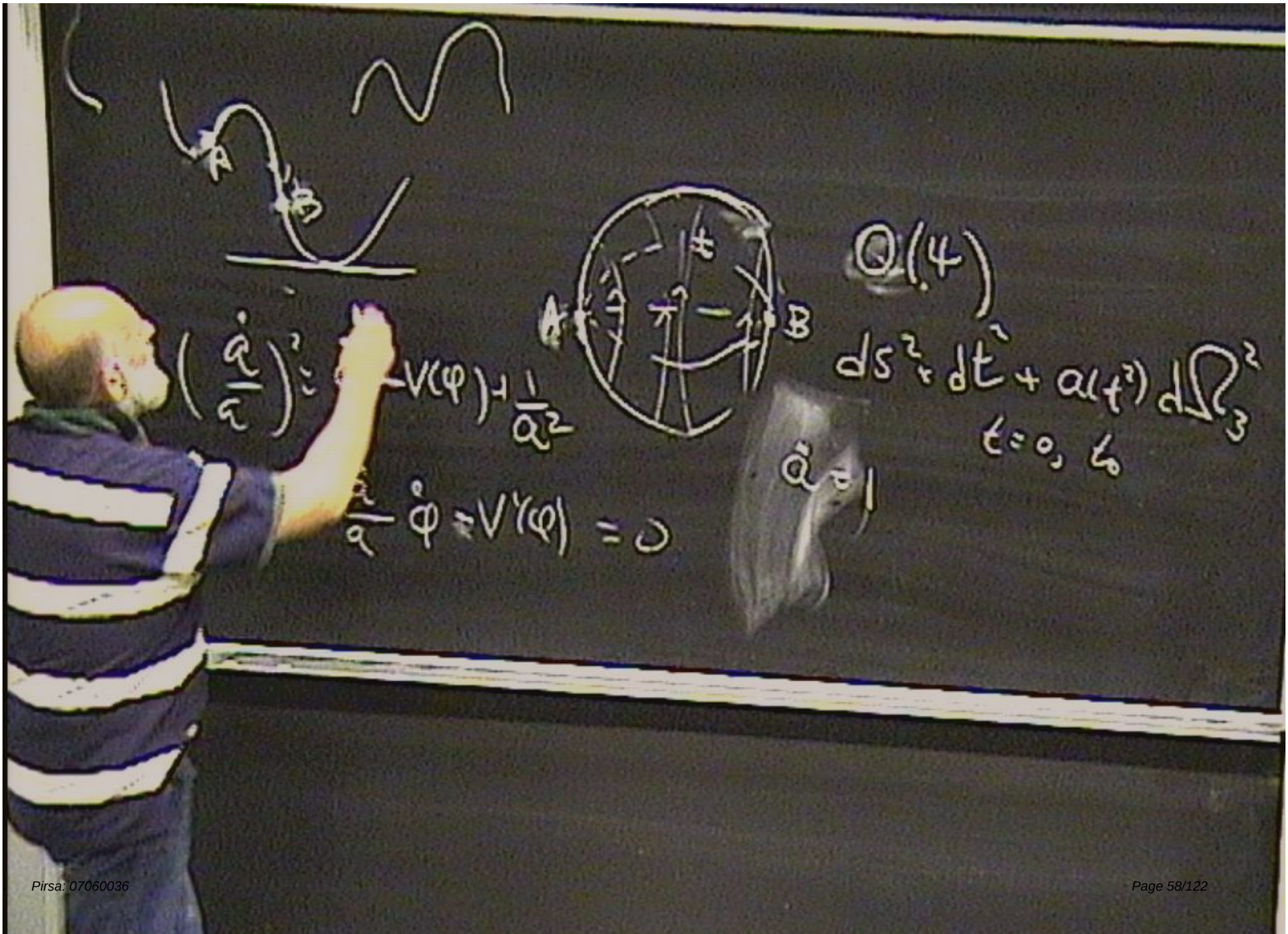
$$\left(\frac{\dot{a}}{a}\right)^2 = \dot{\phi}^2 - V(\phi) + \frac{1}{a^2}$$

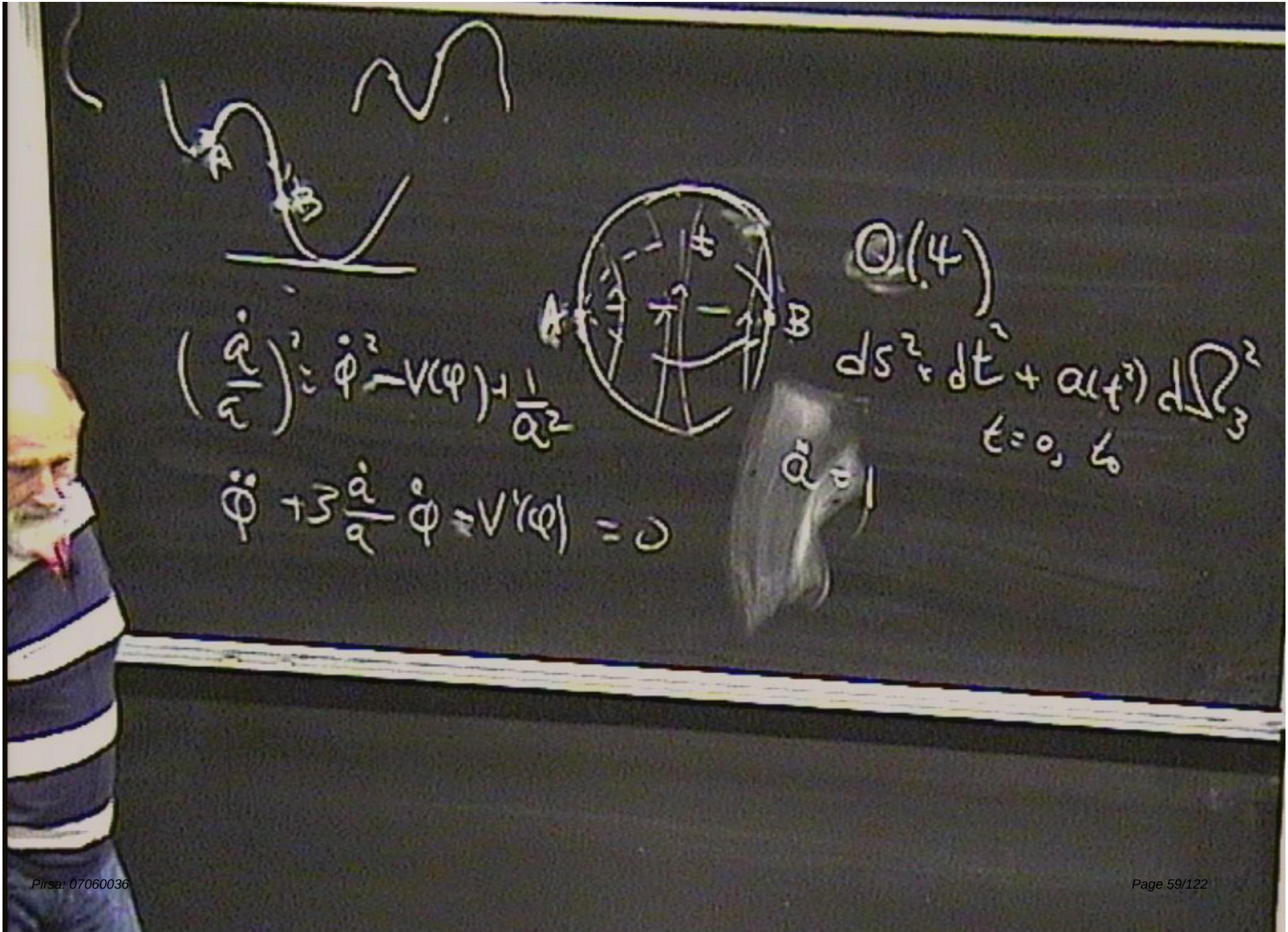
$$ds^2 = dt^2 + a(t^2)\, d\Omega_3^2$$

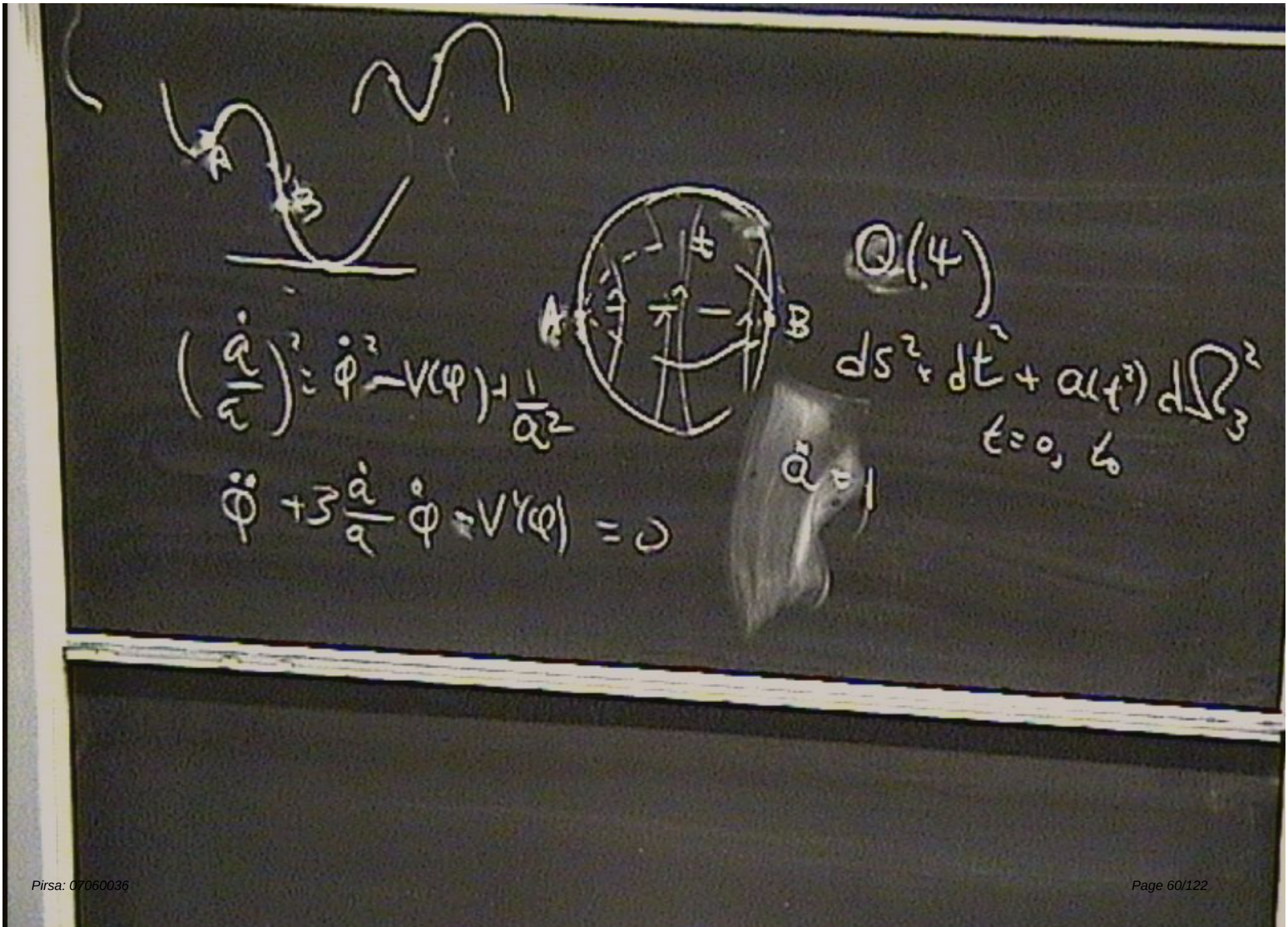
$t = 0, \infty$

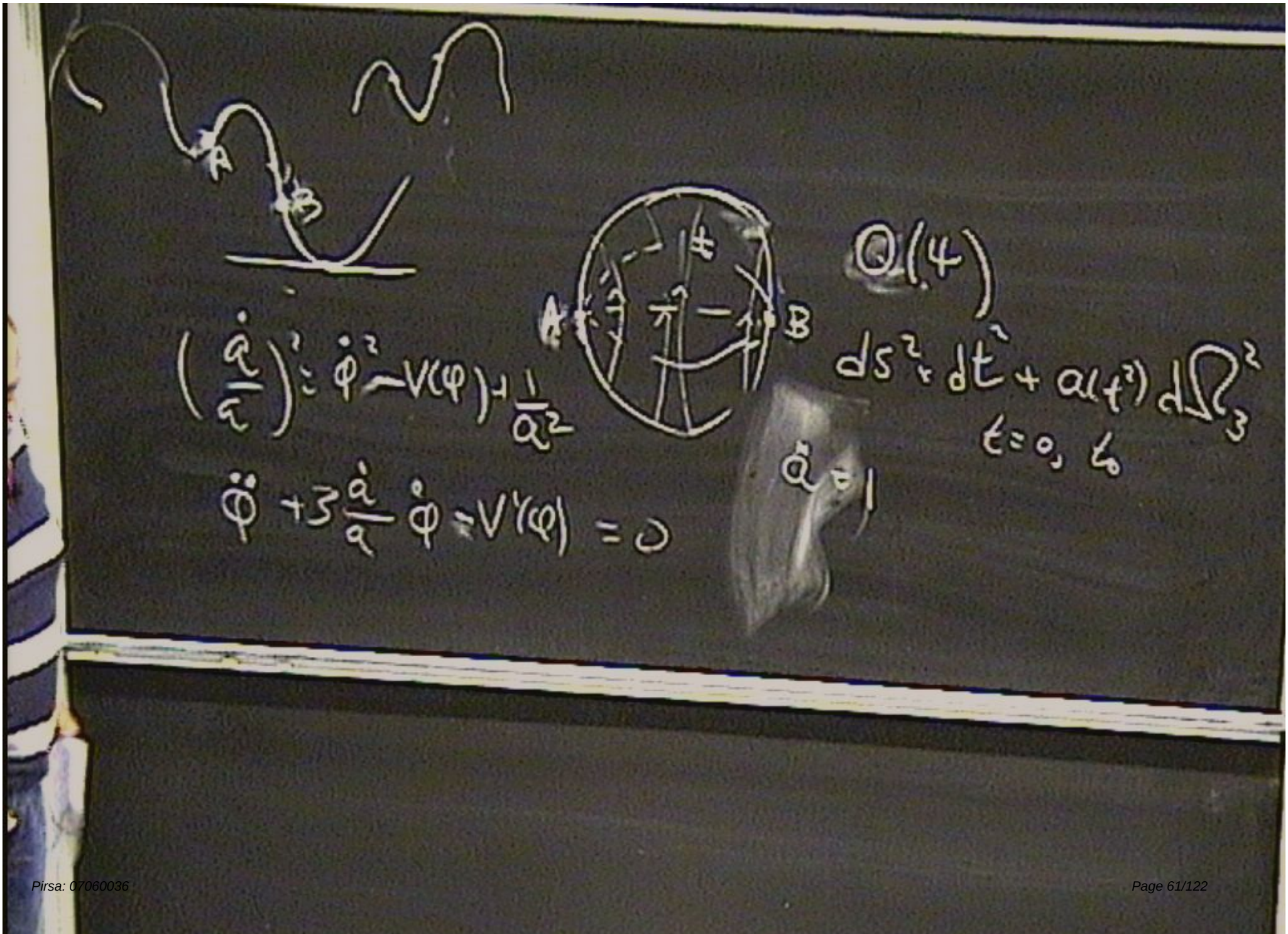
$$\ddot{\phi} + 3\frac{\dot{a}}{a}\dot{\phi} = V'(\phi) = 0$$

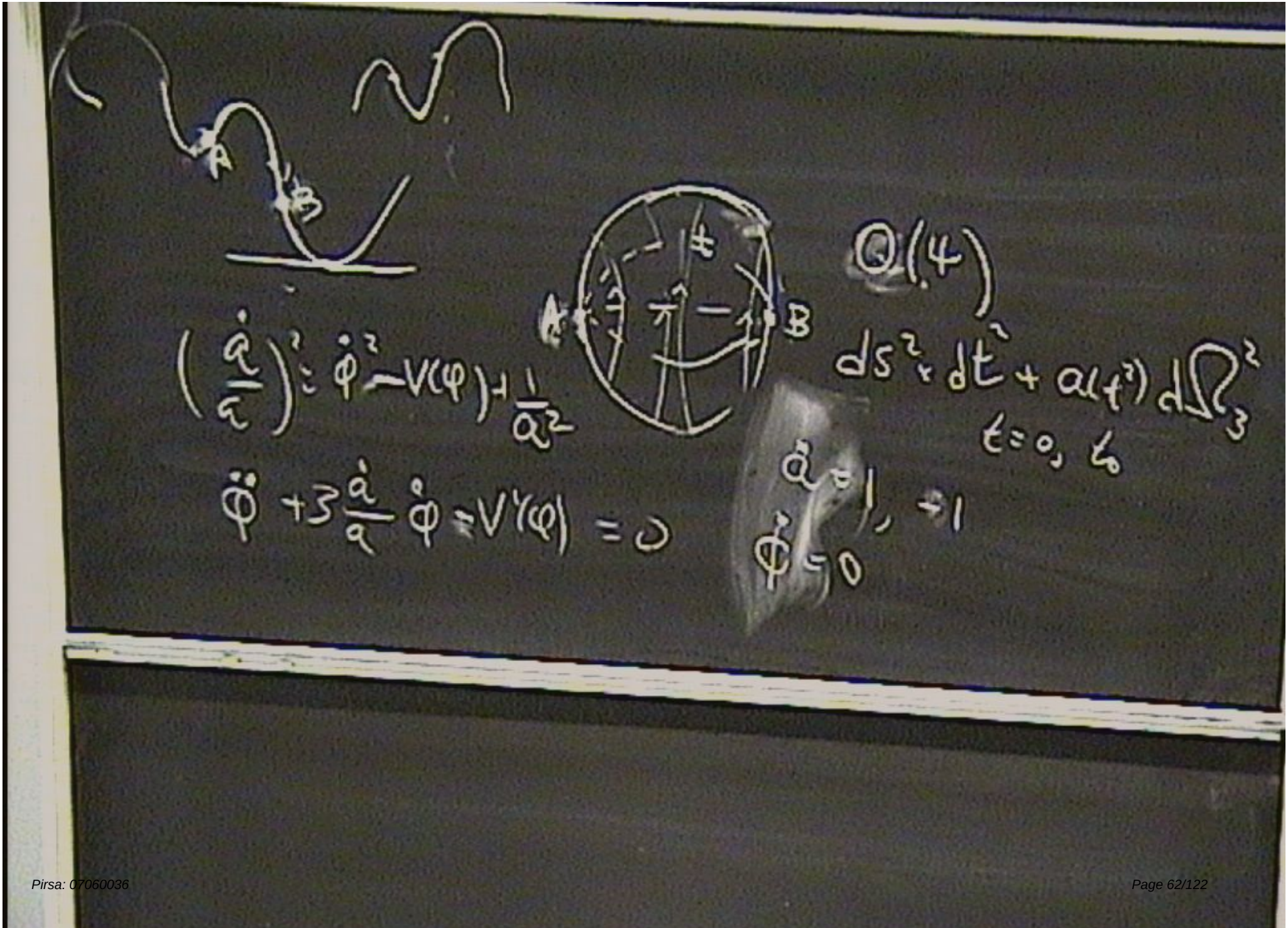
$a = 1$

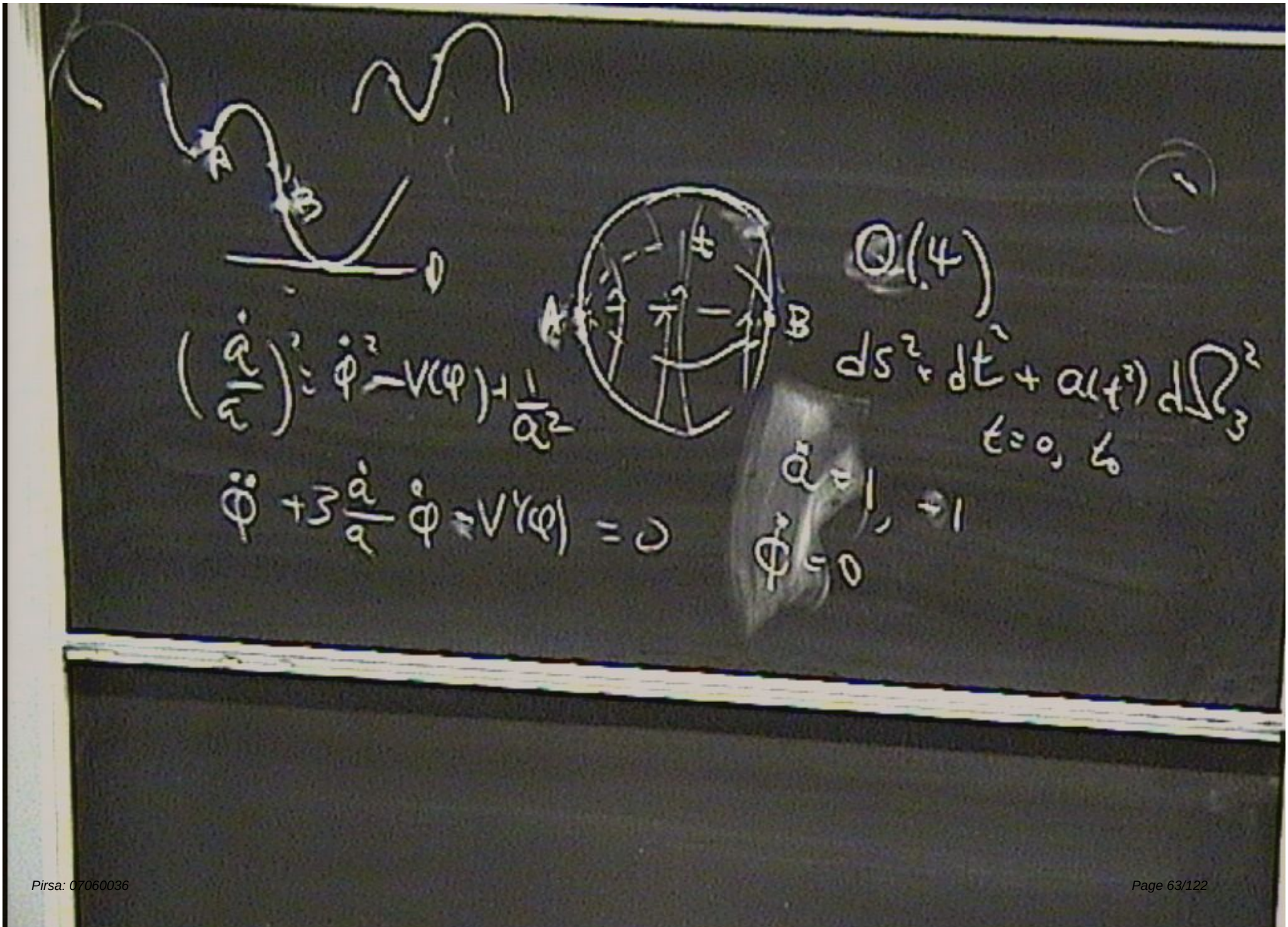

A
B
A
B
O(4)
$\left(\frac{\dot{a}}{a}\right)^2 = -V(\varphi) + \frac{1}{a^2}$
$ds^2 = dt^2 + a(t^2)\, d\Omega_3^2$
$t = 0, 4$
$a = 1$
$\frac{\partial}{\partial} \dot{\varphi} = V'(\varphi) = 0$

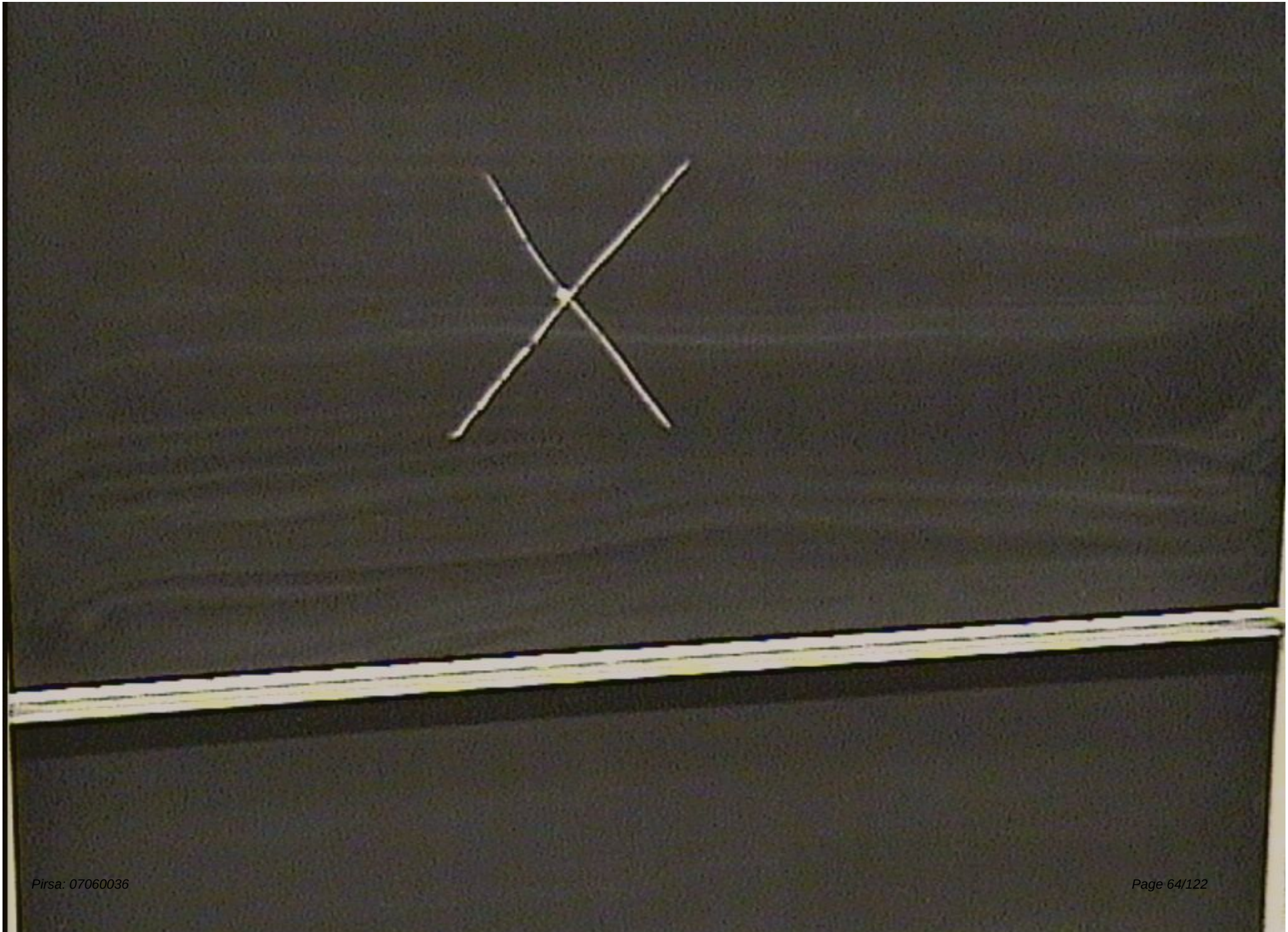

A
B
A
B
O(4)
$\left(\frac{\dot{a}}{a}\right)^2 = \dot{\phi}^2 - V(\phi) + \frac{1}{a^2}$
$ds^2 = dt^2 + a(t^2)\, d\Omega_3^2$
$t = 0, 4$
$a = 1$
$\ddot{\phi} + 3\frac{\dot{a}}{a}\dot{\phi} = V'(\phi) = 0$

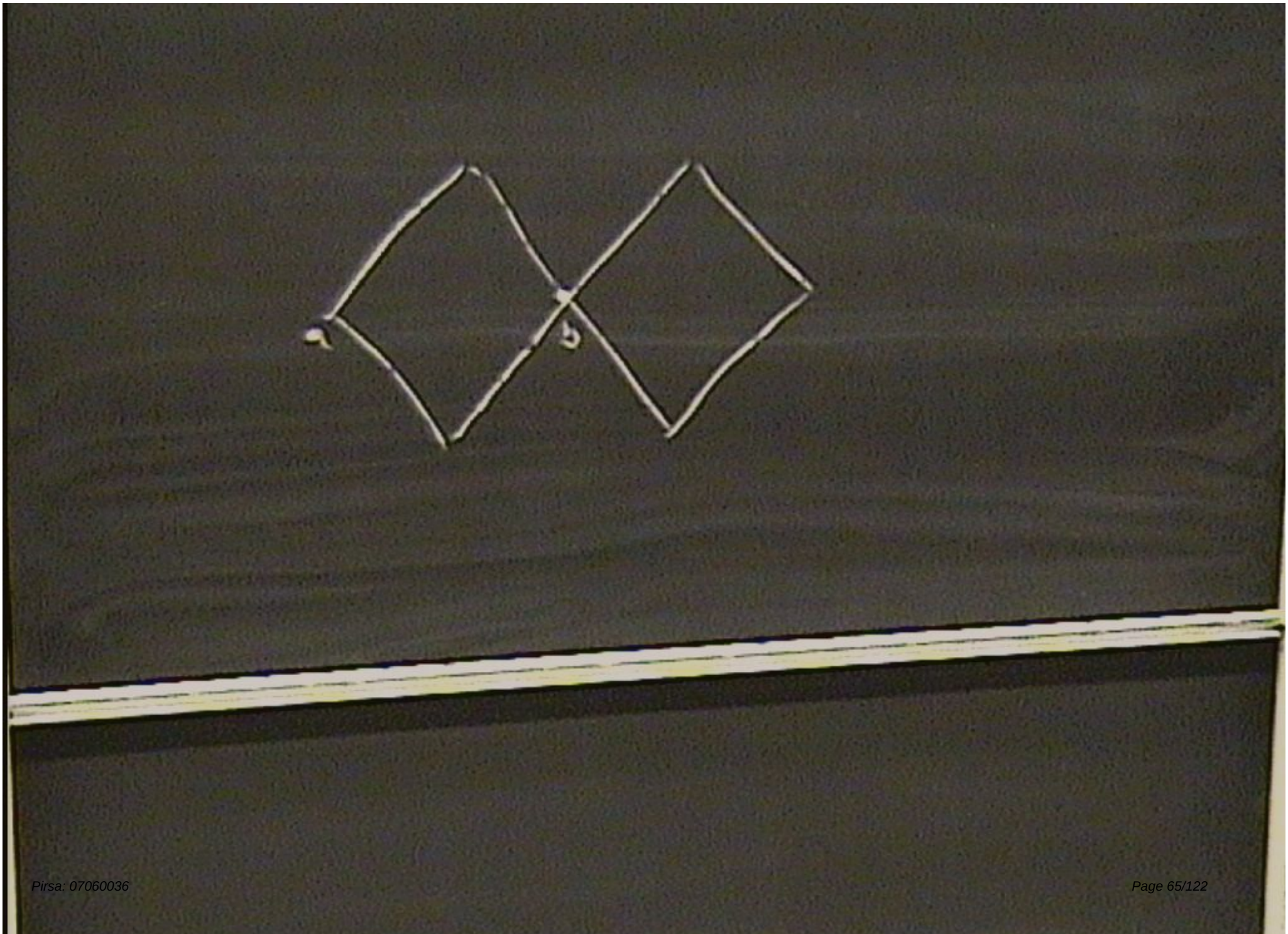

A
B
A
B
$\left(\frac{\dot{a}}{a}\right)^2 = \dot{\phi}^2 - V(\phi) + \frac{1}{a^2}$
$\ddot{\phi} + 3\frac{\dot{a}}{a}\dot{\phi} - V'(\phi) = 0$
$Q(t)$
$ds^2 = dt^2 + a(t^2)\, d\Omega_3^2$
$t = 0, 6$
$a = 1$

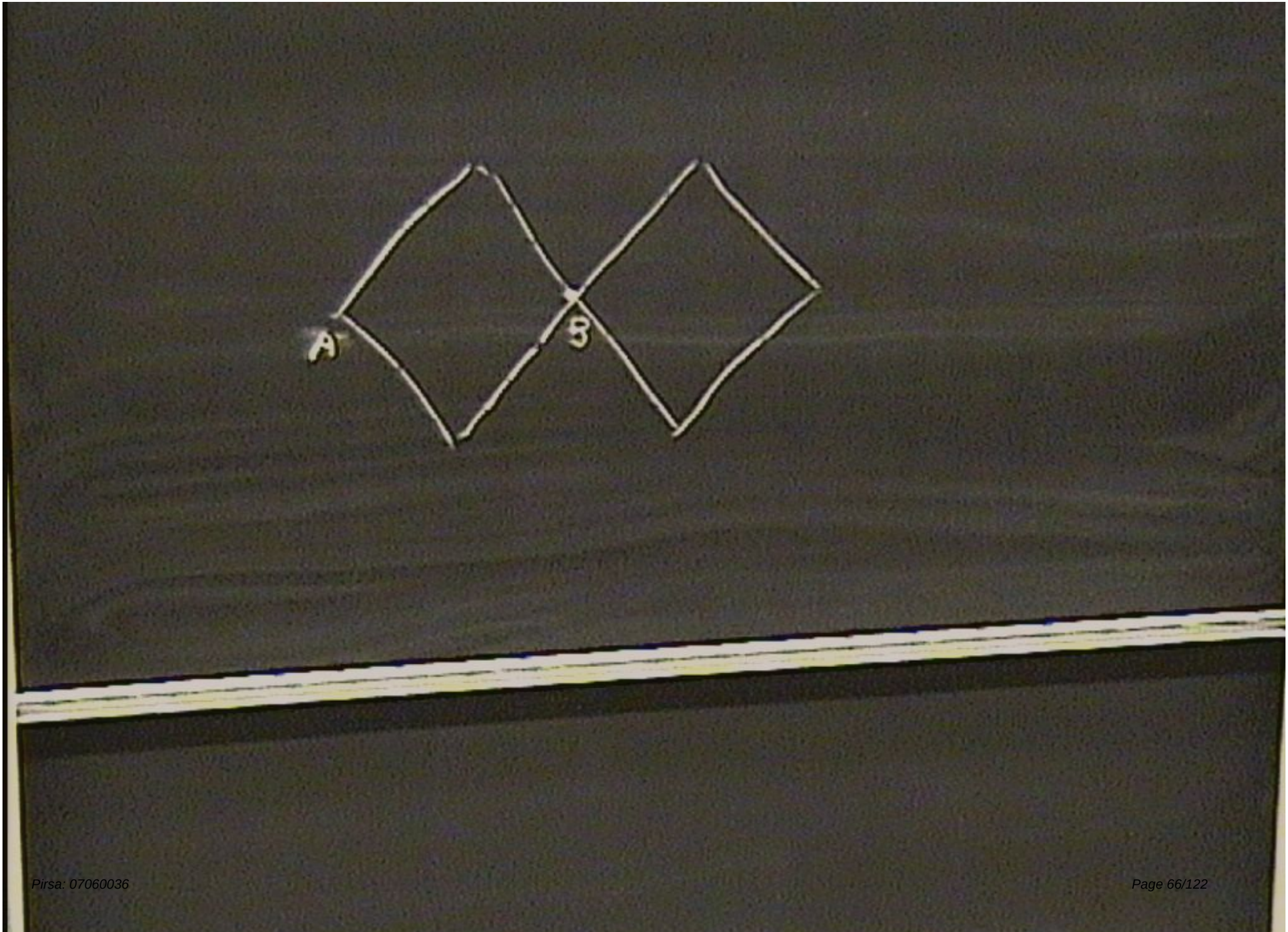

A
B
A
B
$\left(\frac{\dot{a}}{a}\right)^2 = \dot{\phi}^2 - V(\phi) + \frac{1}{a^2}$
$\ddot{\phi} + 3\frac{\dot{a}}{a}\dot{\phi} - V'(\phi) = 0$
O(4)
$ds^2 = dt^2 + a(t^2)\, d\Omega_3^2$
$t = 0, \ell$
$a = 1$

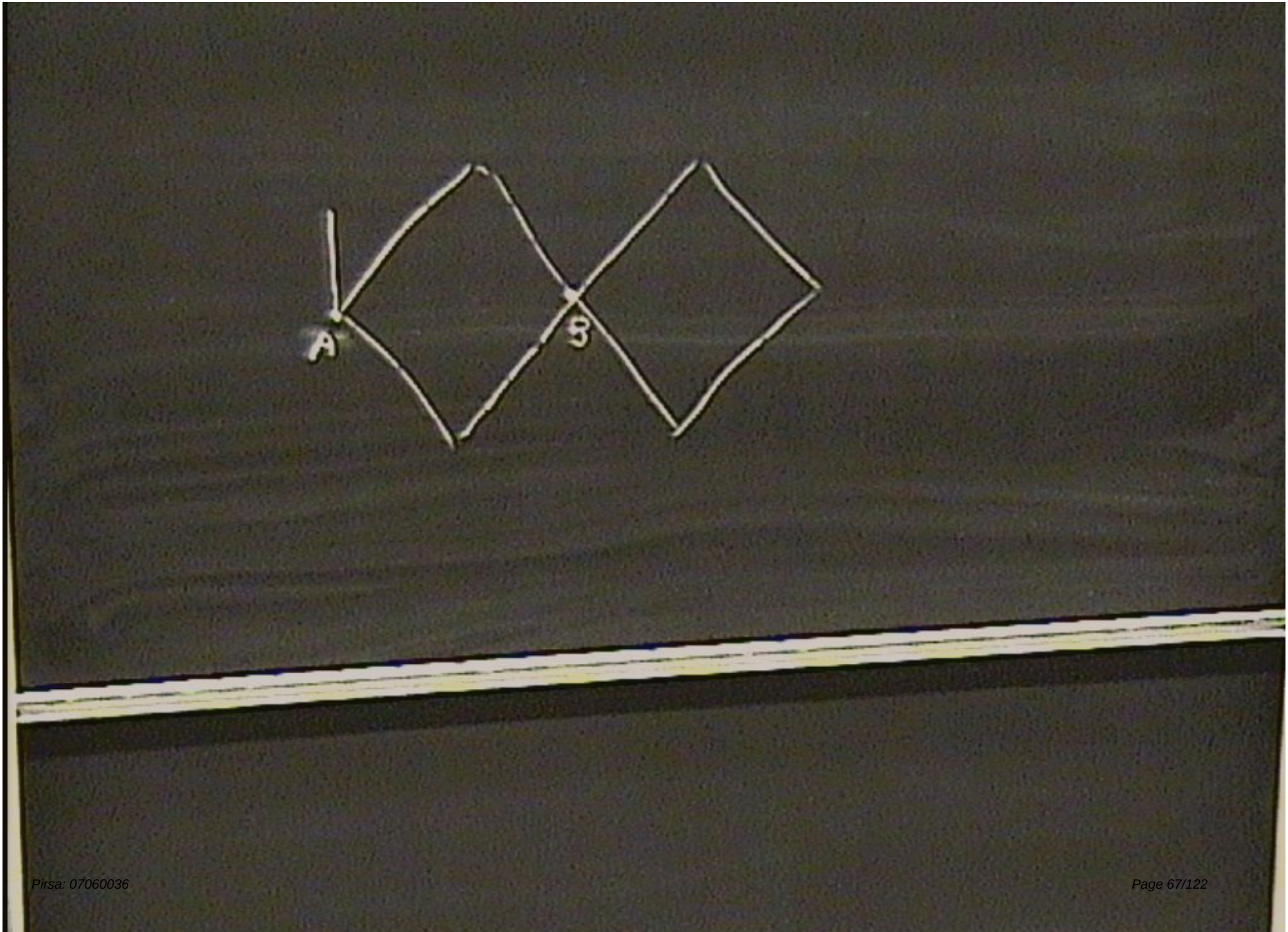

A
B
A
B
$\left(\frac{\dot{a}}{a}\right)^2 = \dot{\phi}^2 - V(\phi) + \frac{1}{a^2}$
$\ddot{\phi} + 3\frac{\dot{a}}{a}\dot{\phi} = V'(\phi) = 0$
$O(4)$
$ds^2 = dt^2 + a(t^2)\, d\Omega_3^2$
$t = 0, \infty$
$a = 1, \infty$
$\dot{\phi} = 0$

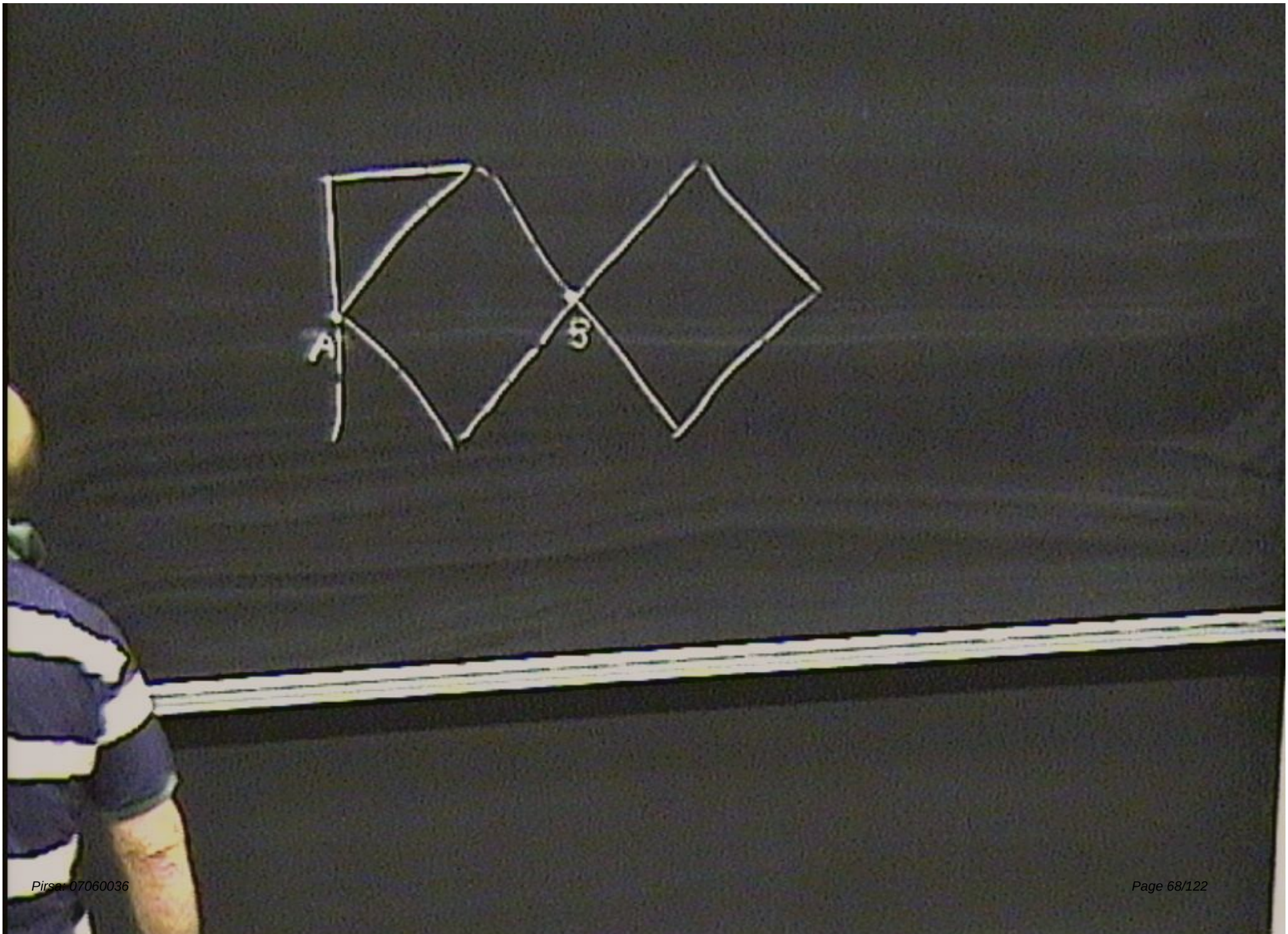

A
B
O
A
B
Q(4)
$\left(\frac{\dot{a}}{a}\right)^2 = \dot{\phi}^2 - V(\phi) + \frac{1}{a^2}$
$ds^2 = dt^2 + a(t^2)\, d\Omega_3^2$
$t = 0, 4$
$\ddot{\phi} + 3\frac{\dot{a}}{a}\dot{\phi} = V'(\phi) = 0$
$\dot{a} = 1, -1$
$\dot{\phi} = 0$

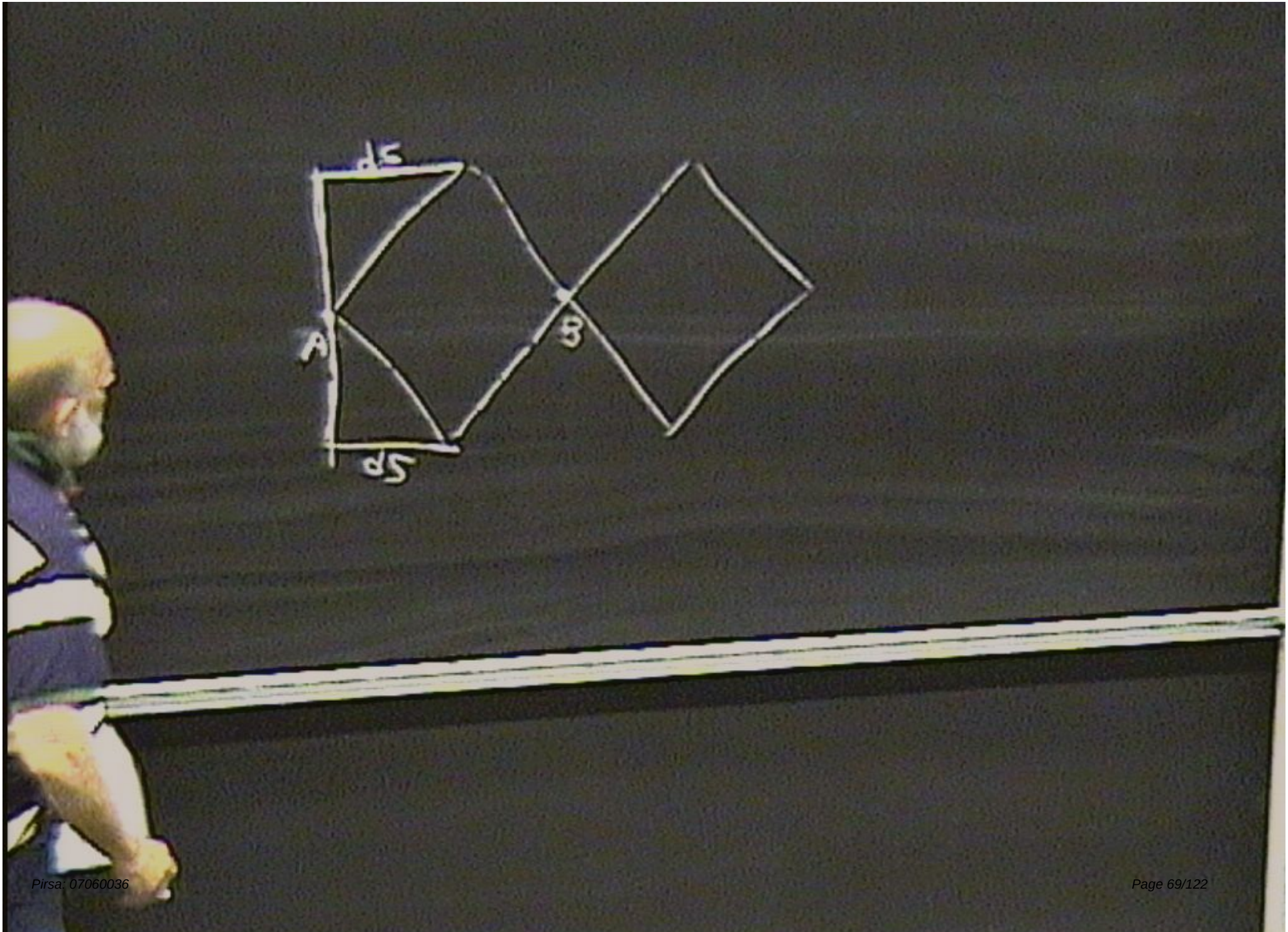


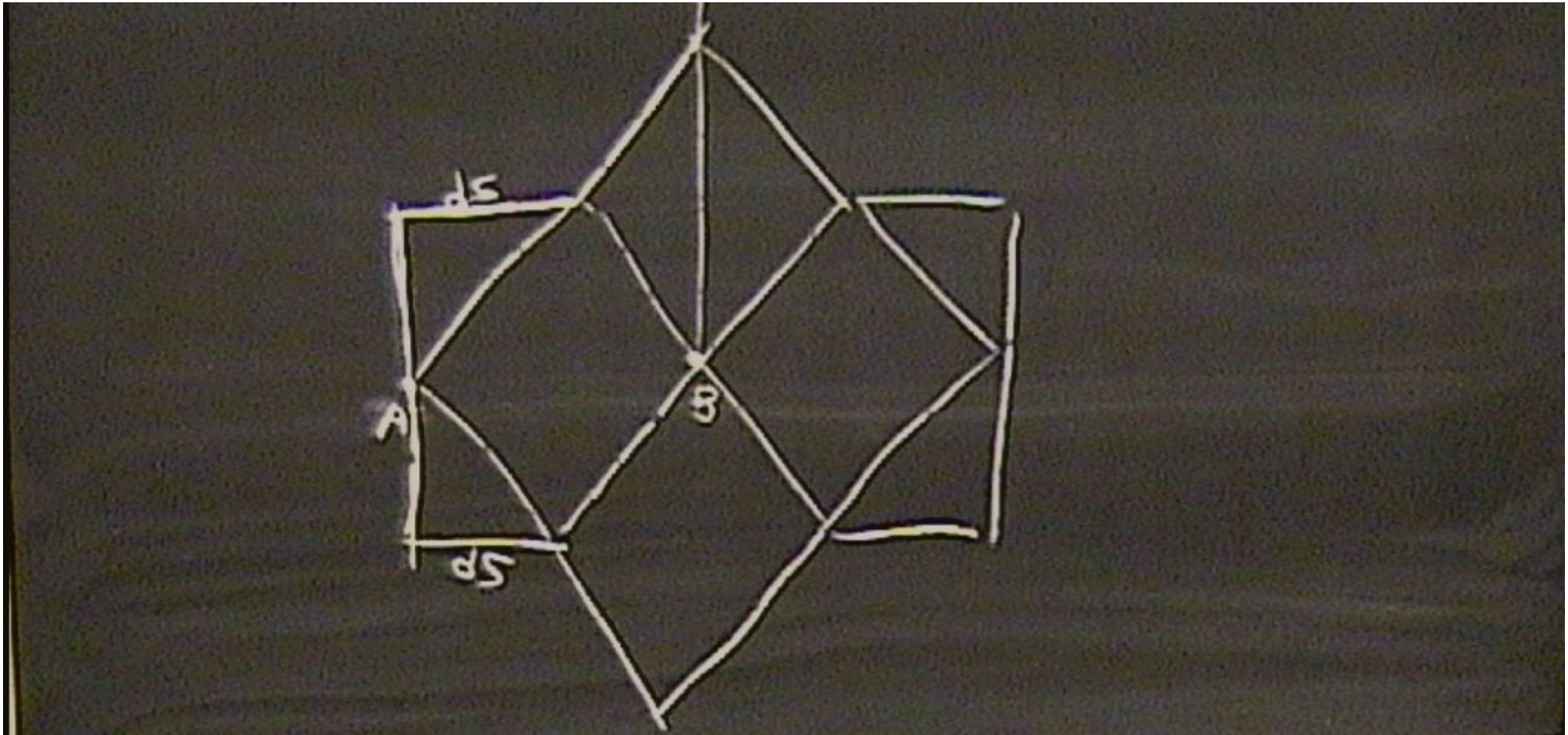

a
b

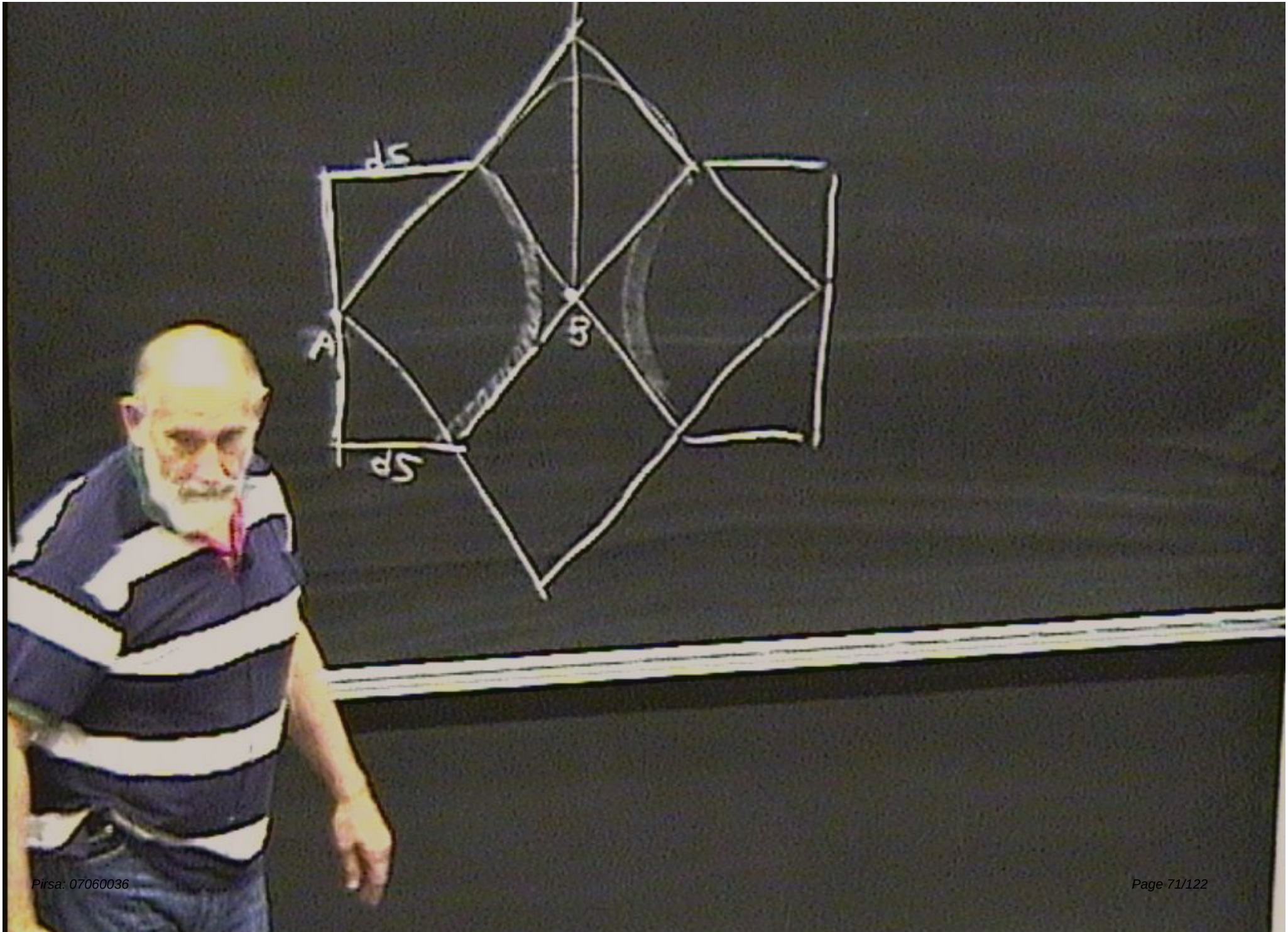

A
B

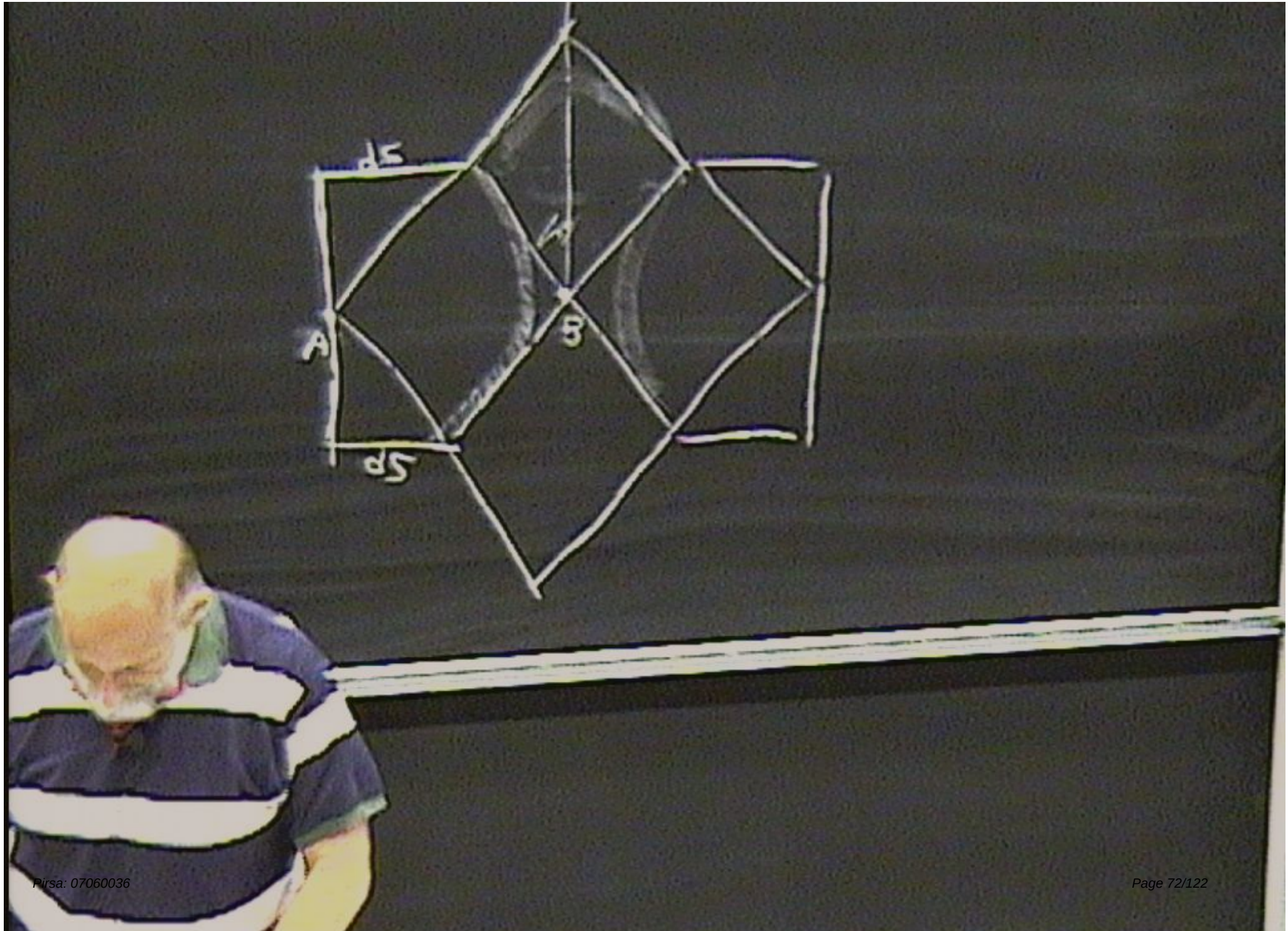

A
B


A
B

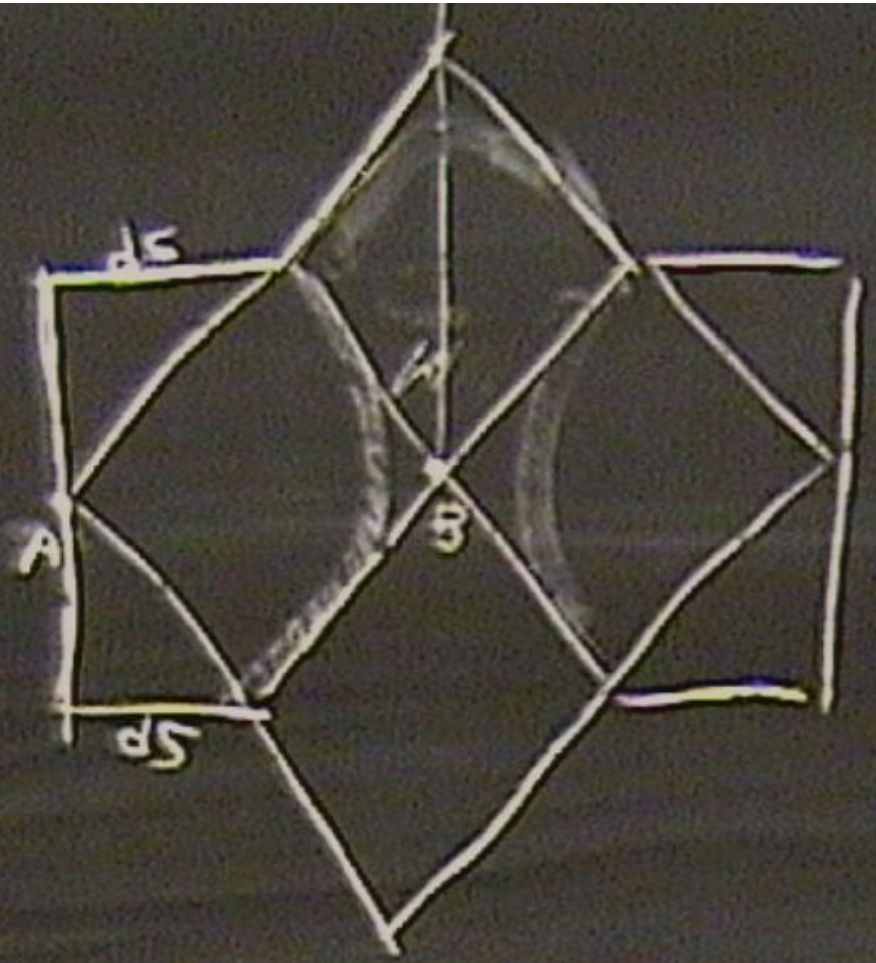

dz
A
B
dz


dS
A
B
dS

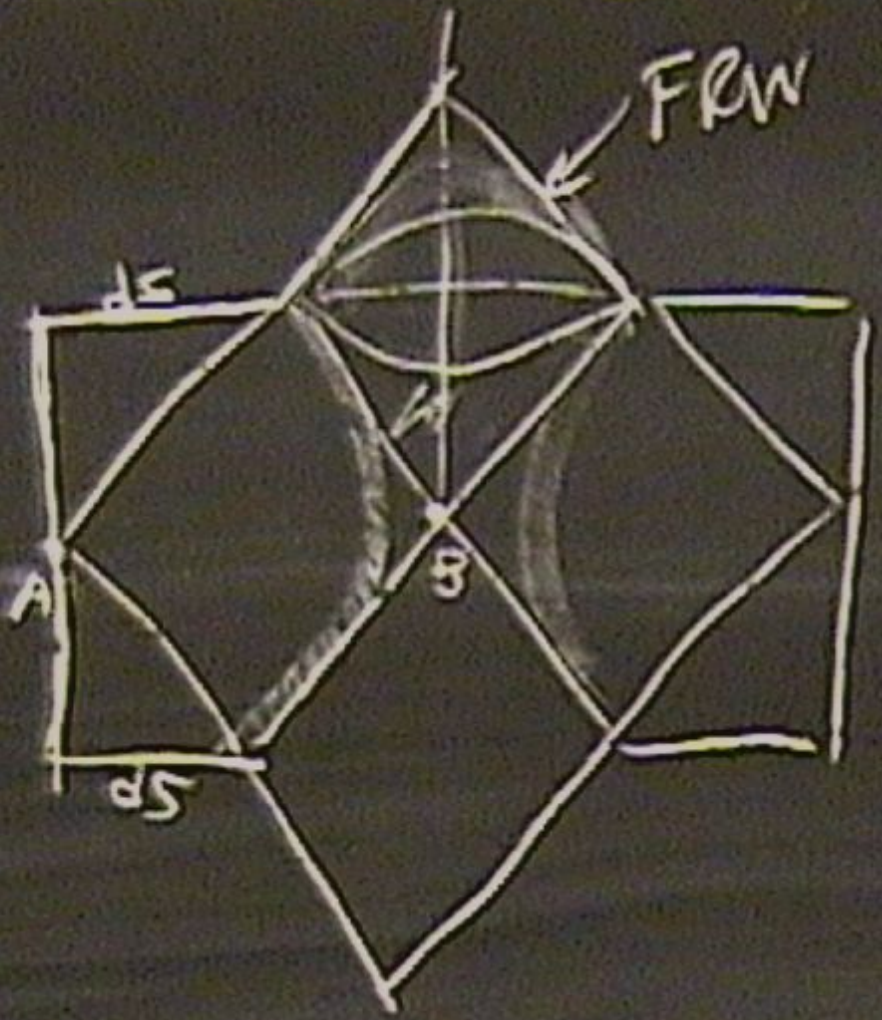

dS
A
B
dS


dp
A
B
dp

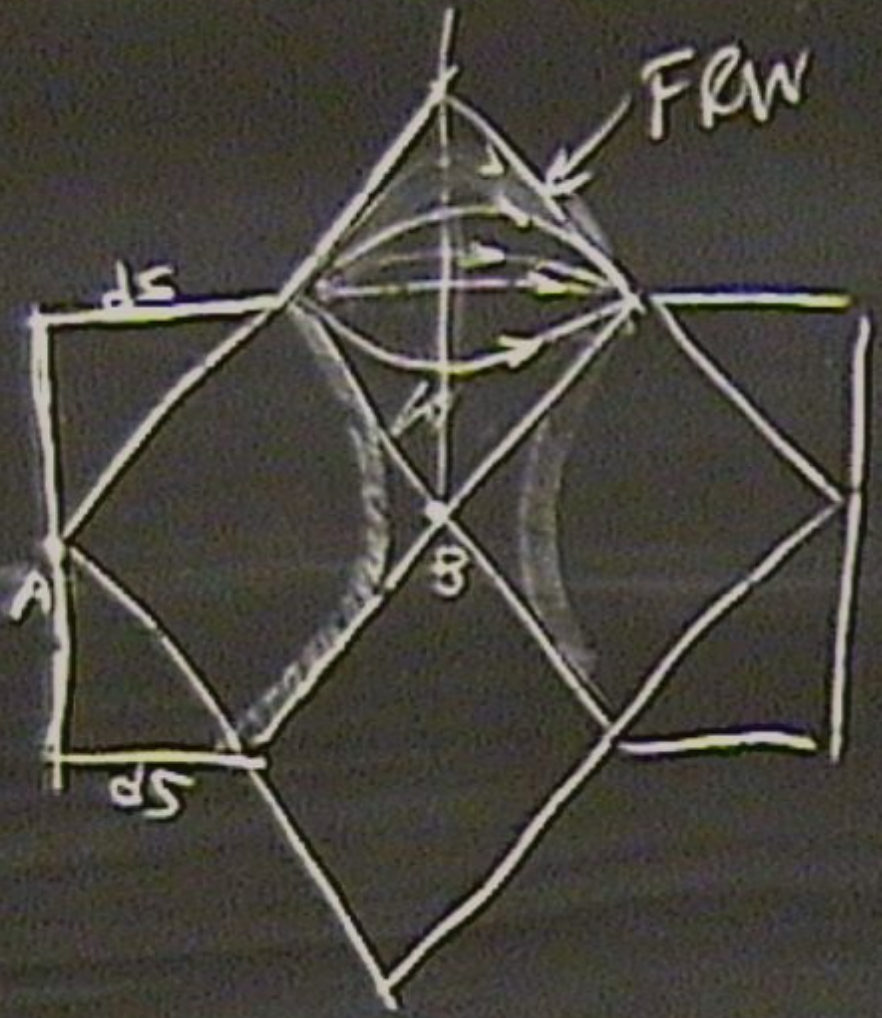
O(3,1)



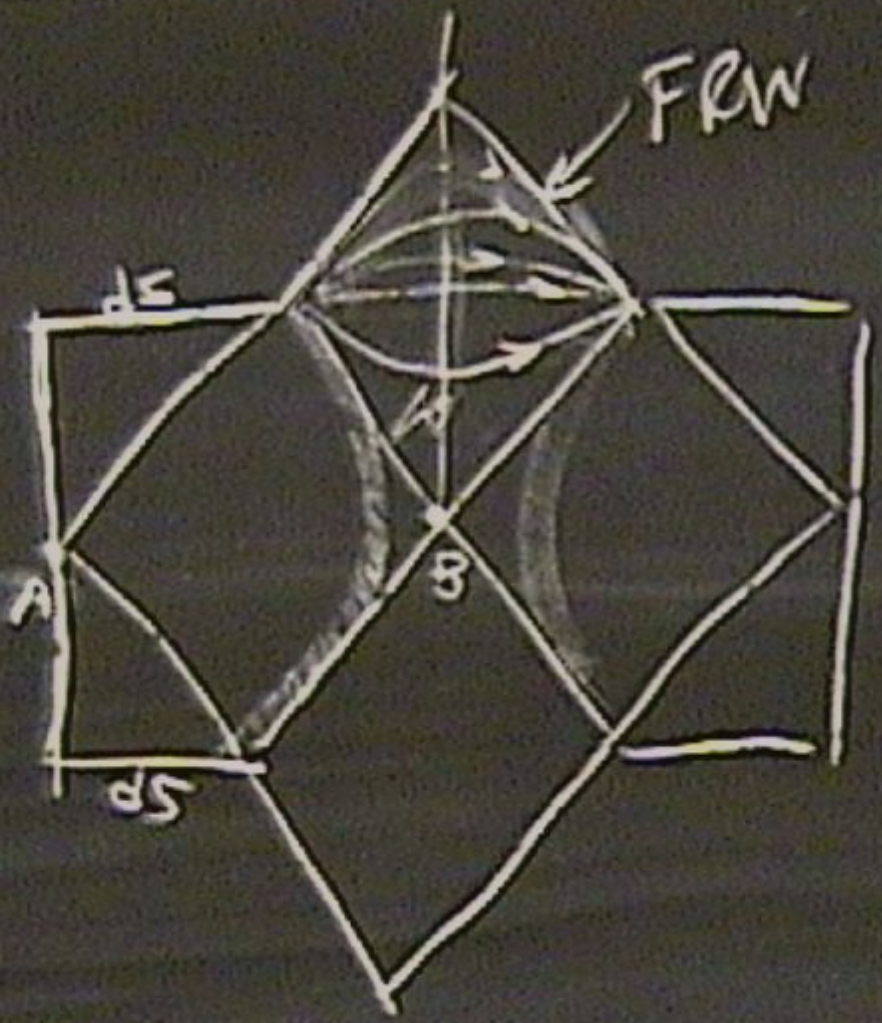
O(3,1)

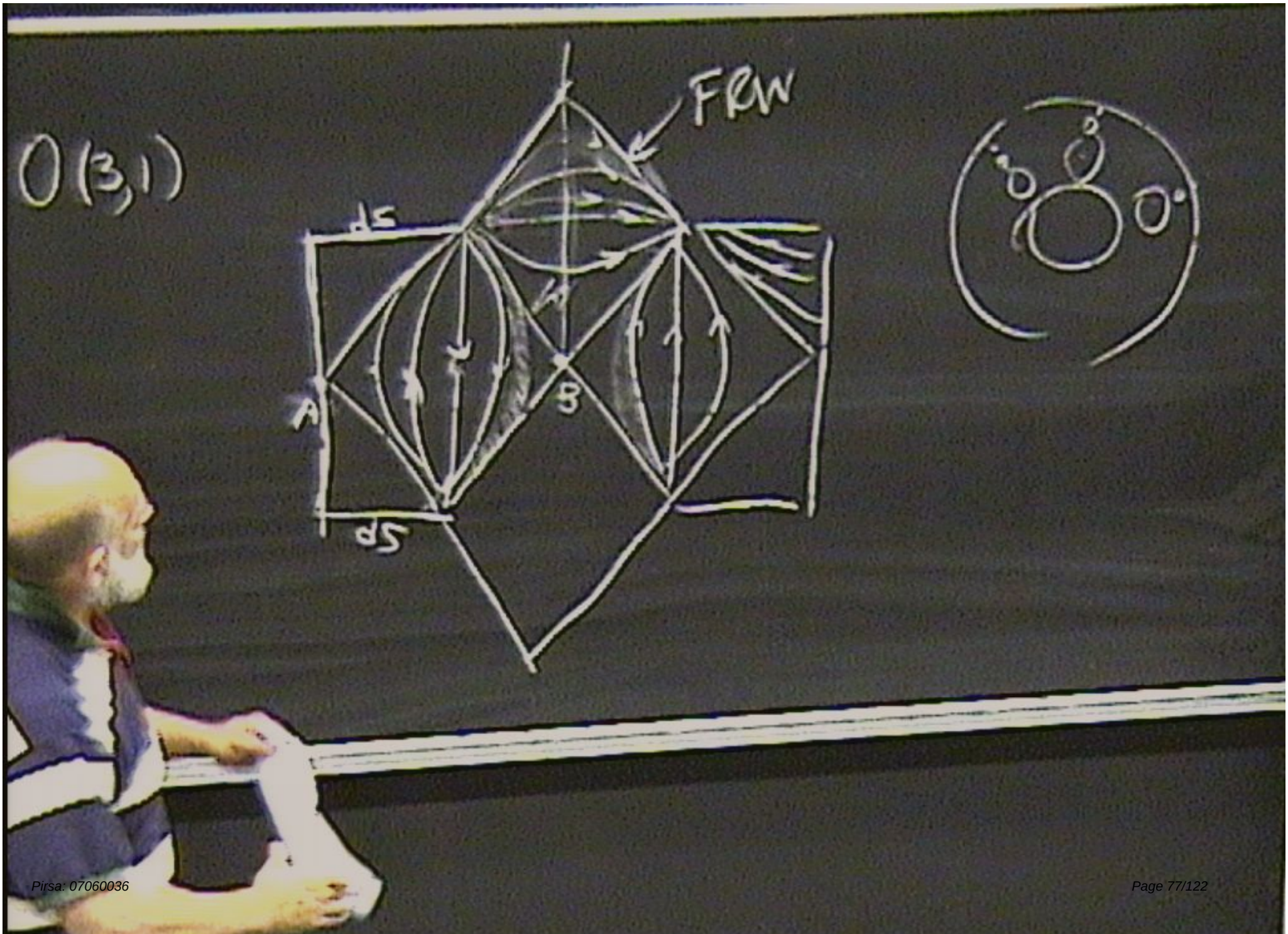


O(3,1)



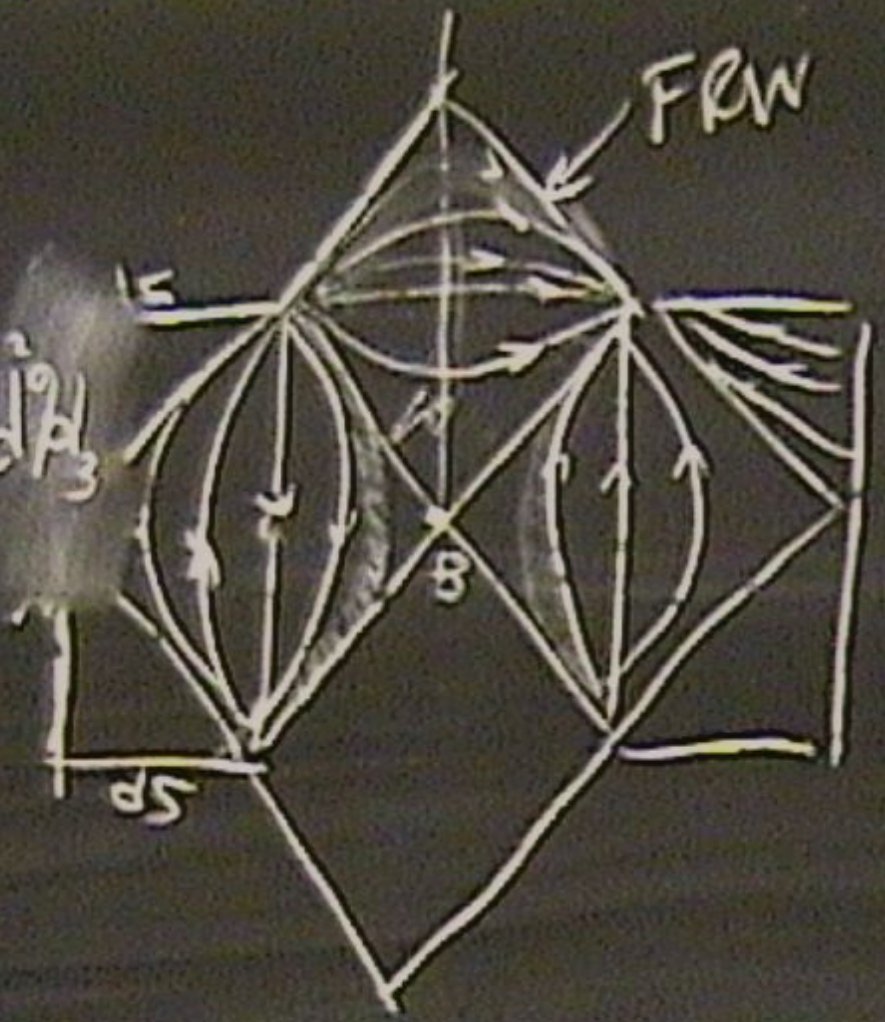
O(3,1)




O(3,1)
FRW
dS
dS

O(3,1)

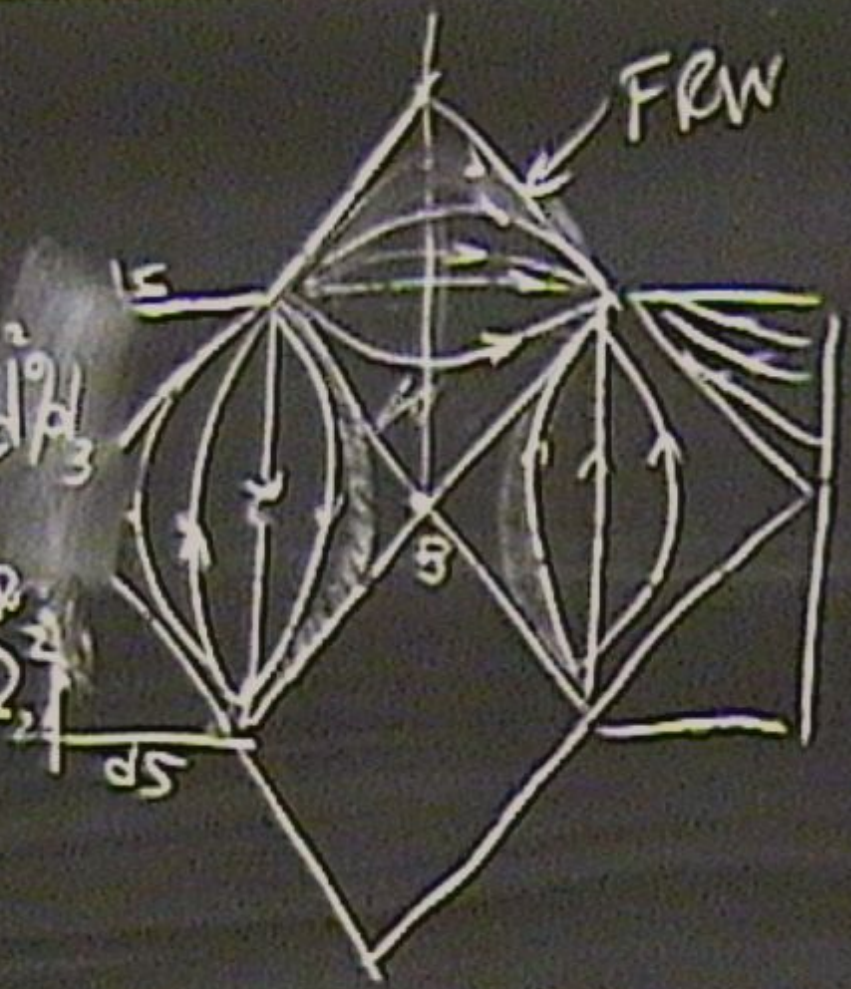
$ds^2 = -dt^2 + a(t^2) d^3p_3$



$O(3,1)$

$ds^2 = -dt^2 + a(t^2)\, d\mathcal{H}_3^2$

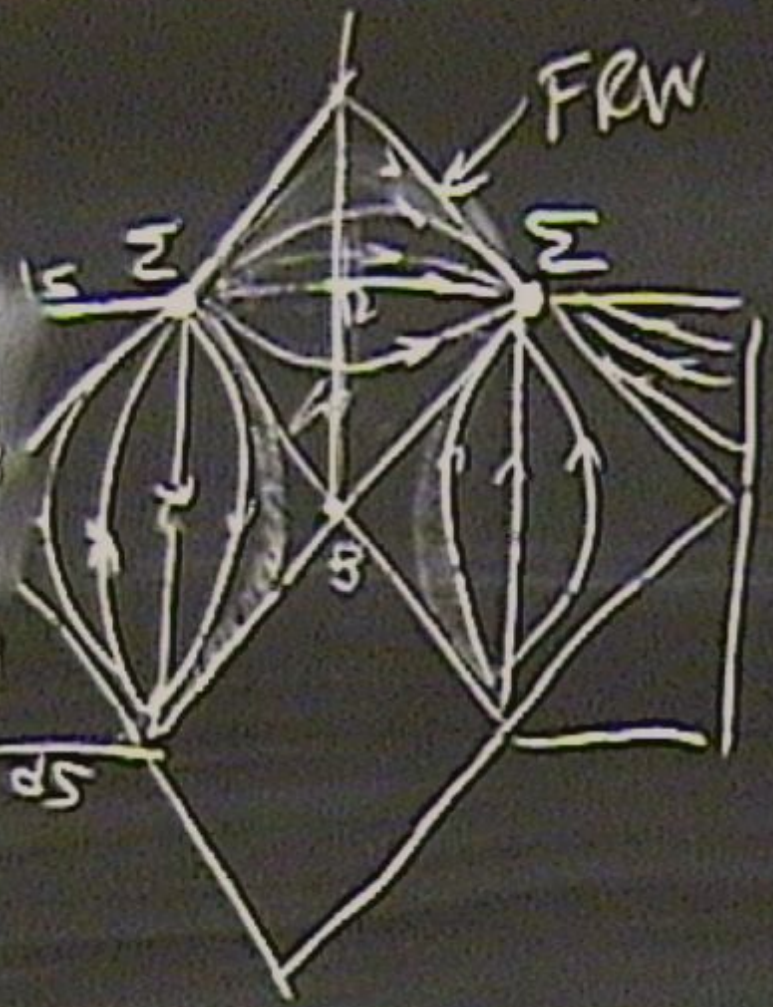
$d\mathcal{H}_3^2 = dR^2 + \sinh^2 R\, d\Omega_2^2$

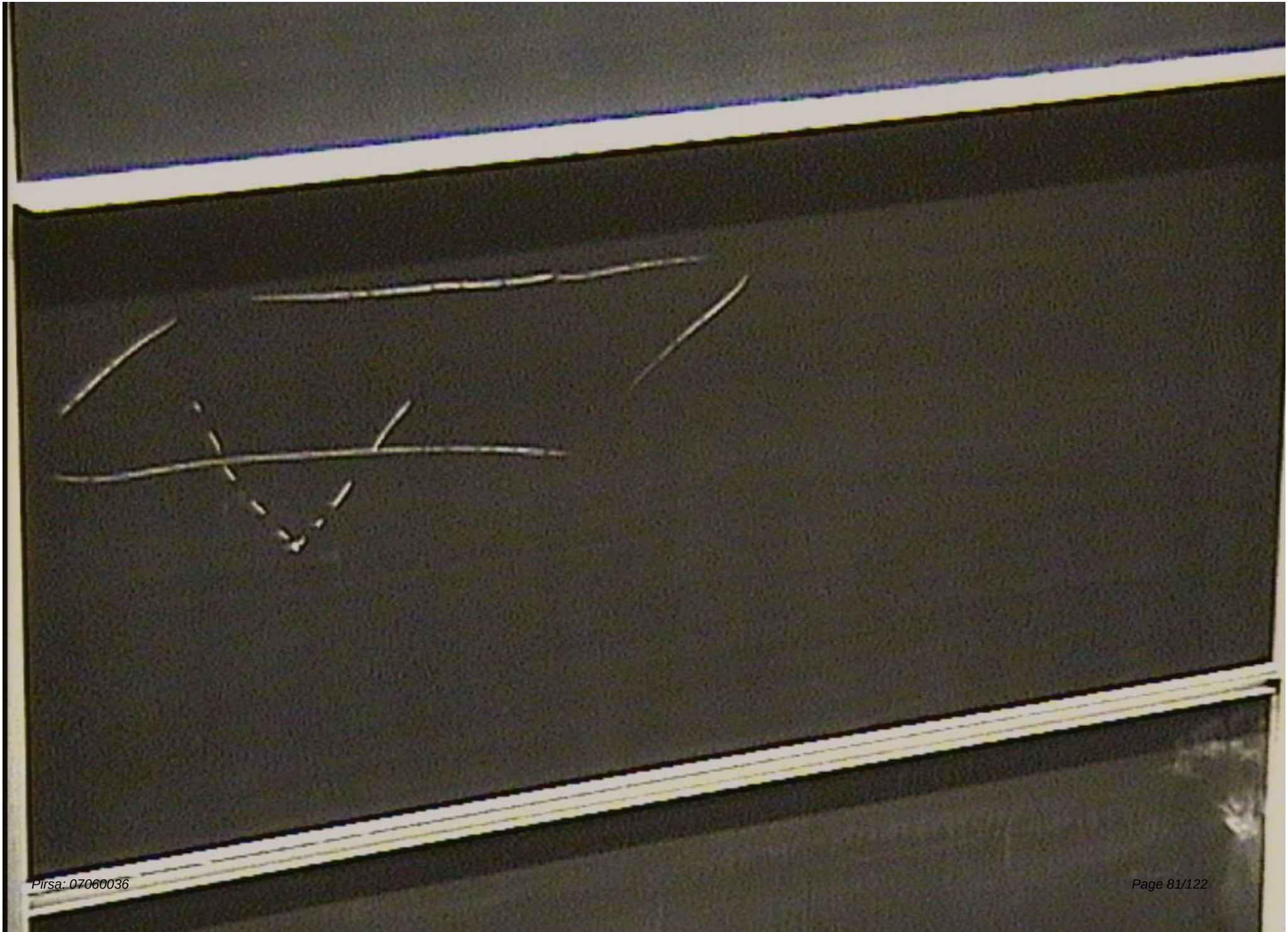


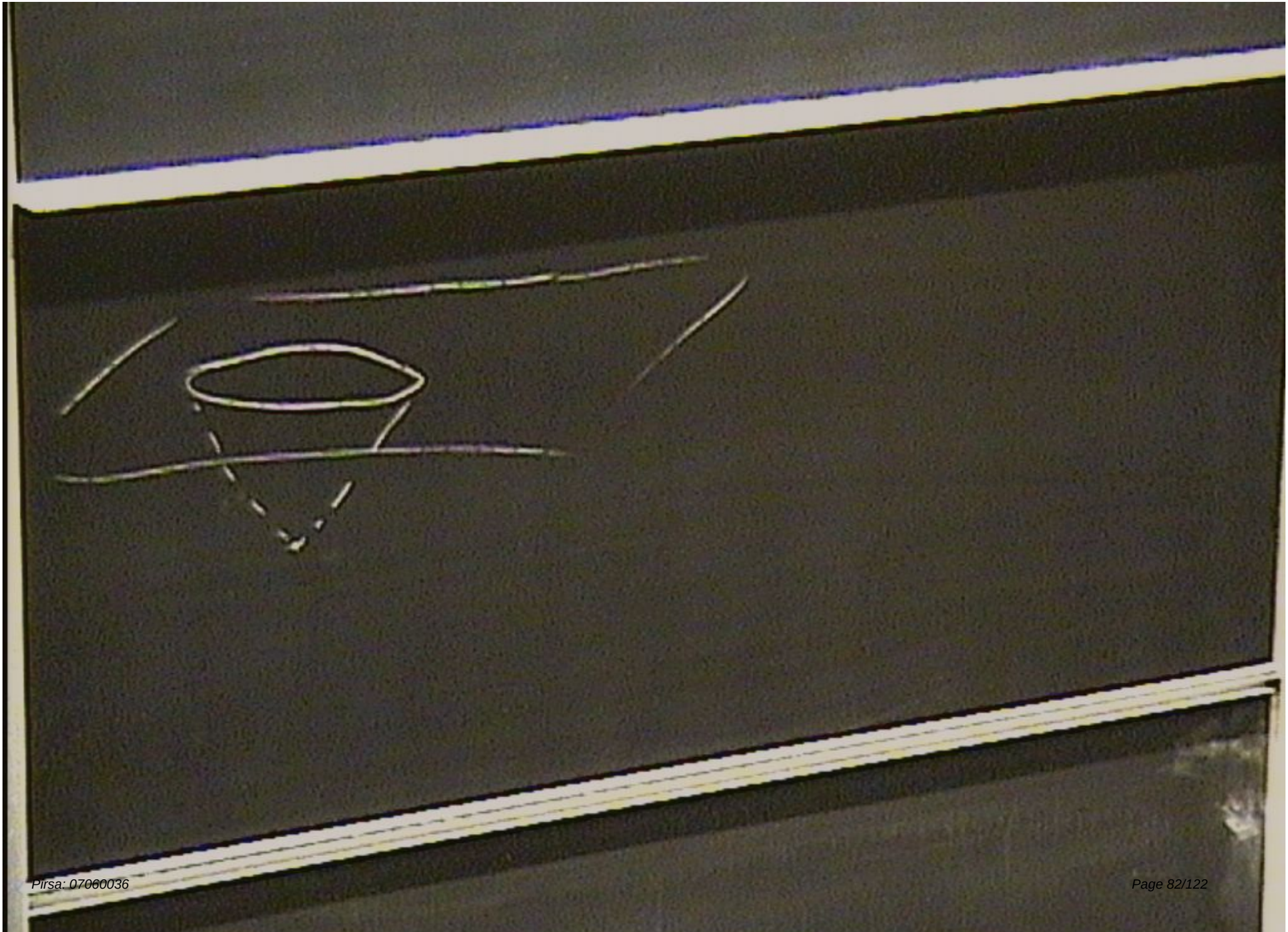
$O(3,1)$

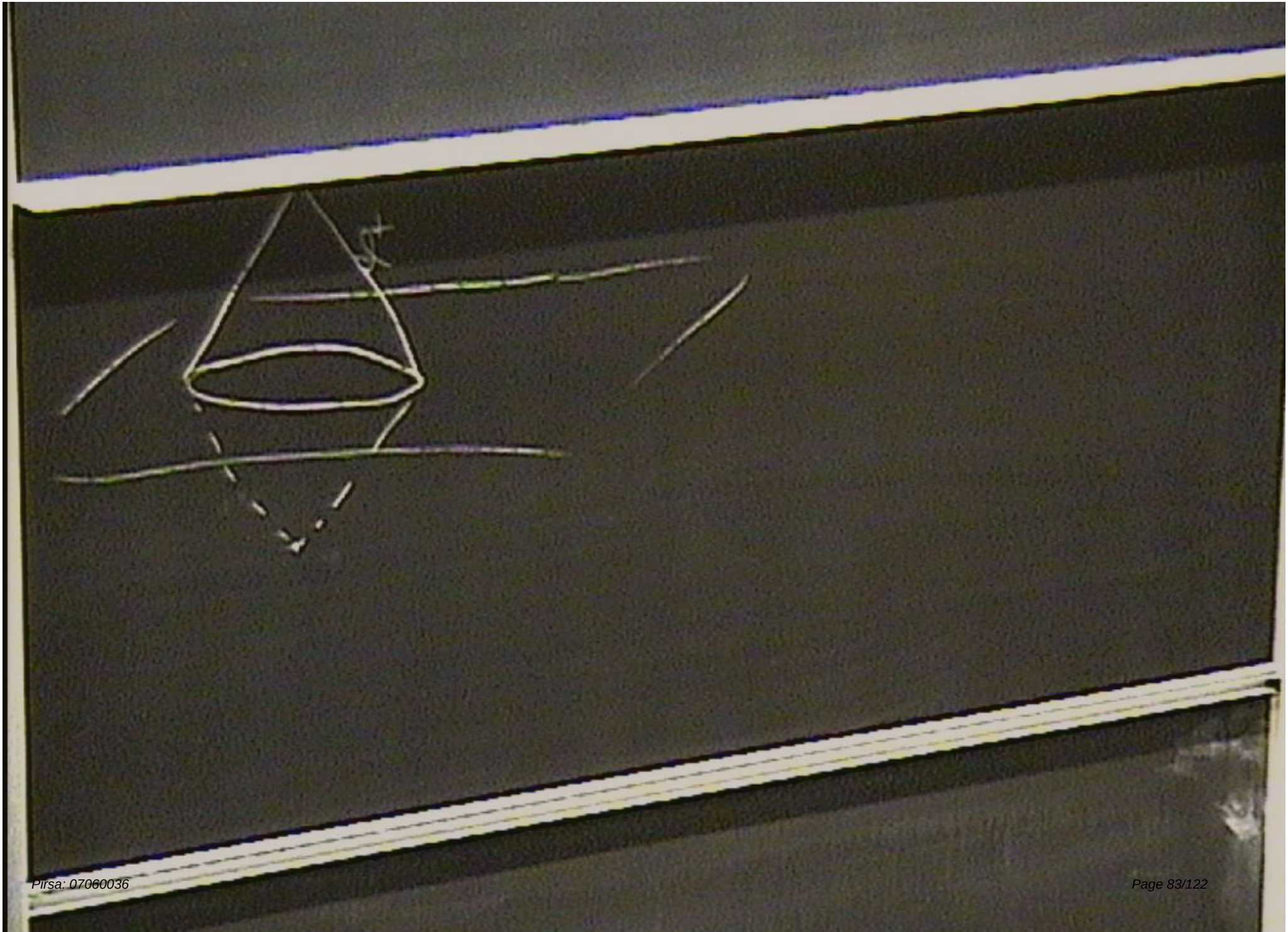
$ds^2 = -dt^2 + a(t^2)\, d\mathcal{H}_3^2$

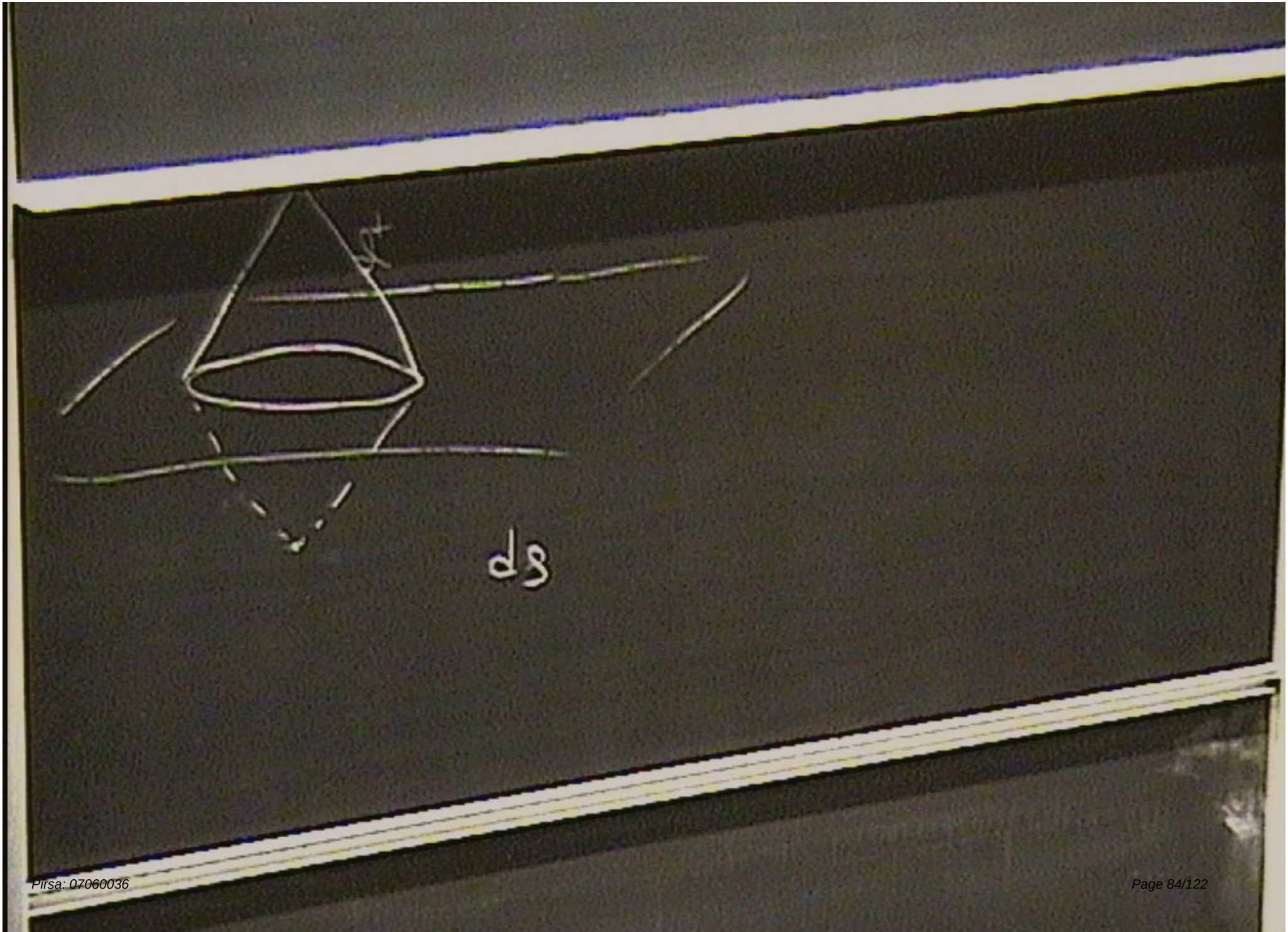
$d\mathcal{H}_3^2 = dR^2 + \sinh^2 R\, d\Omega_2^2$

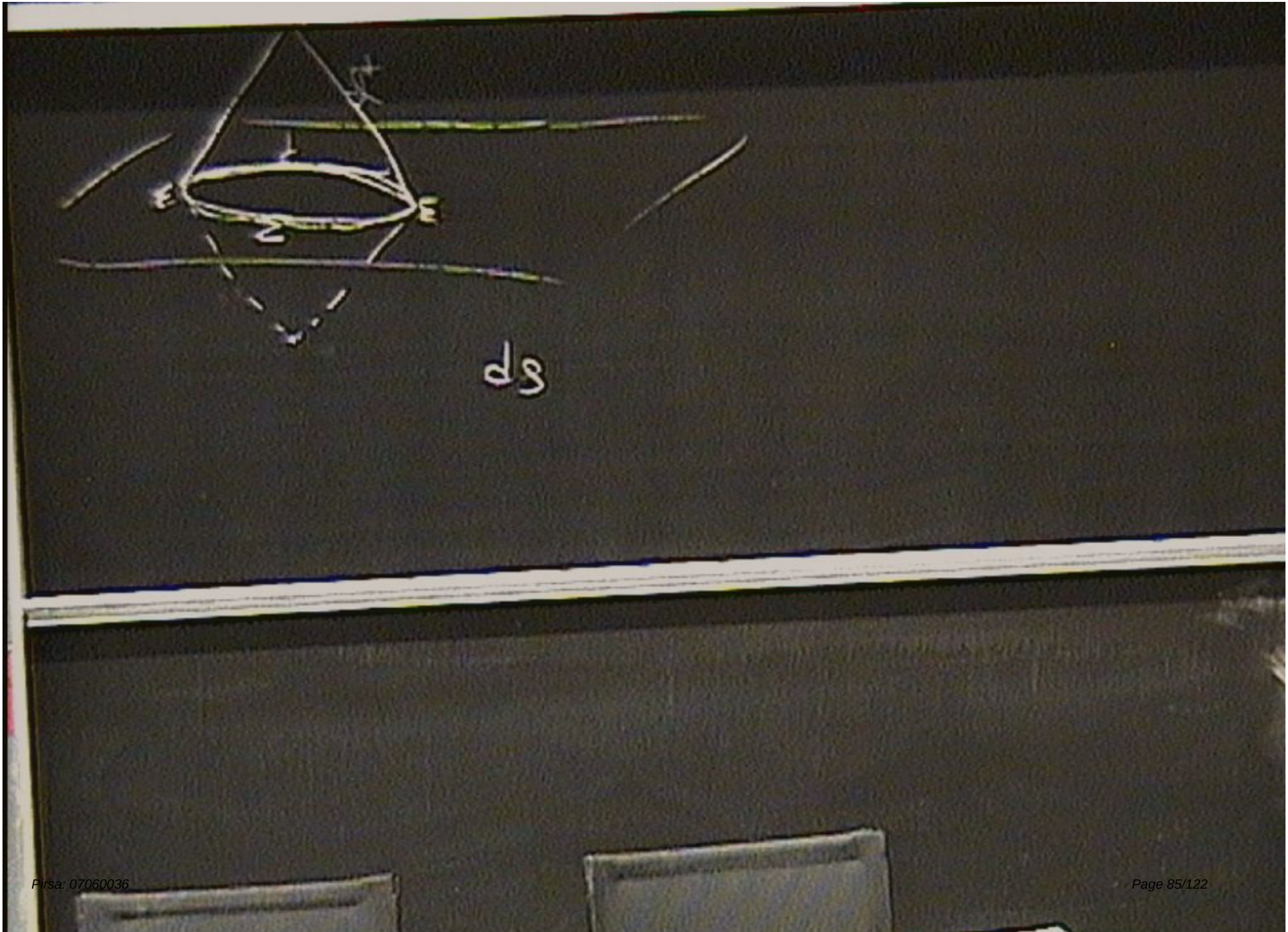


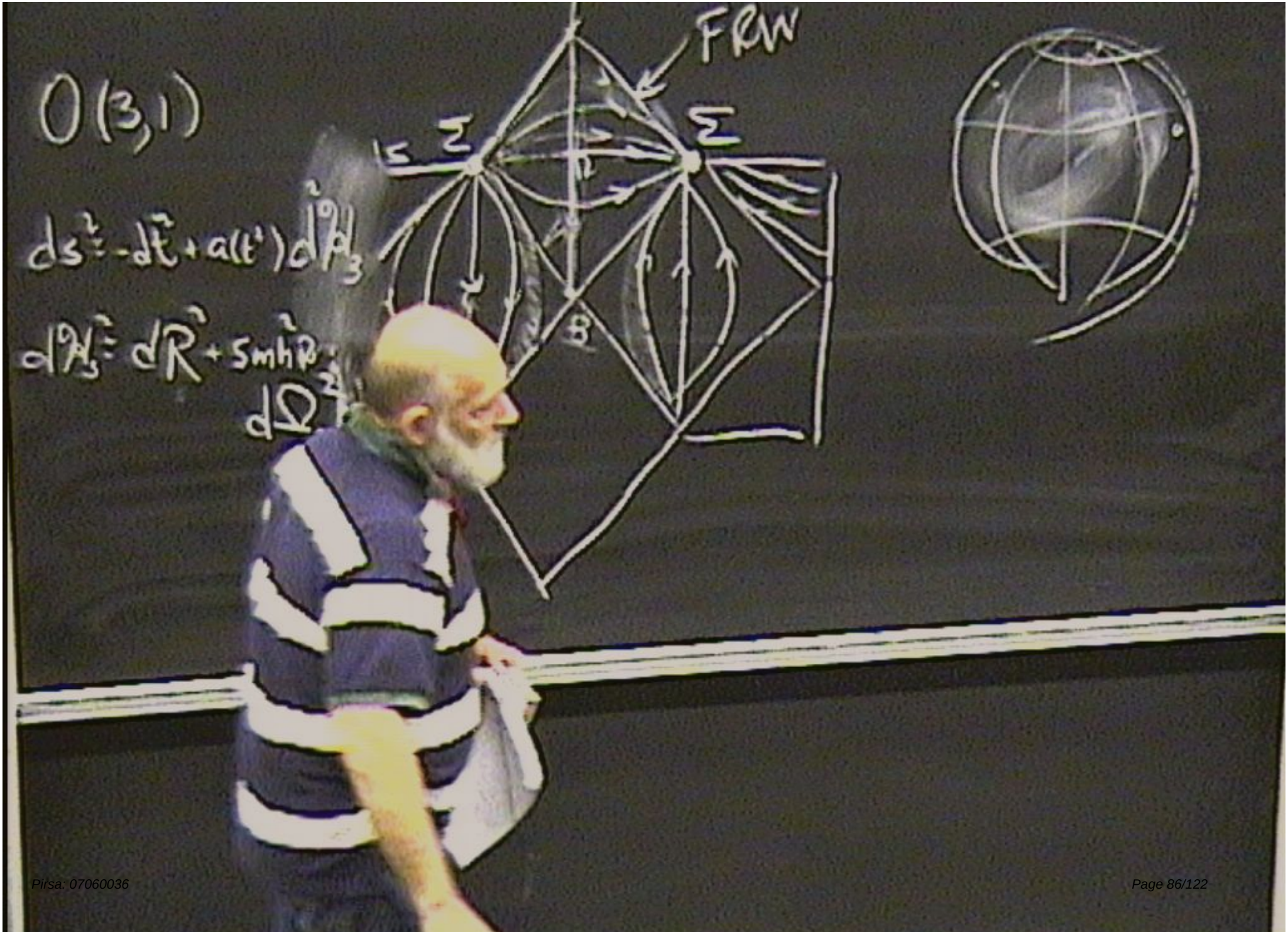


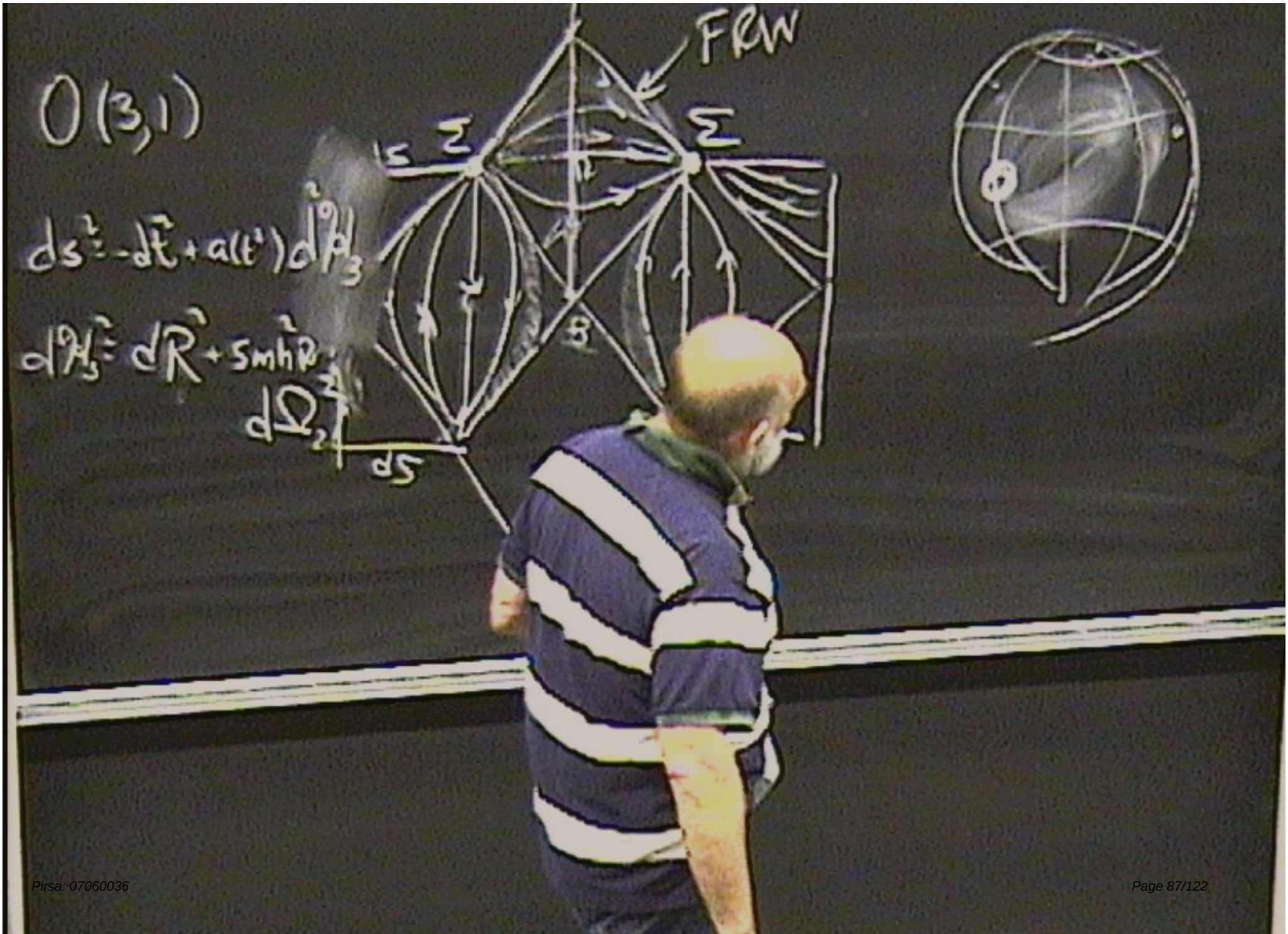


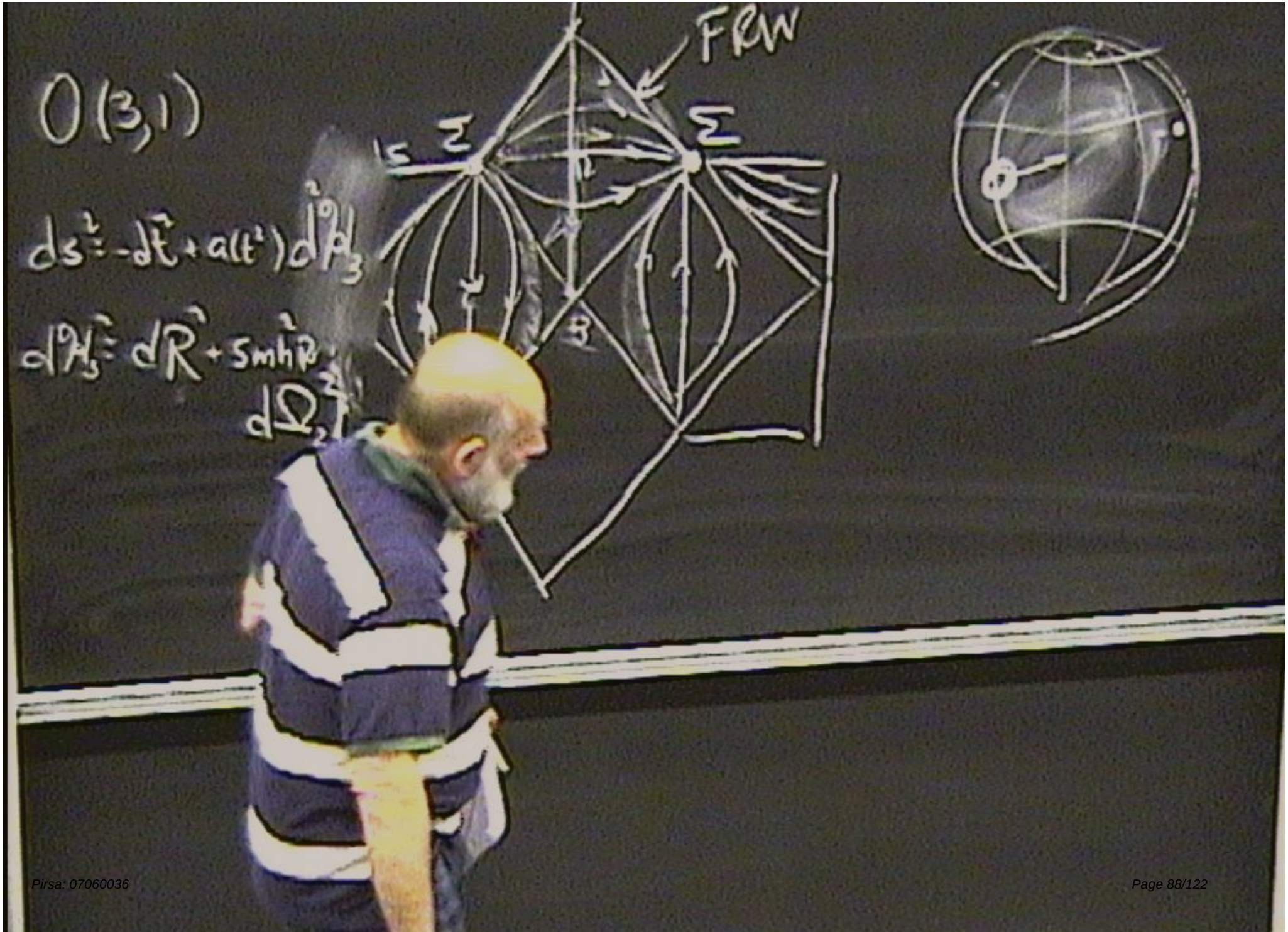


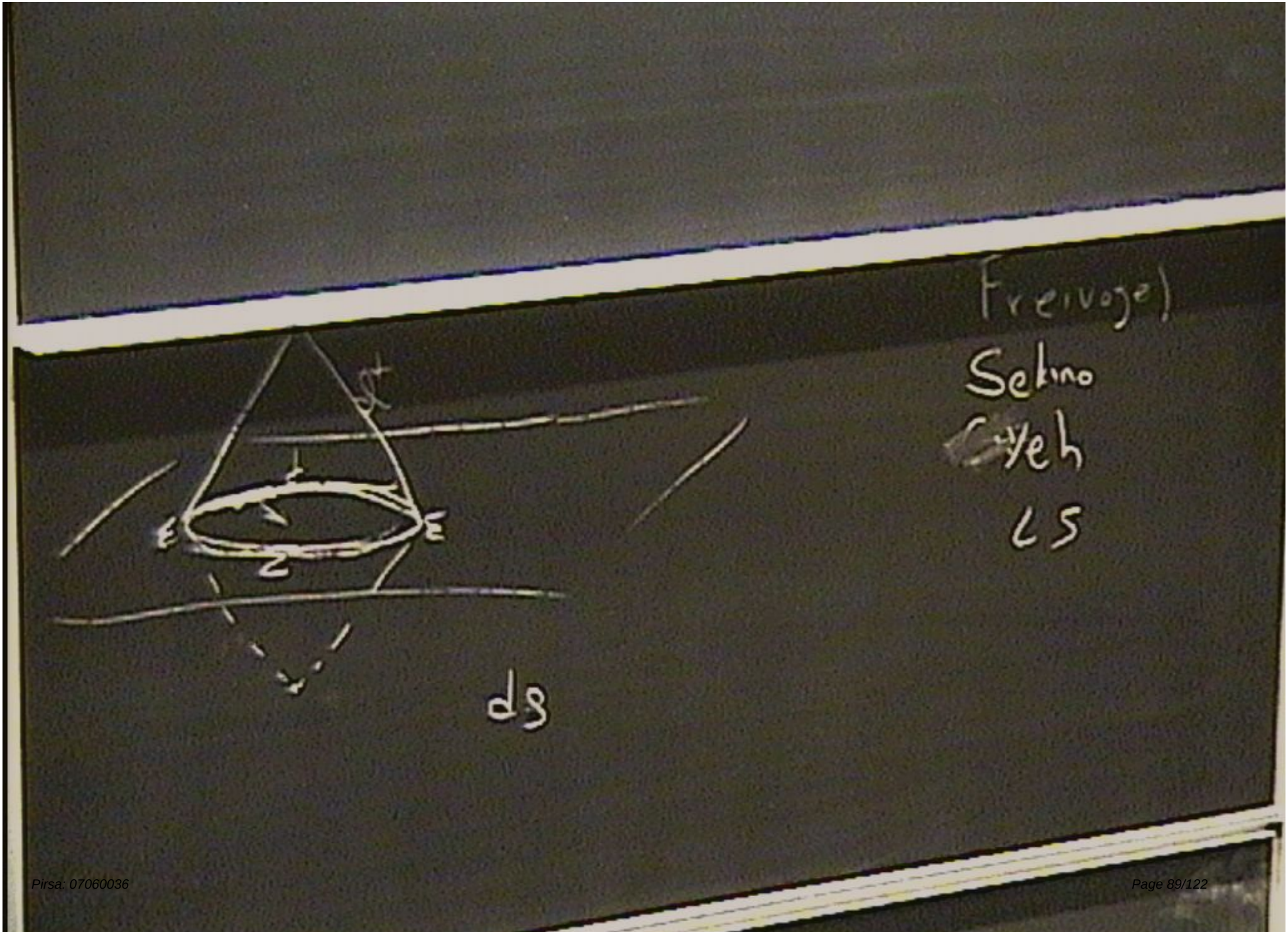

dS

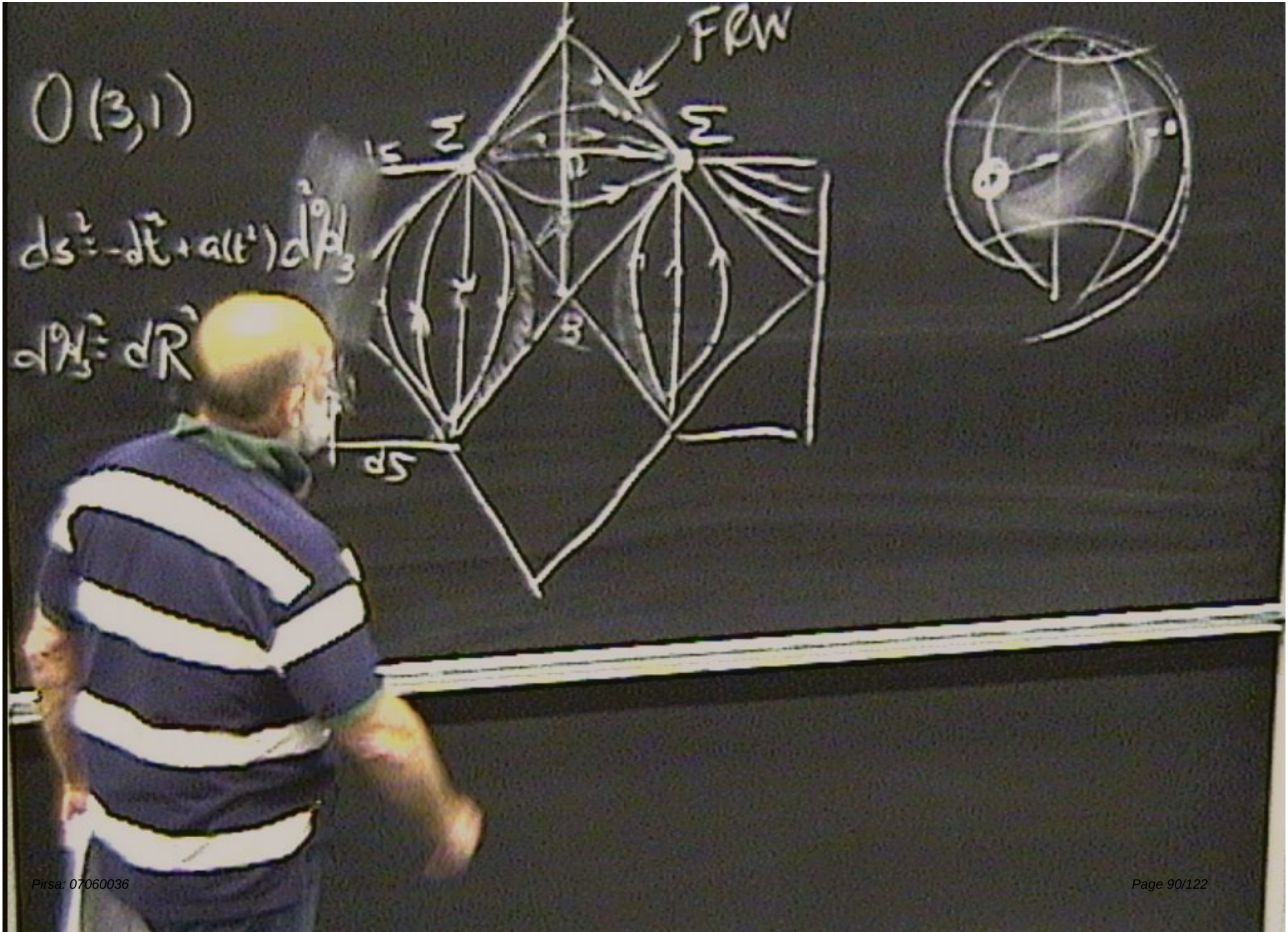

E
E
ds

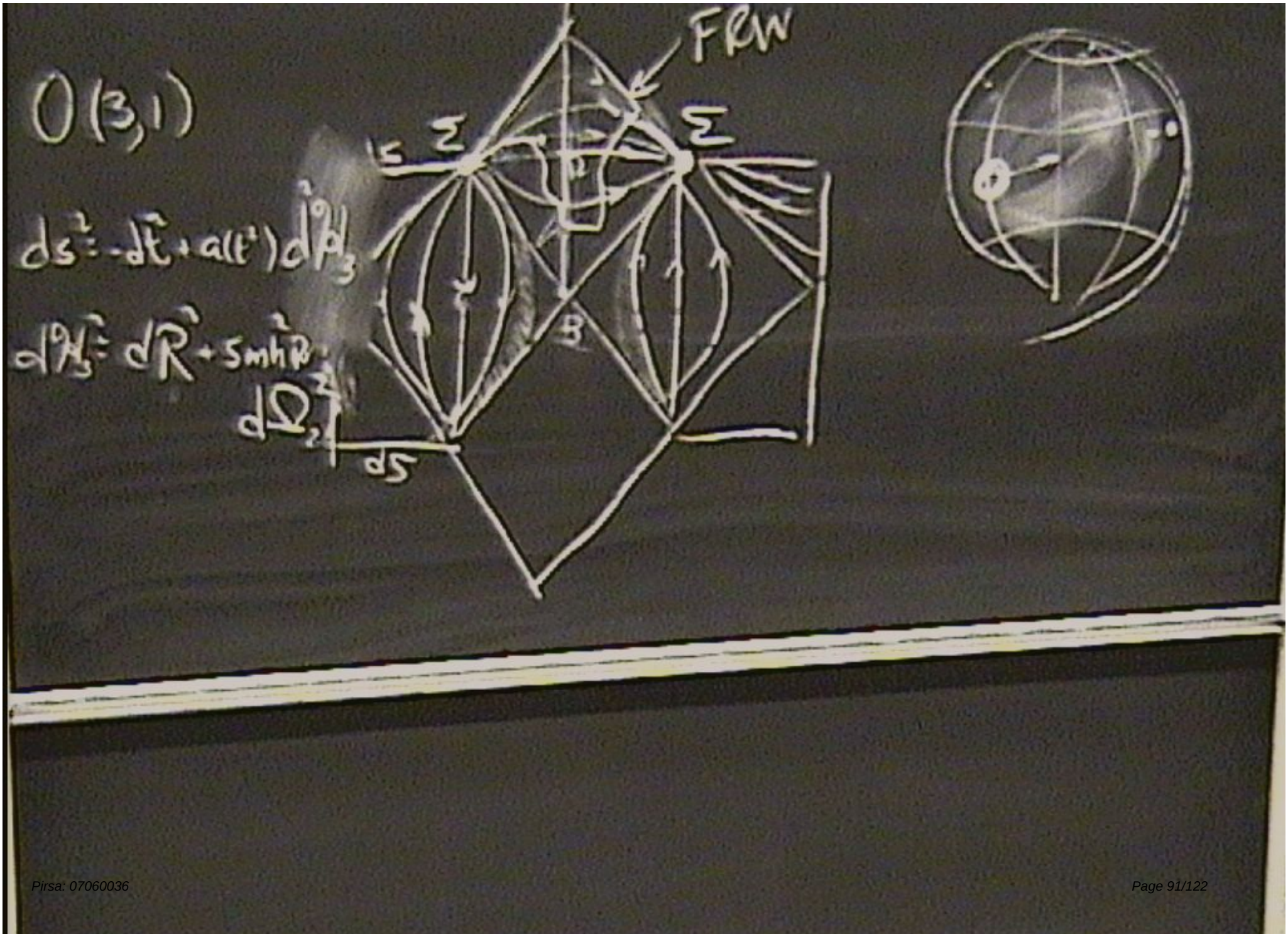

O(3,1)
FRW
Σ
Σ
B

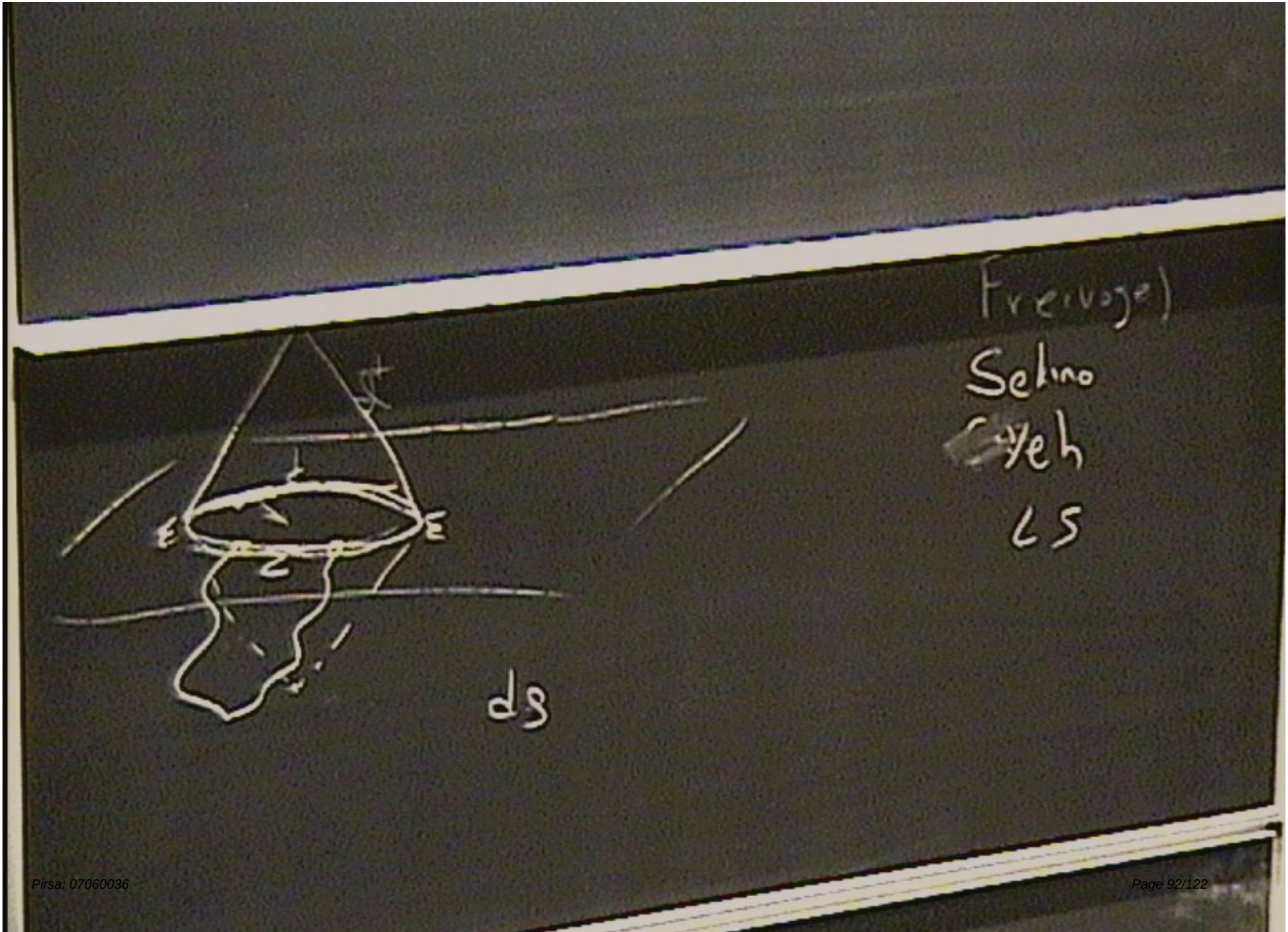

O(3,1)
FRW
Σ
Σ
B
dS

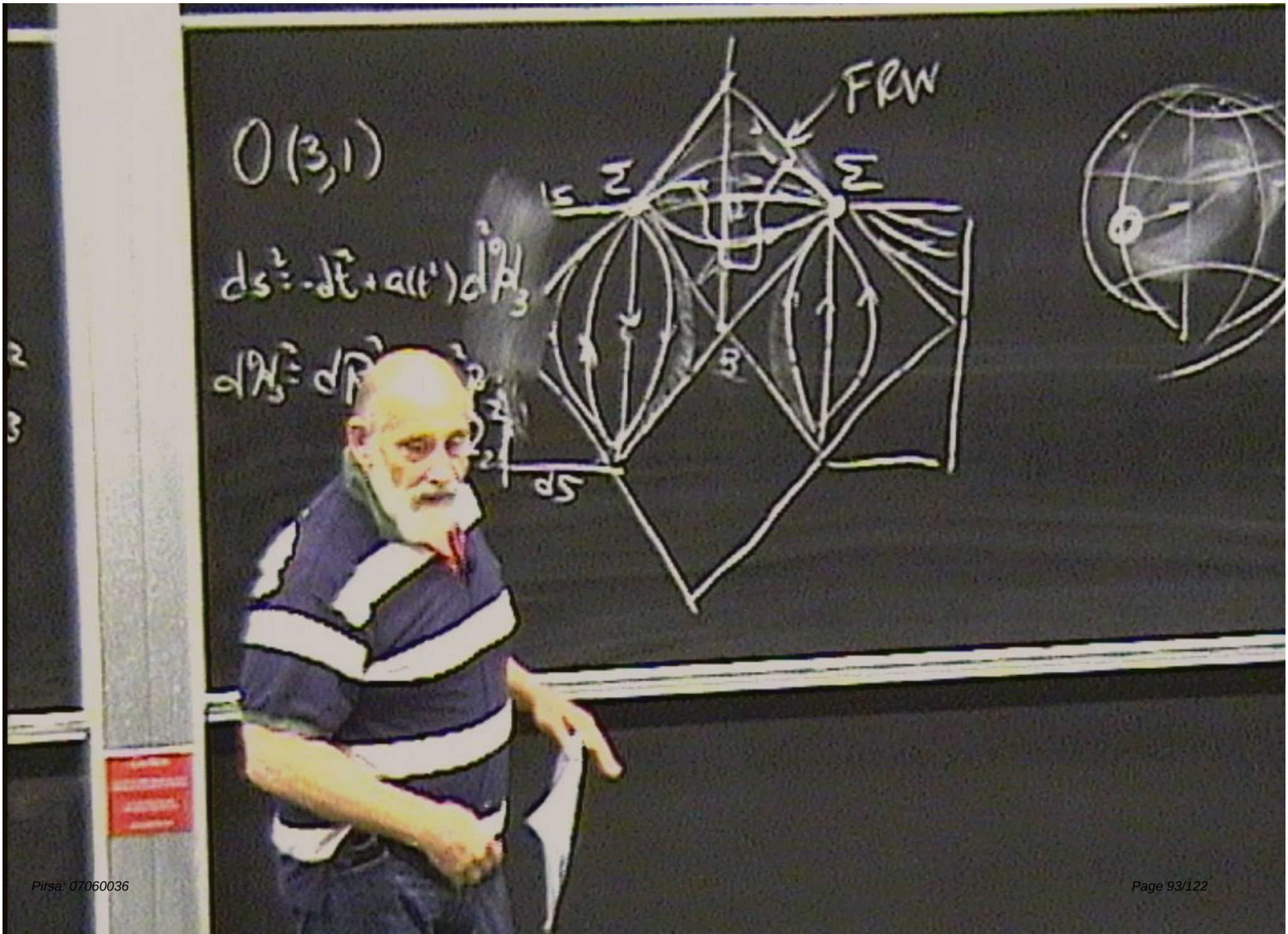

O(3,1)
FRW
Σ
Σ
ds² = -dt² + a(t²) dΩ₃²
dΩ₃² = dR² + sinh²R dΩ₂²

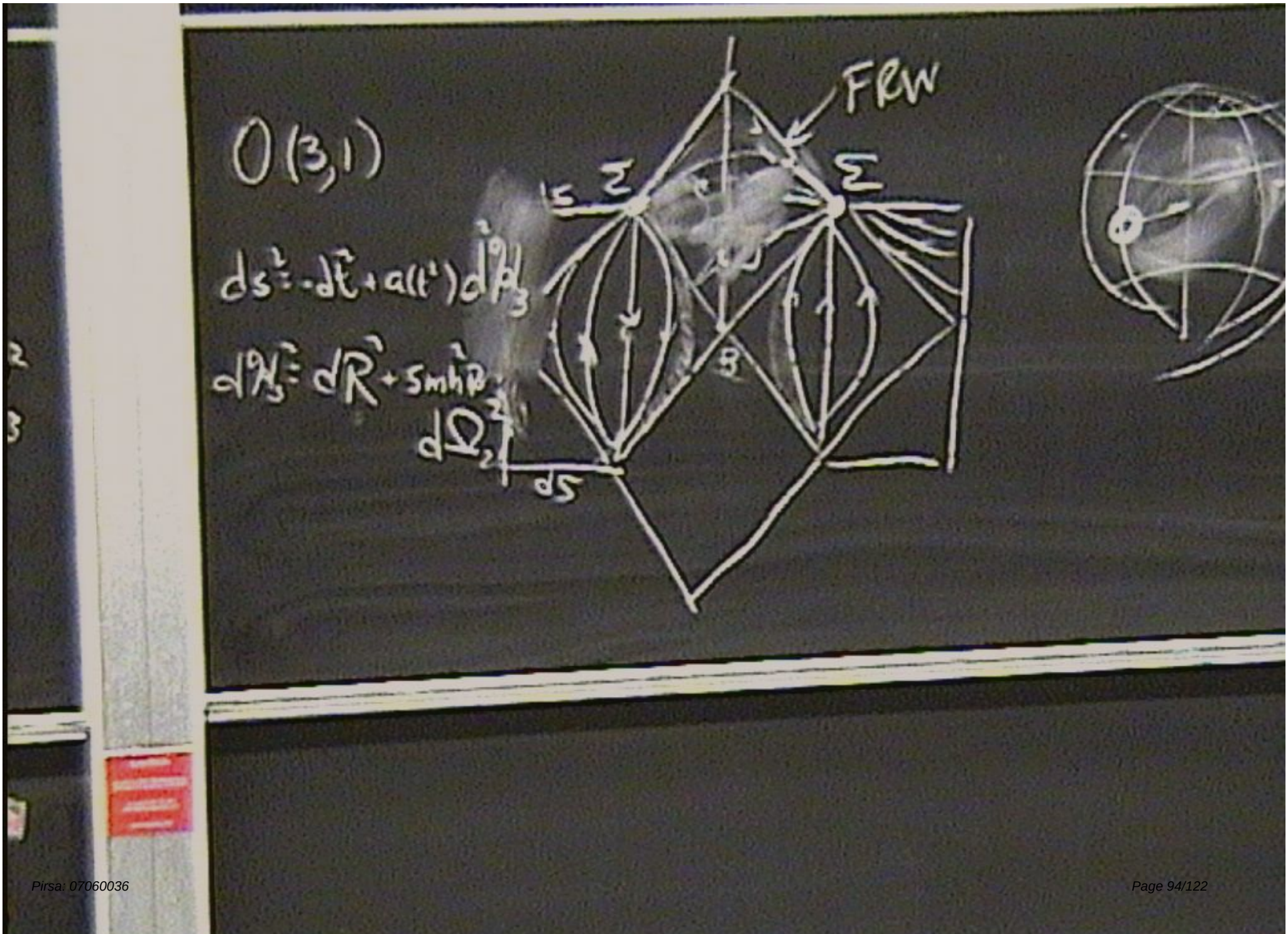

Freivogel
Sekino
Susy
LS
dS

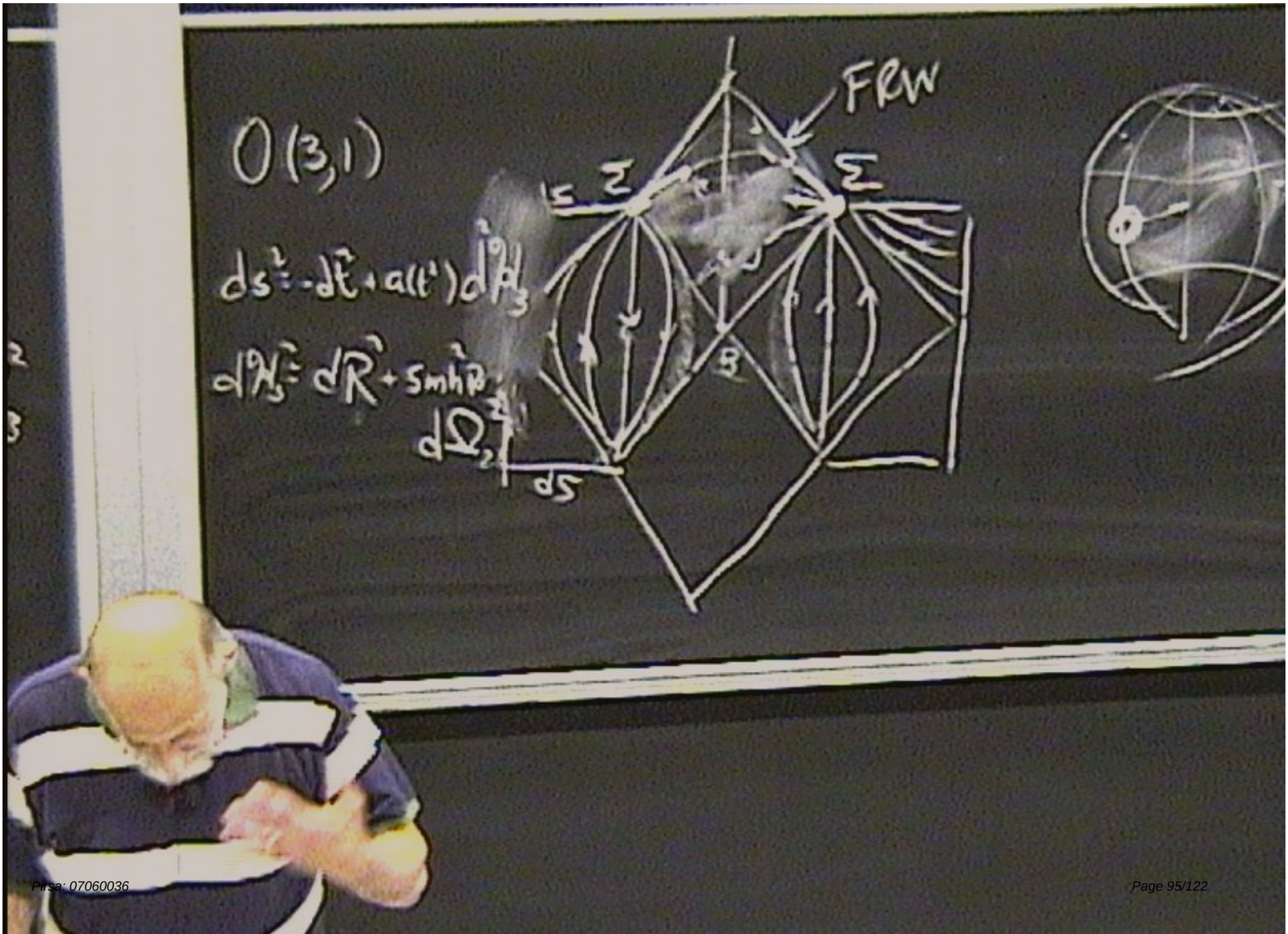

O(3,1)
FRW
Σ
Σ
B
dS

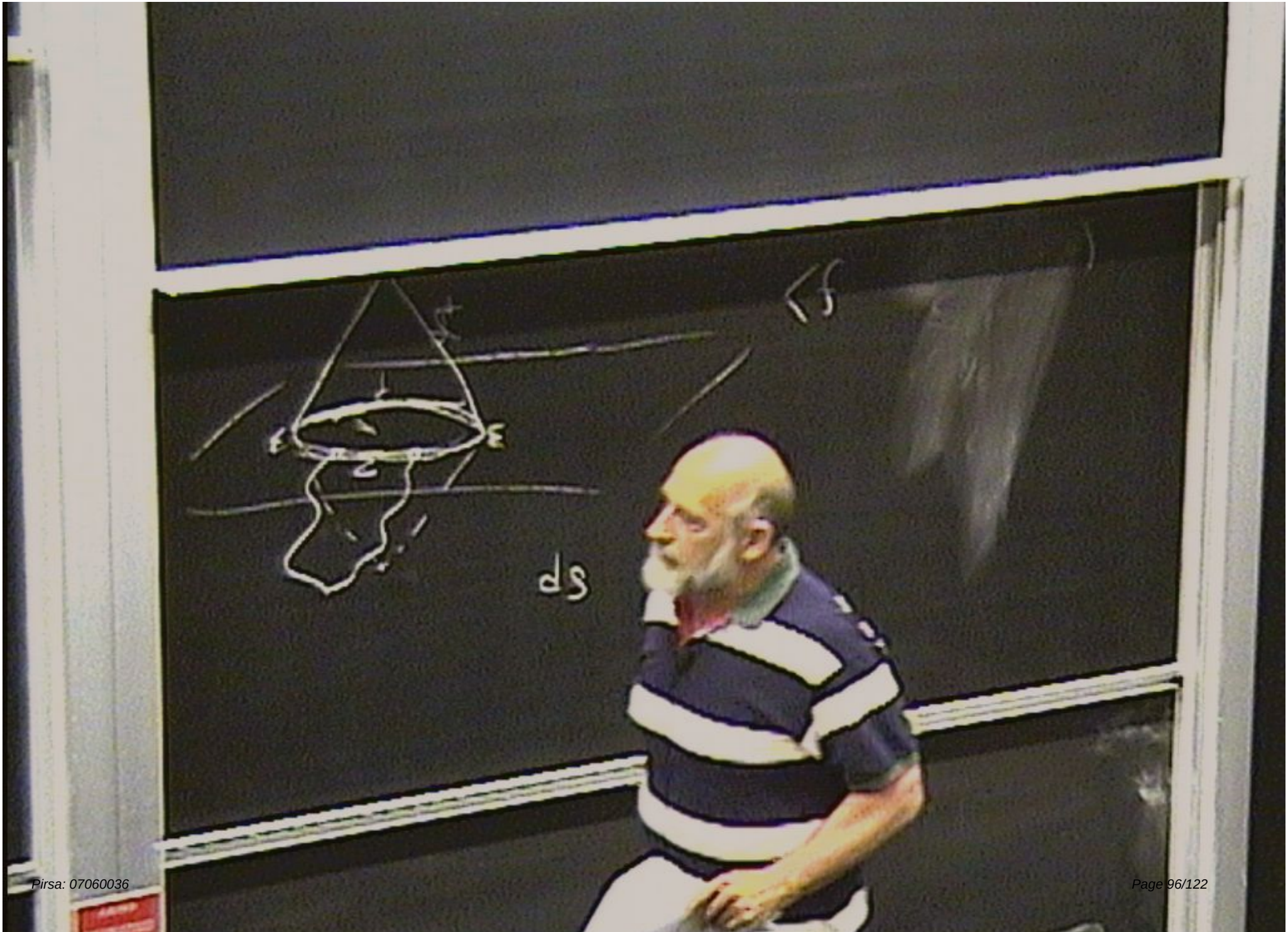

O(3,1)
$ds^2 = -dt^2 + a(t^2) d\mathcal{H}_3^2$
$d\mathcal{H}_3^2 = dR^2 + \sinh^2 R \, d\Omega_2^2$
FRW
Σ
Σ
B
dS

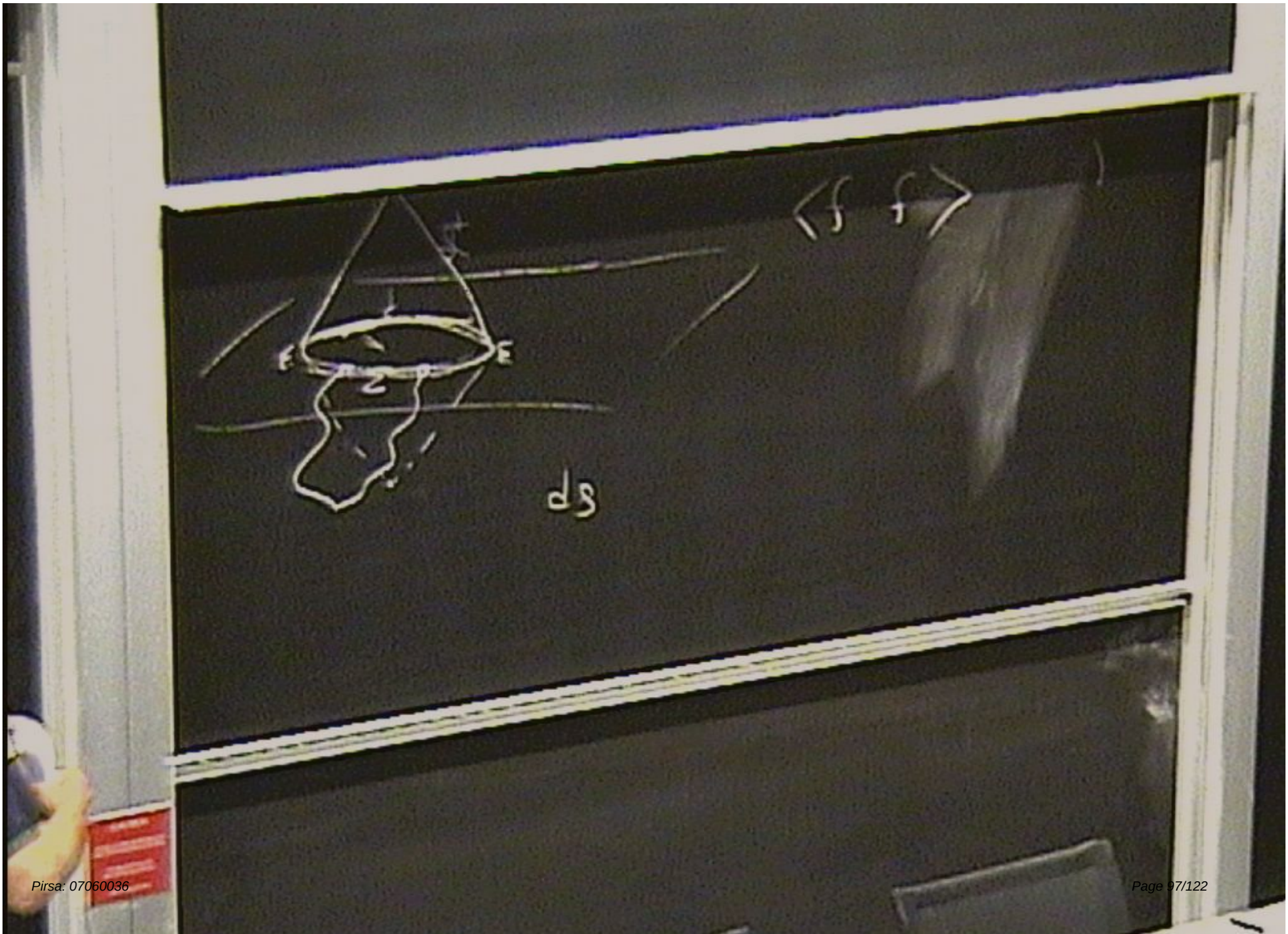

Freivogel
Selino
Yeh
LS
ds

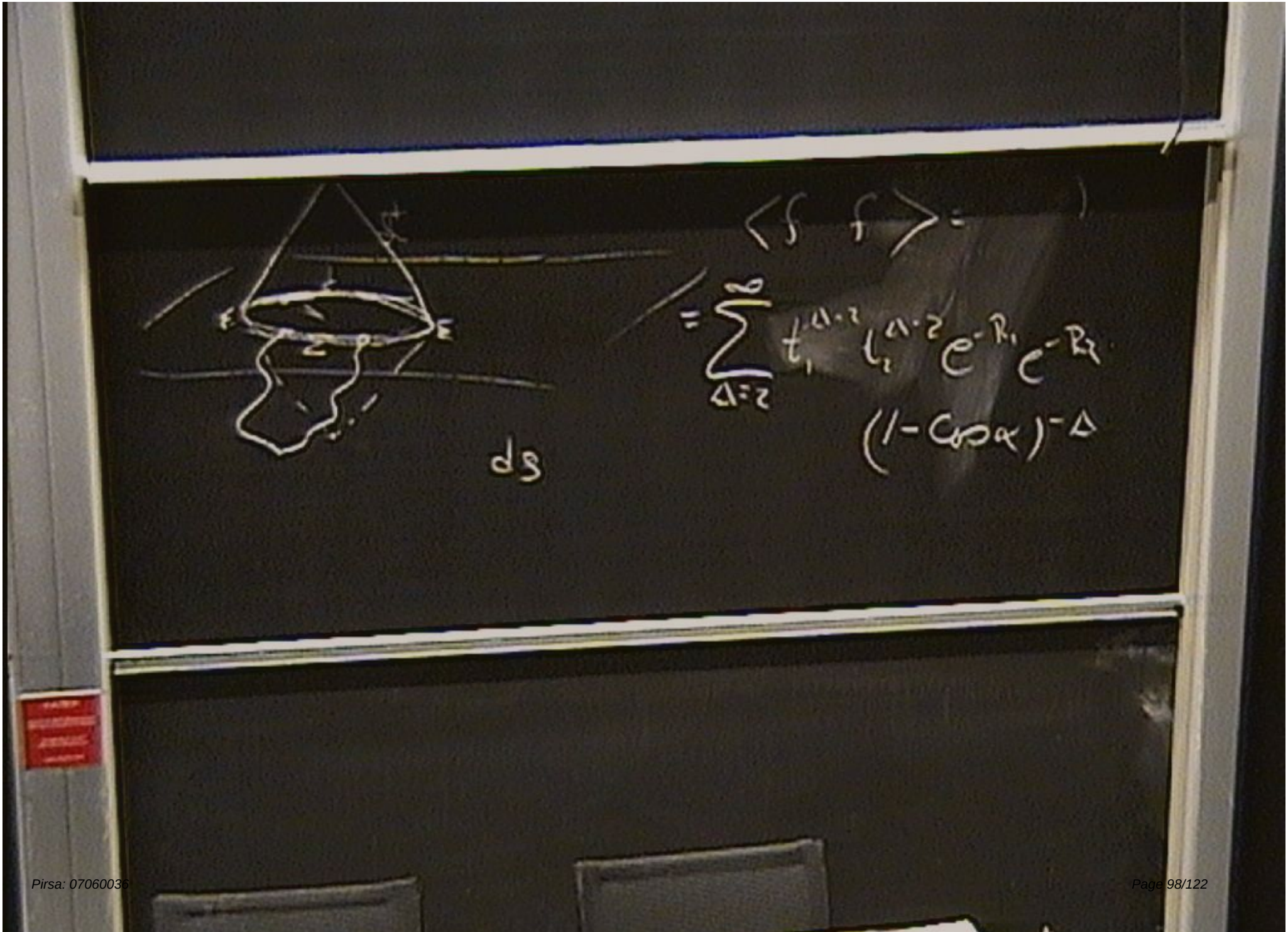

O(3,1)
FRW

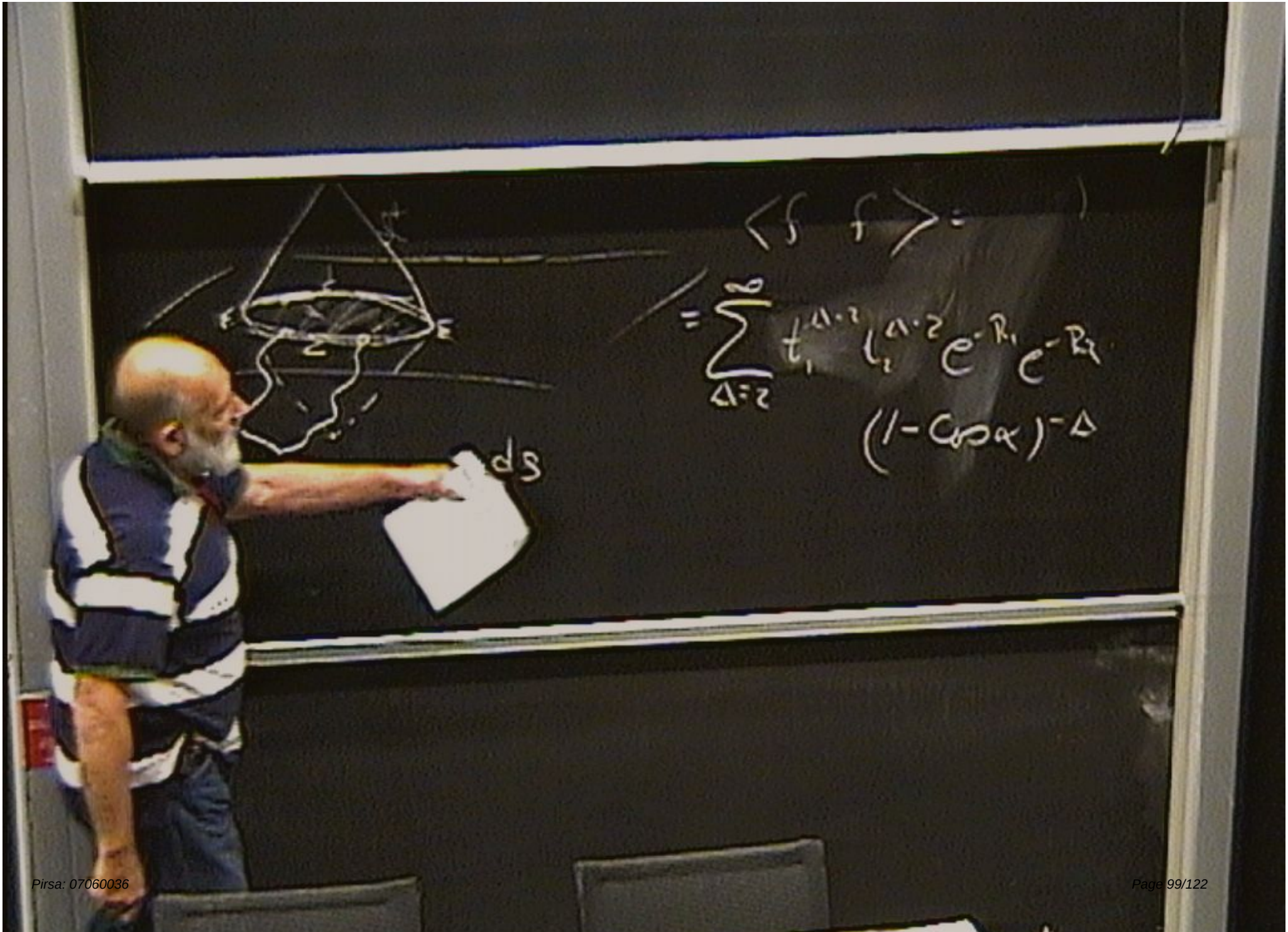

O(3,1)
$ds^2 = -dt^2 + a(t)^2 d\Sigma_3^2$
$d\Sigma_3^2 = dR^2 + \sinh^2 R\, d\Omega_2^2$
FRW
Σ
Σ
$\mathcal{B}$
dS

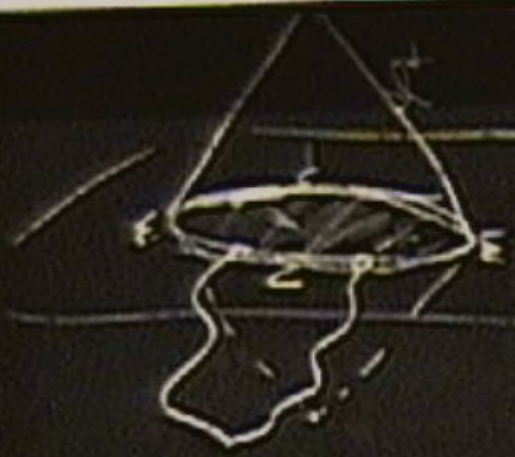

O(3,1)
FRW
$ds^2 = -dt^2 + a(t^2) d\mathcal{H}_3^2$
$d\mathcal{H}_3^2 = dR^2 + \sinh^2 R\, d\Omega_2^2$
ds


dS


dS


$\langle f \rangle =$
$= \sum_{\Delta=2}^{\infty} t_1^{\Delta-2} t_2^{\Delta-2} e^{-R_1} e^{-R_2} (1-\cos\alpha)^{-\Delta}$
$d\Omega$

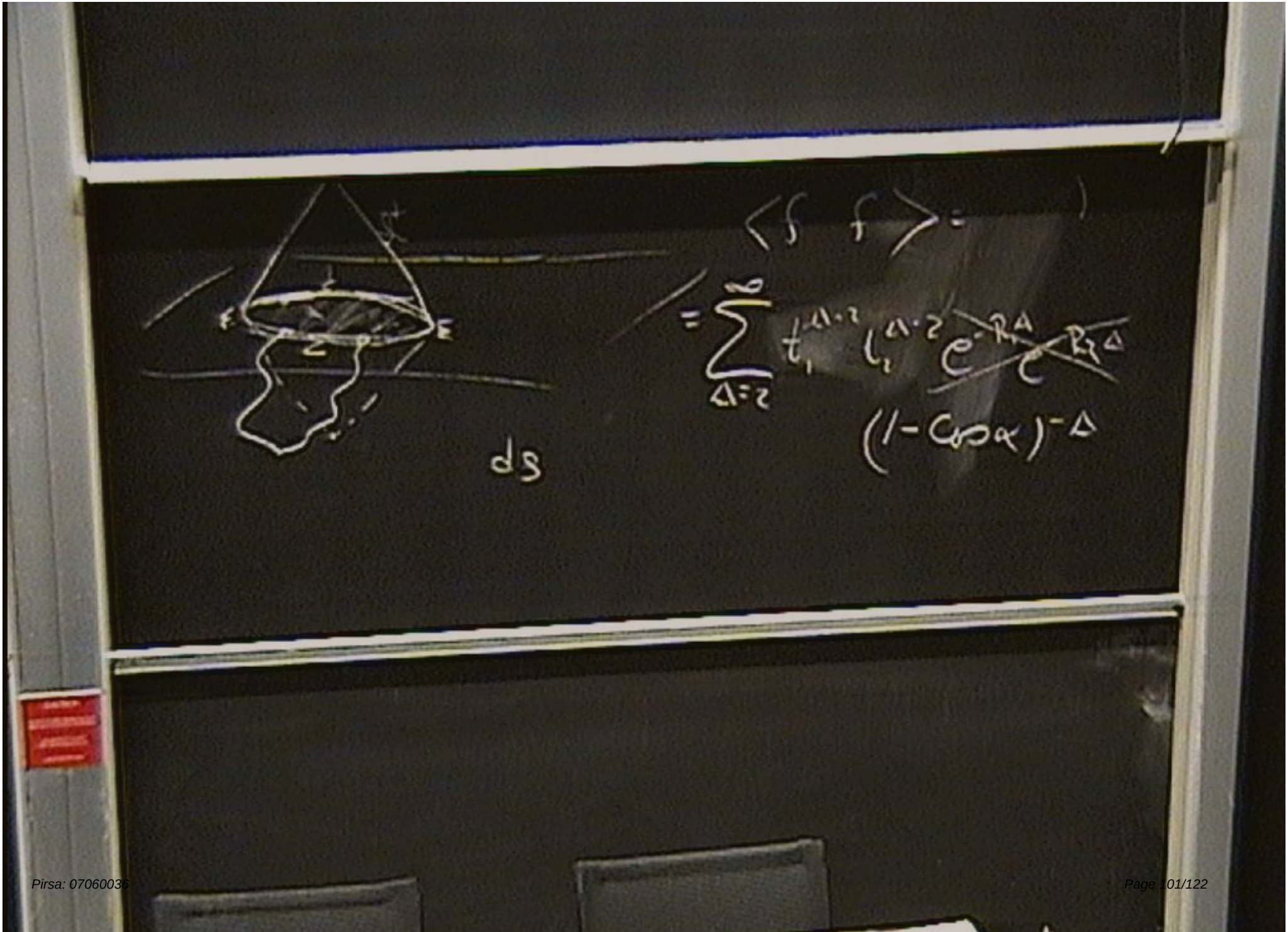

ds

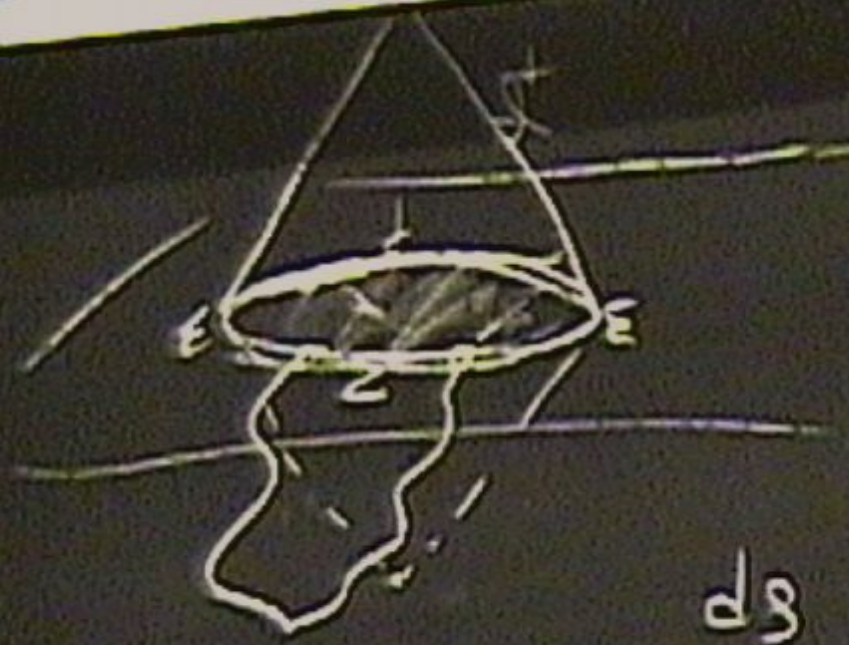


dS

$$\langle f \; f \rangle =$$

$$= \sum_{\Delta=2}^{\infty} t_1^{\Delta-2} t_2^{\Delta-2} e^{-R_1 \Delta} e^{-R_2 \Delta} \left(1-\cos\alpha\right)^{-\Delta}$$


$\langle f \; f \rangle =$
$= \sum_{\Delta=2}^{\infty} t_1^{\Delta-2} t_2^{\Delta-2} e^{-R_1 \Delta} e^{-R_2 \Delta} (1-\cos\alpha)^{-\Delta}$
dS



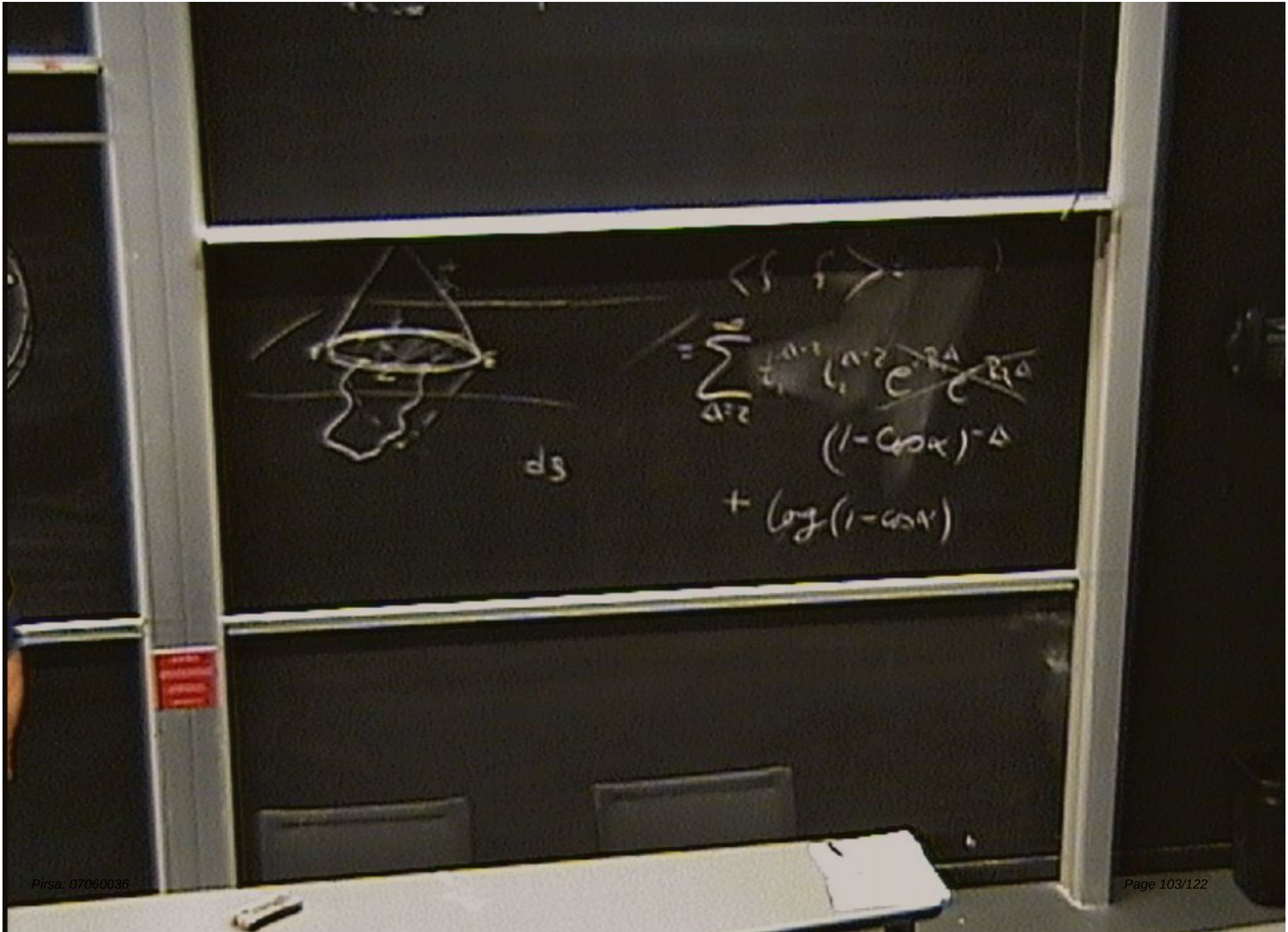
$$\langle f\ f \rangle = 1$$

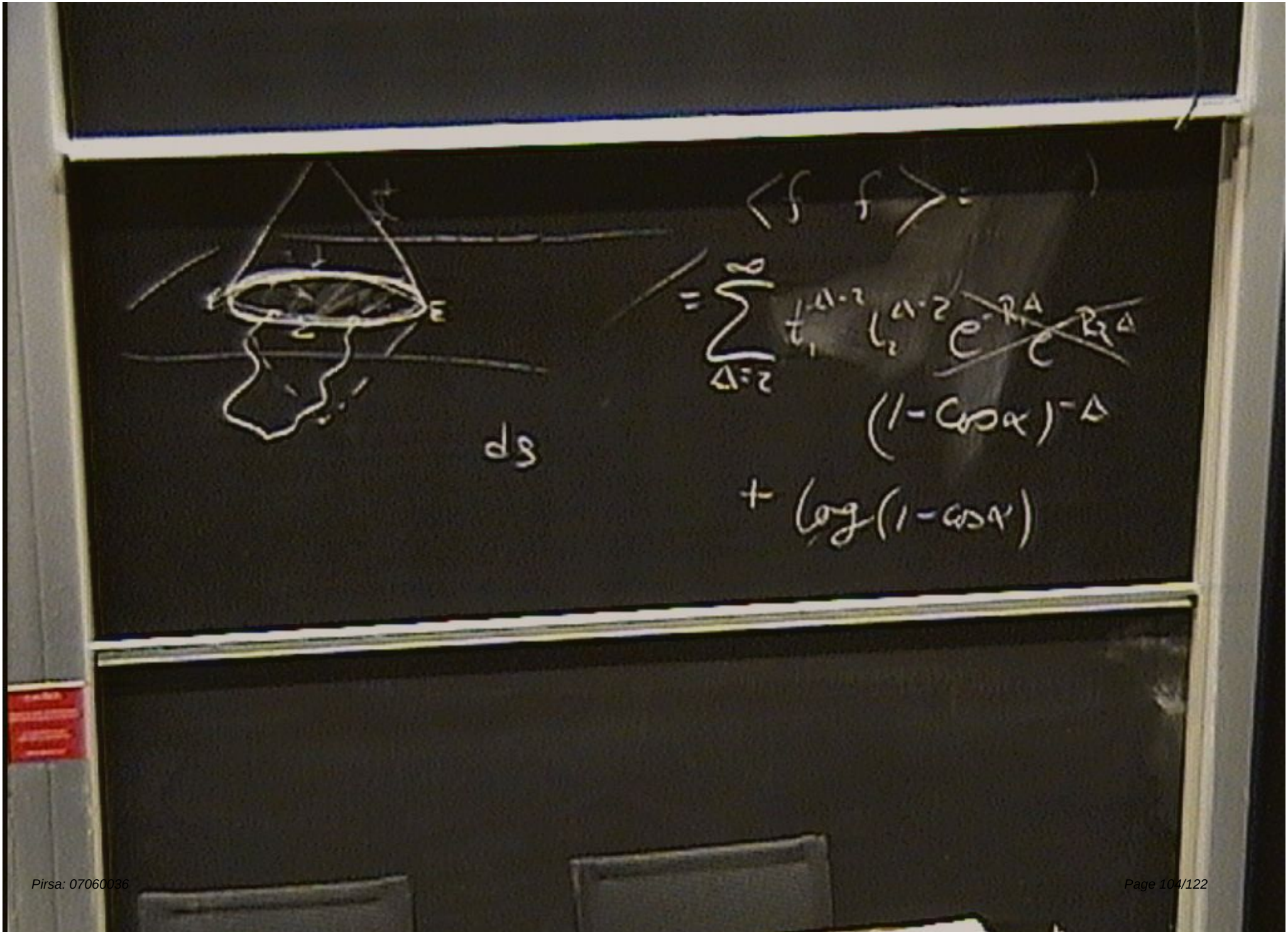
$$= \sum_{\Delta=2}^{\infty} t_1^{\Delta-3}\, t_2^{\Delta-2}\, e^{-\beta\Delta}$$

$$(1-\cos\alpha)^{-\Delta}$$

$$+ \log(1-\cos\alpha)$$

$$d\beta$$


dg
+ log(1-cosα)


$\langle f \; f \rangle =$
$= \sum_{\Delta=2}^{\infty} t_1^{\Delta-2} t_2^{\Delta-2} e^{-R_1 \Delta} e^{-R_2 \Delta}$
$(1-\cos\alpha)^{-\Delta}$
$+ \log(1-\cos\alpha)$
dS

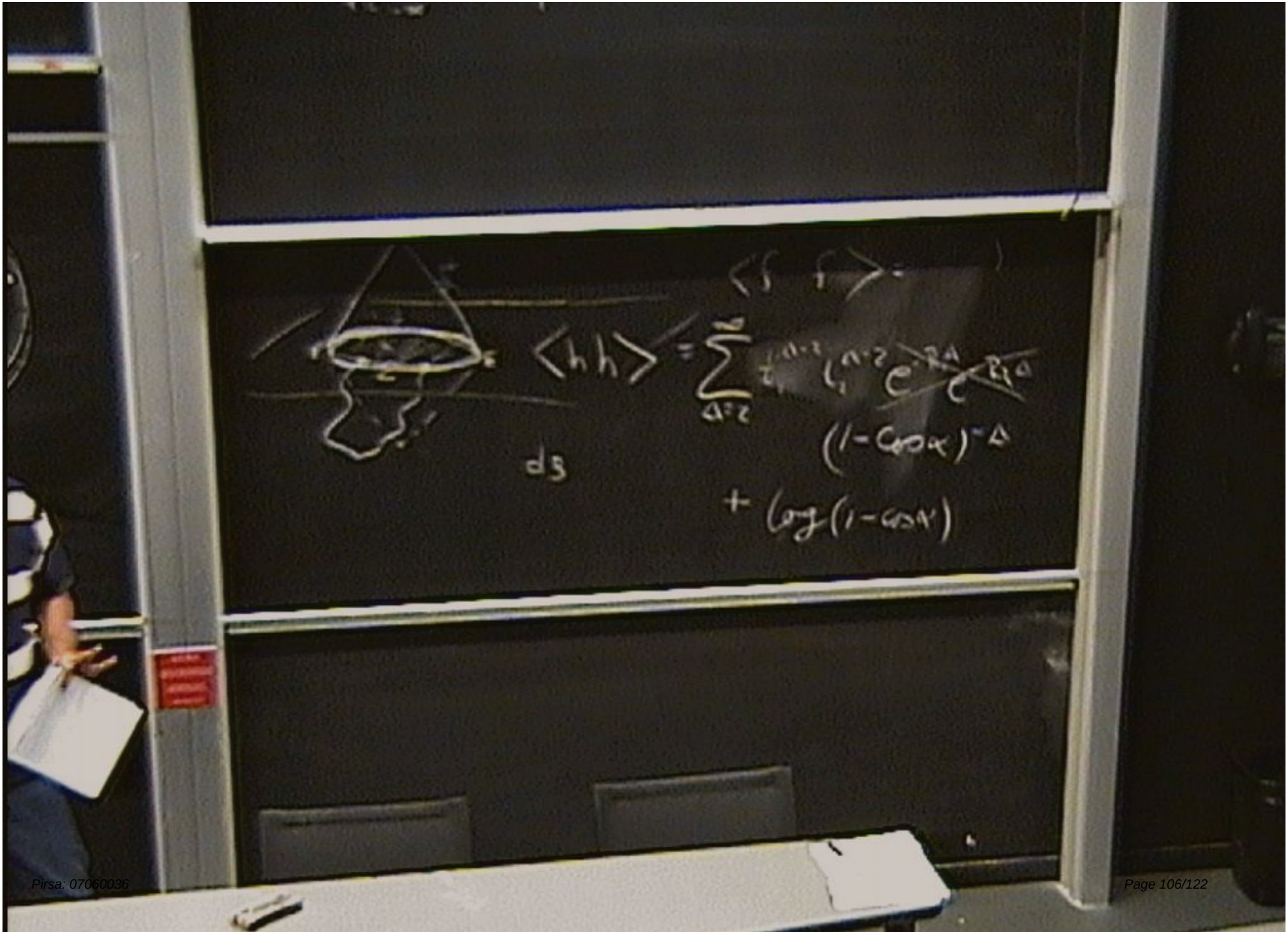
$\langle h h \rangle = \sum_{\Delta=2}^{\infty} t_1^{\Delta-2} t_2^{\Delta-2} e^{-R\Delta} e^{-R_2\Delta}$

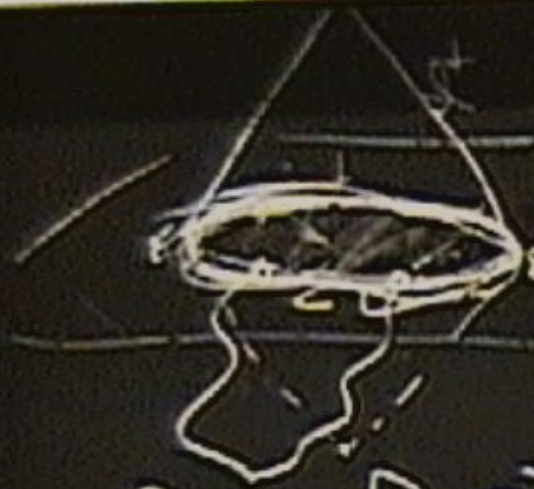
$(1-\cos\alpha)^{-\Delta}$

$+ \log(1-\cos\alpha)$

ds

$\langle s\ s \rangle =$


$\langle h h \rangle = \sum_{\Delta=2}^{\infty}$
$(1-\cos\alpha)^{-\Delta}$
$+ \log(1-\cos\alpha)$
ds



$\langle f \; f \rangle =$

$\langle h h \rangle = \sum_{\Delta=2}^{\infty} t_1^{\Delta-2} t_2^{\Delta-2} e^{-R\Delta} \cancel{e^{-R\Delta}}$

$(1-\cos\alpha)^{-\Delta}$

$+ \log(1-\cos\alpha')$

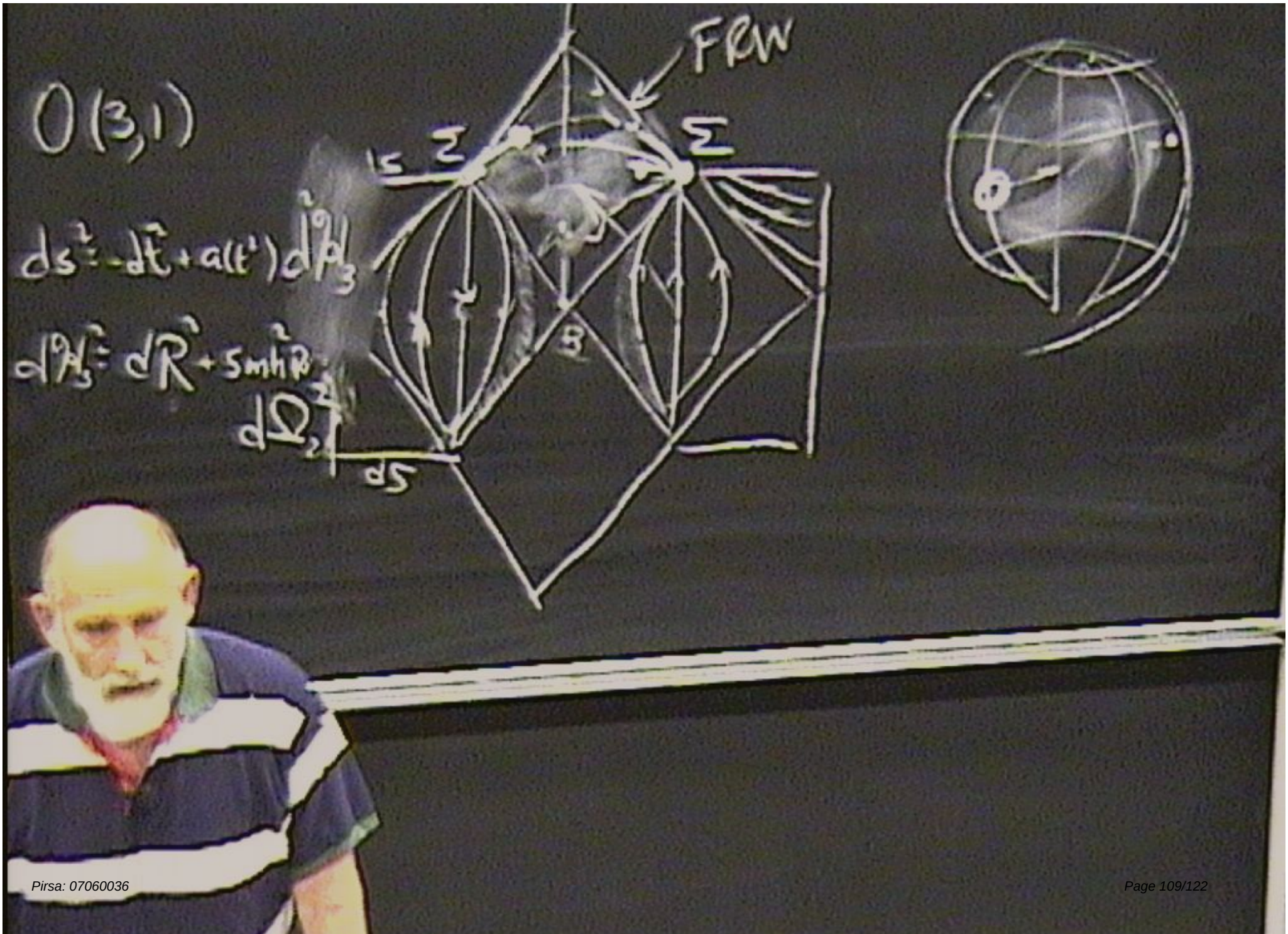
$g_2 = d\Omega_1 e^{2L}$

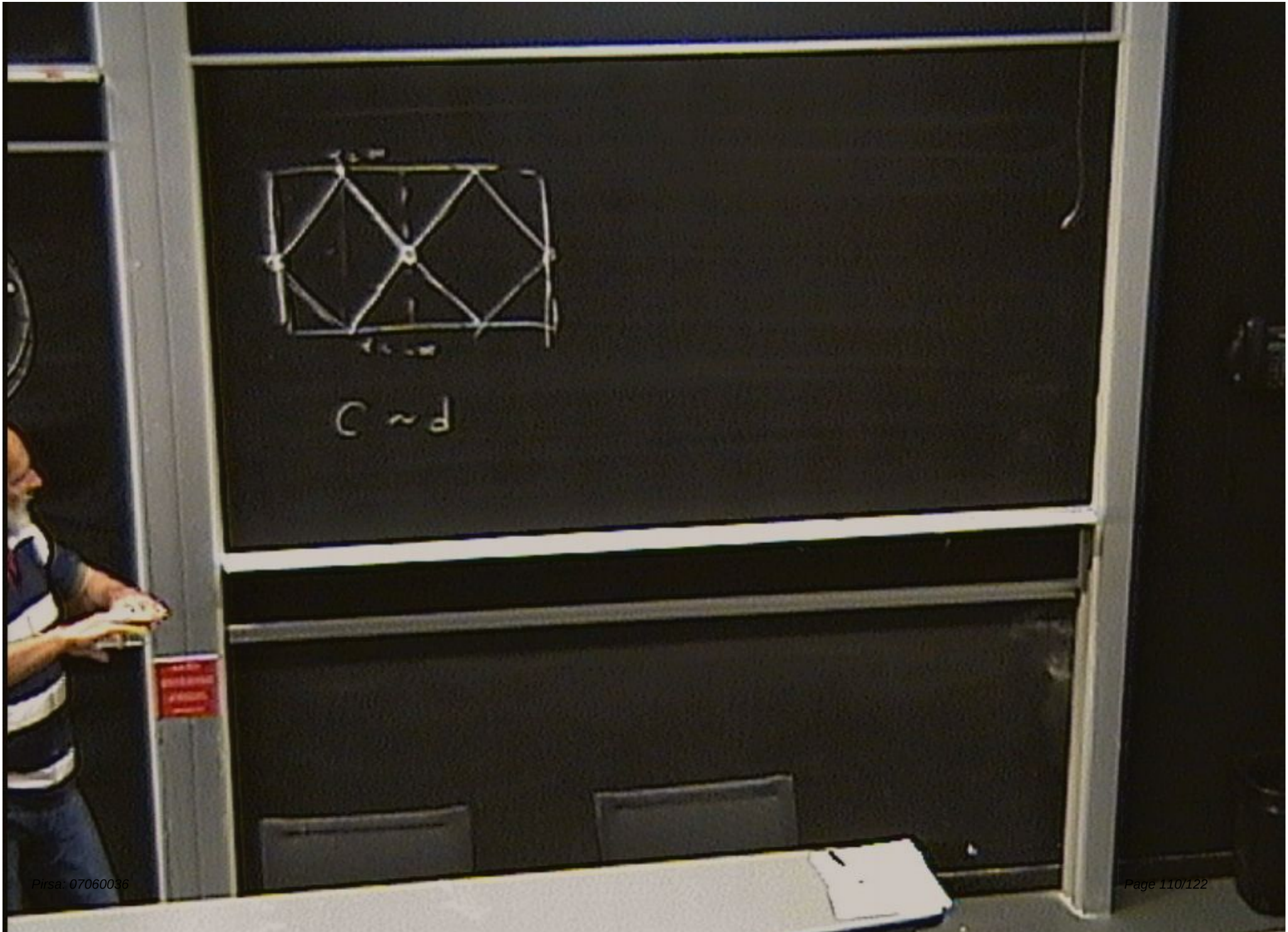
$$\langle h\,h \rangle = \sum_{\Delta=2}^{\infty} t_1^{\Delta-2}\, t_2^{\Delta-2}\, e^{-R\Delta}\, e^{-R_2\Delta}$$

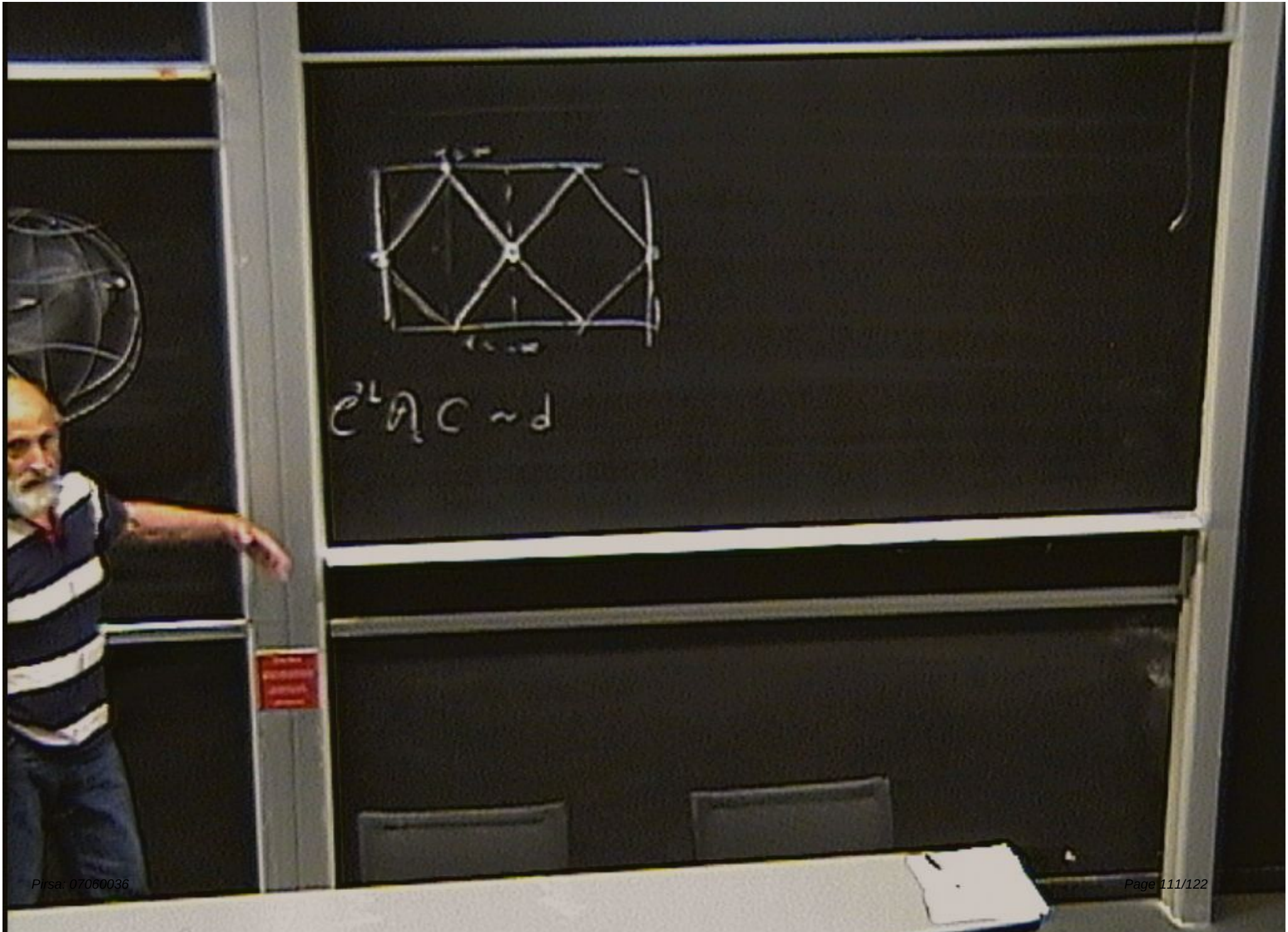
$$(1-\cos\alpha)^{-\Delta}$$

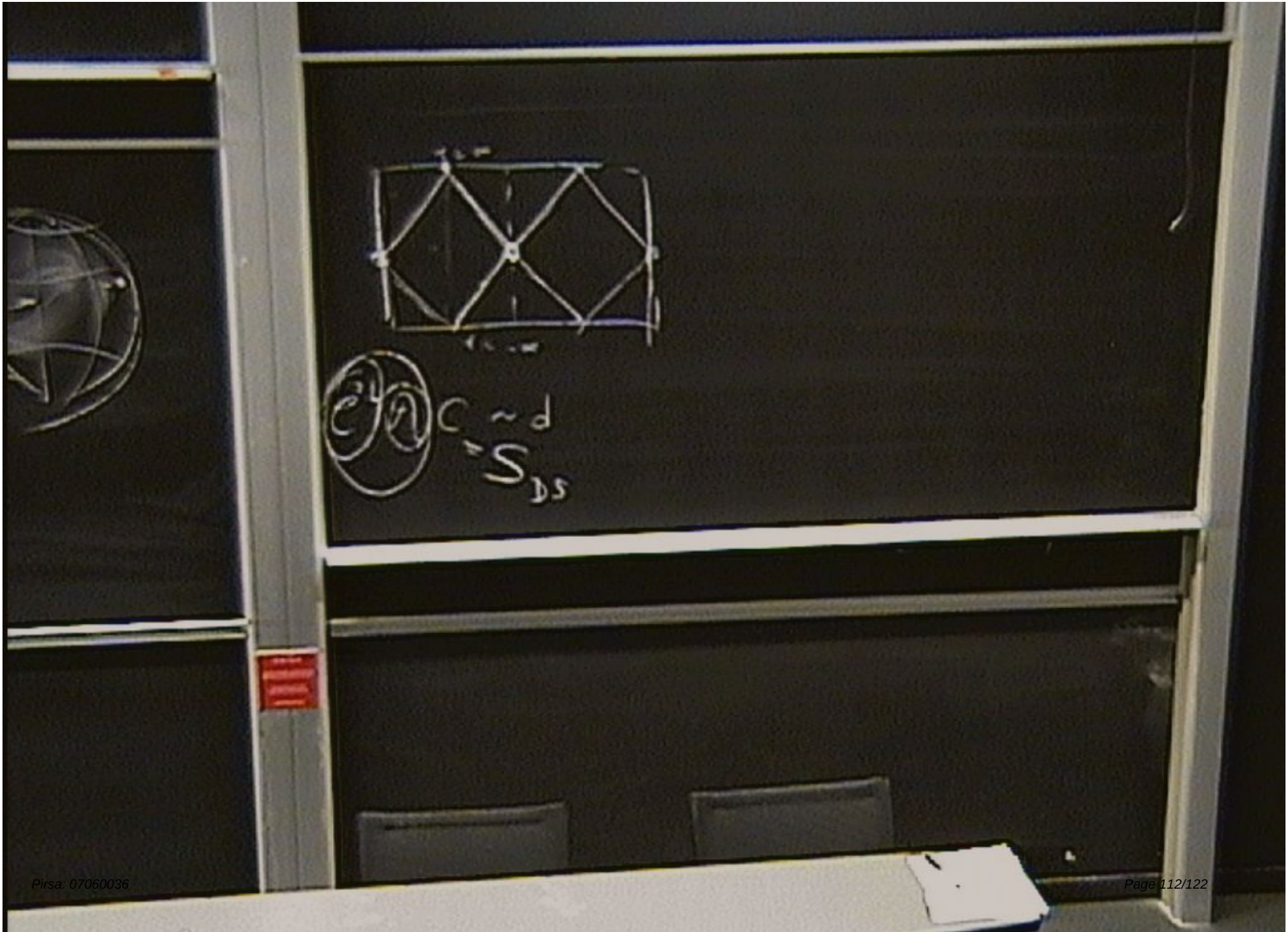
$$+ \log(1-\cos\alpha')$$

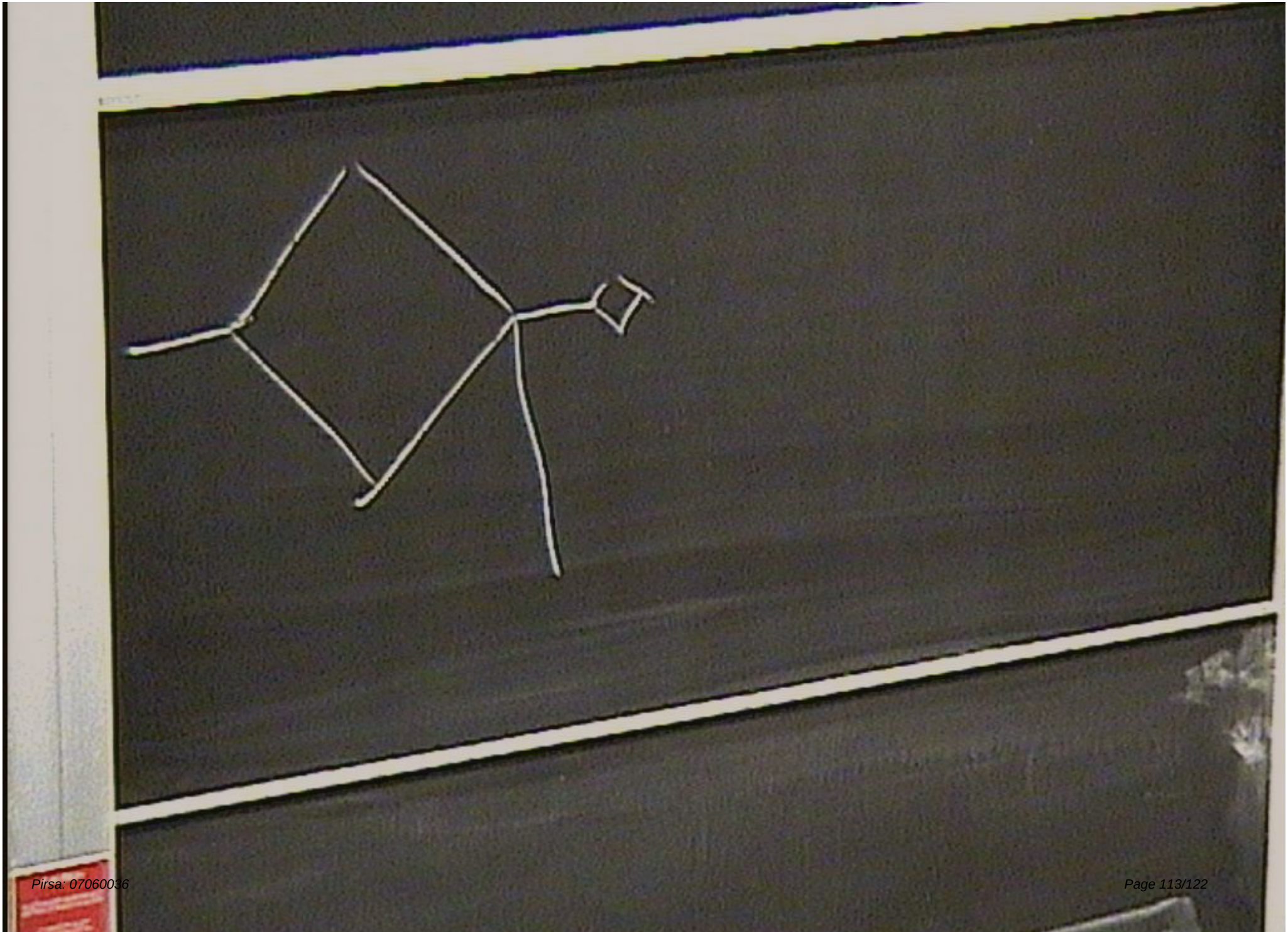
$$\tilde{g}_2 = d\vec{R}_1 e^{2L}$$

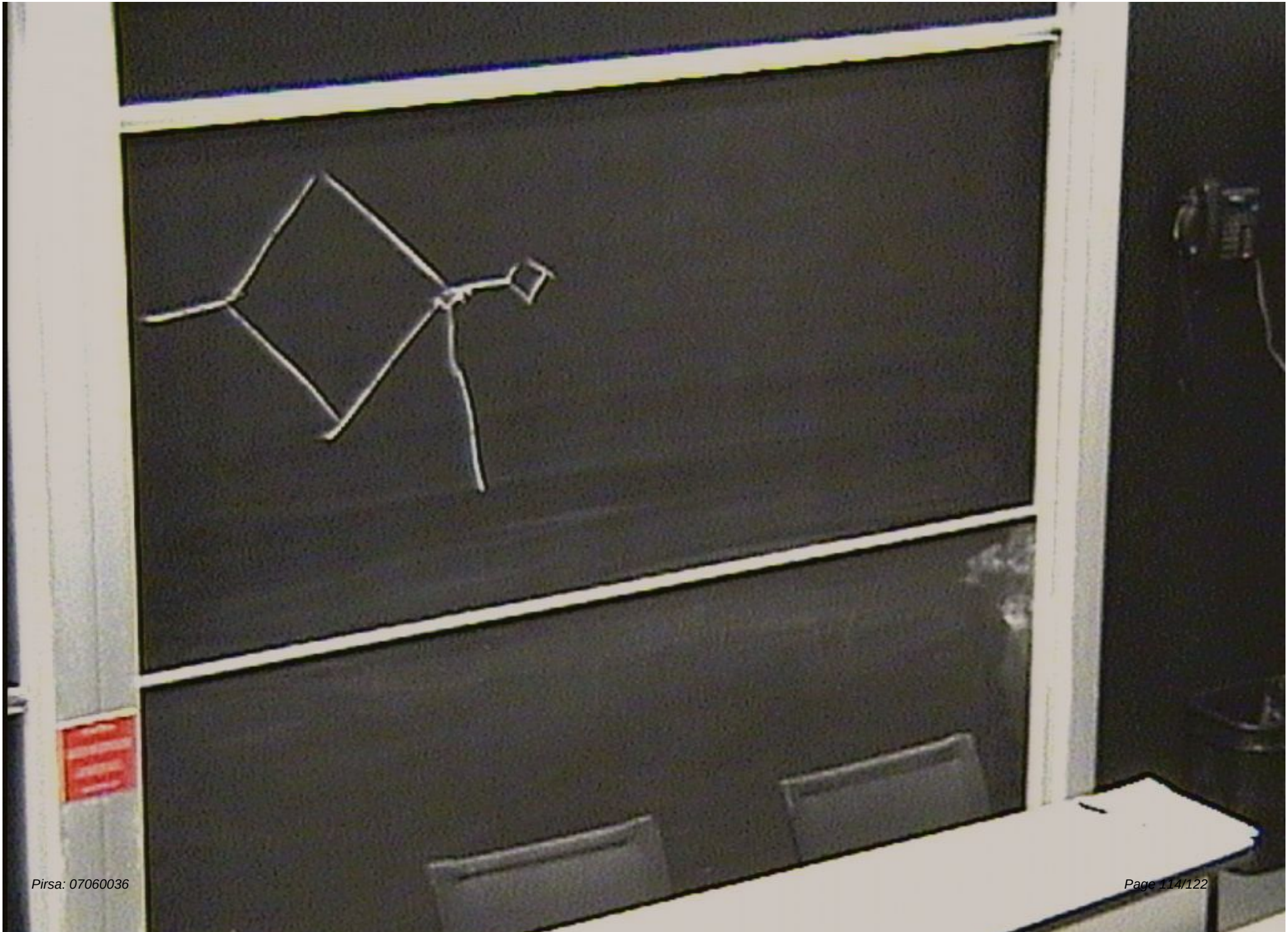

O(3,1)
FRW
Σ
$ds^2 = -dt^2 + a(t)^2 d\mathcal{H}_3^2$
$d\mathcal{H}_3^2 = dR^2 + \sinh^2 R\, d\Omega_2^2$
dS

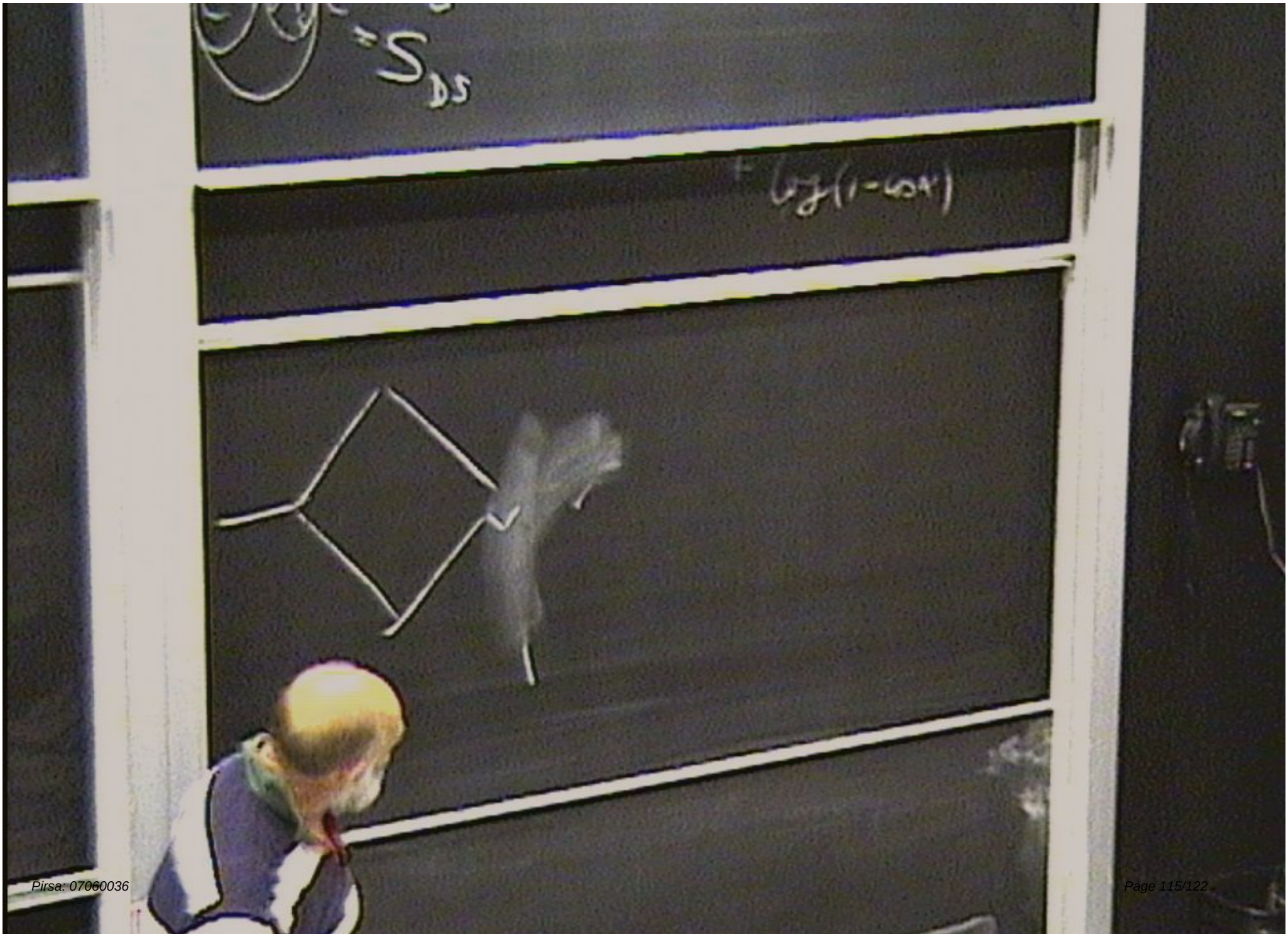

C ~ d

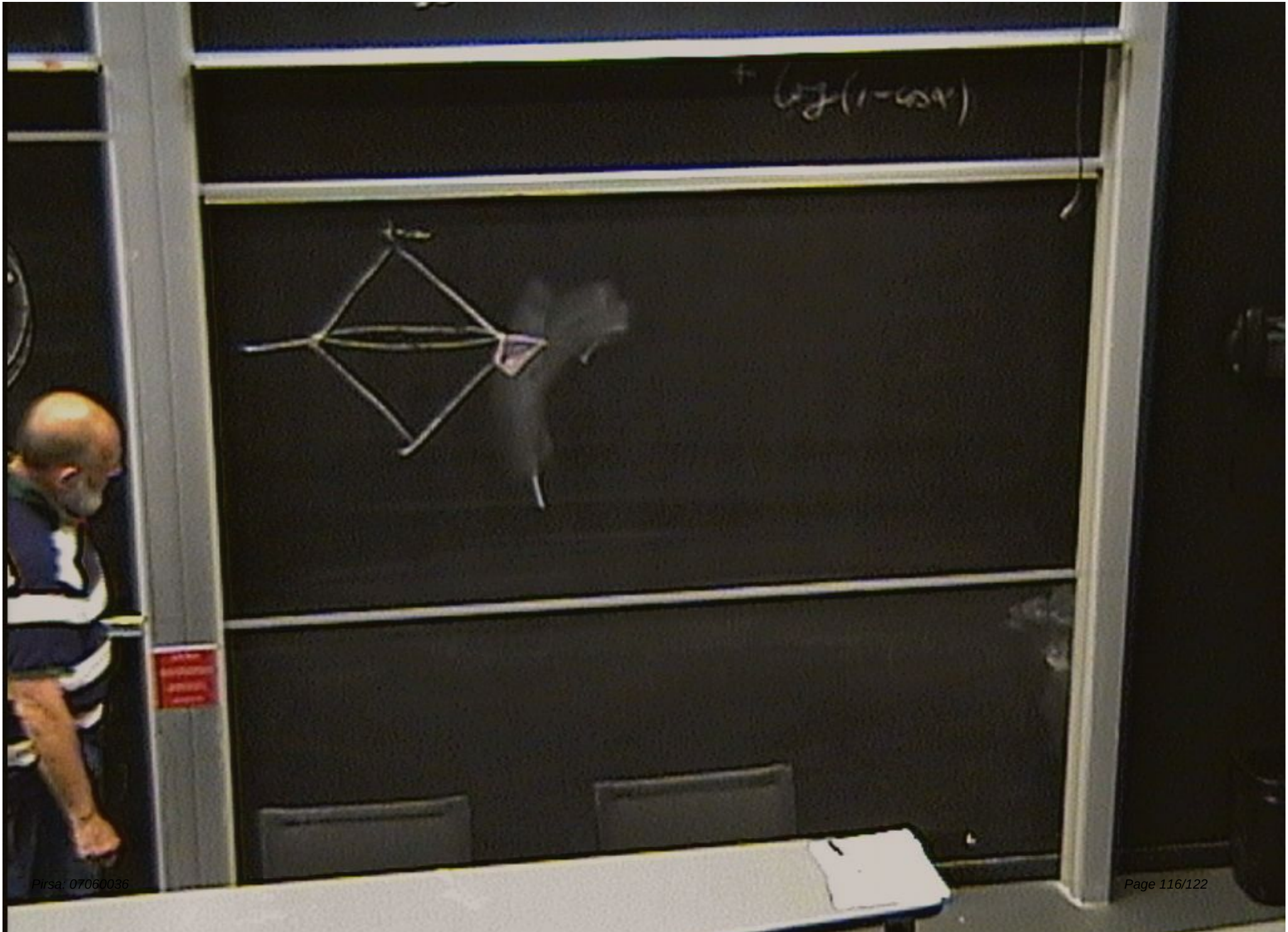

$e^{2L}\Delta C \sim d$

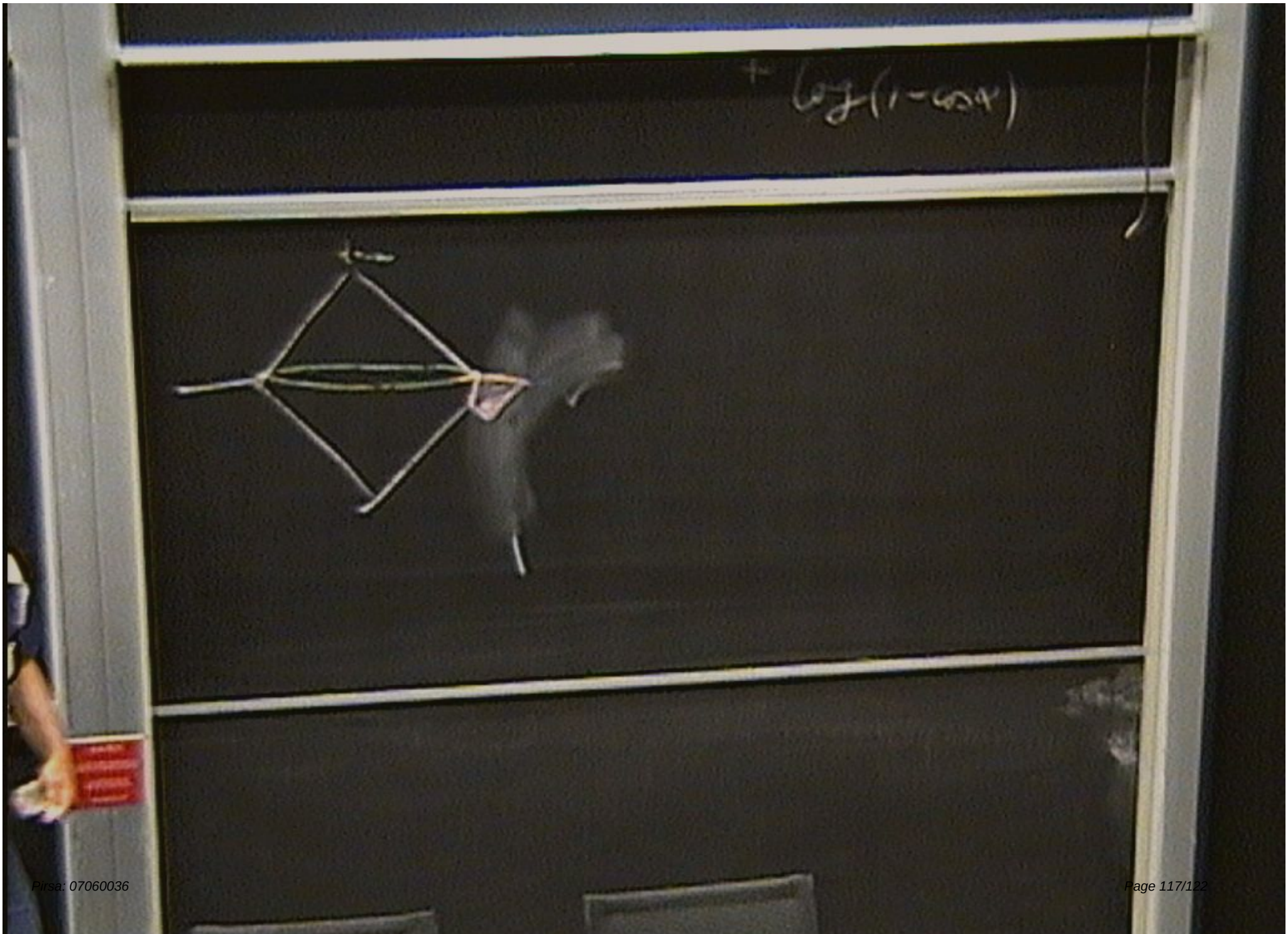

C ~ d
S_DS






$= S_{DS}$
$+ \log_2(1-\delta_{DS})$




+ log(1-