Title: Enrichment Presentation on Special Relativity

Date: Jul 07, 2006 09:00 AM

URL: http://pirsa.org/06070011

Abstract:


Documents
WaterWorks
MarkBook 2005
Microsoft ActiveSync
SJAM Enrolmen...
Crazy Aaron's Puttyworld ...
Microwave Experim...
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WordPerfect 10
Microsoft Outlook
dvd-to-mpeg
Dvd-to-mpeg
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Unused eskto...
Calculator
markbook
wheelchair
Managing Conflict
Measuring the speed of lig...
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Emergent Village
Books I would like to read
2103712
Sample template
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QuickTime Player
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SNC2P Motion
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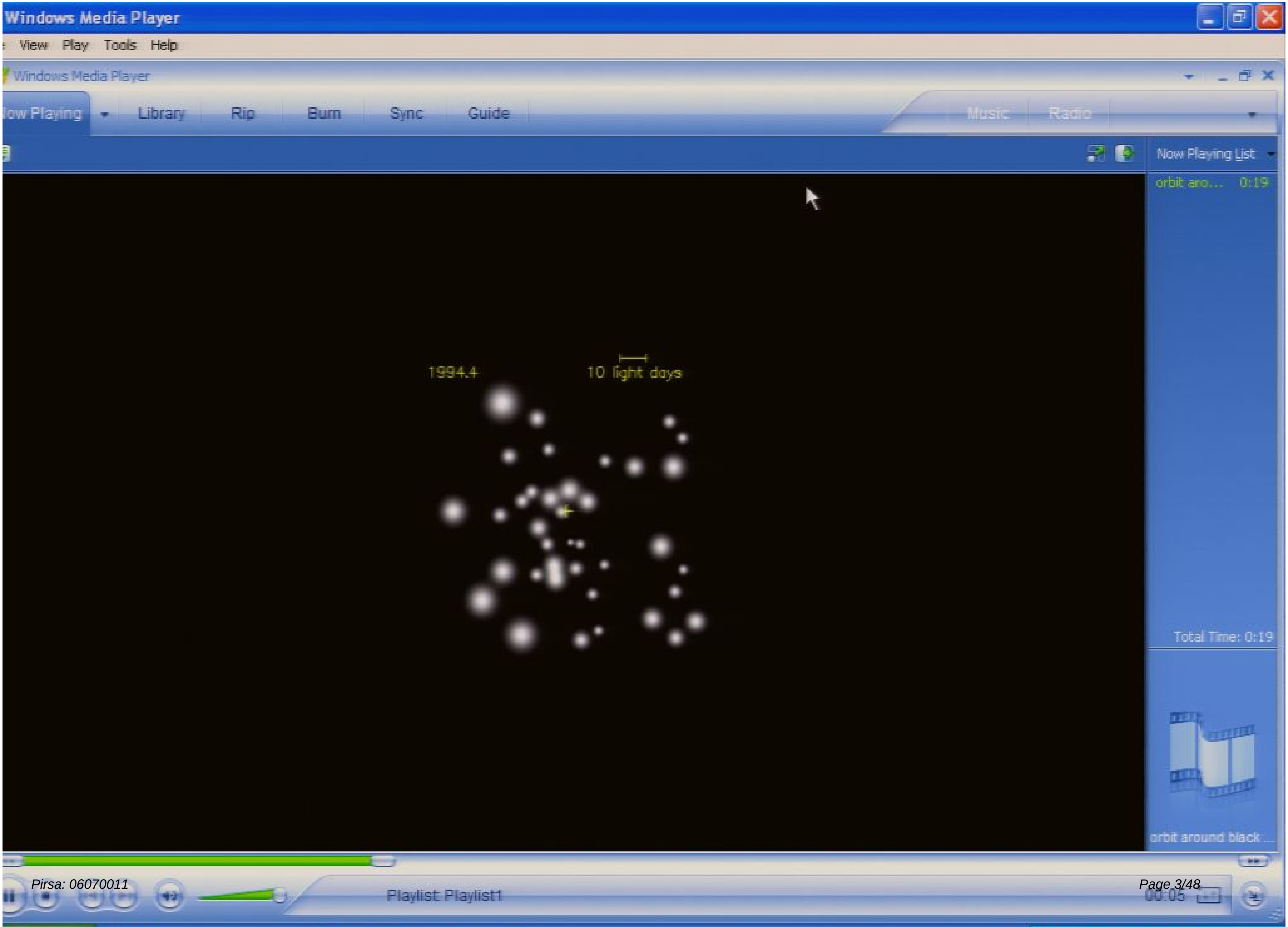
Radio Shows
cps.exe
Tim and Tamara...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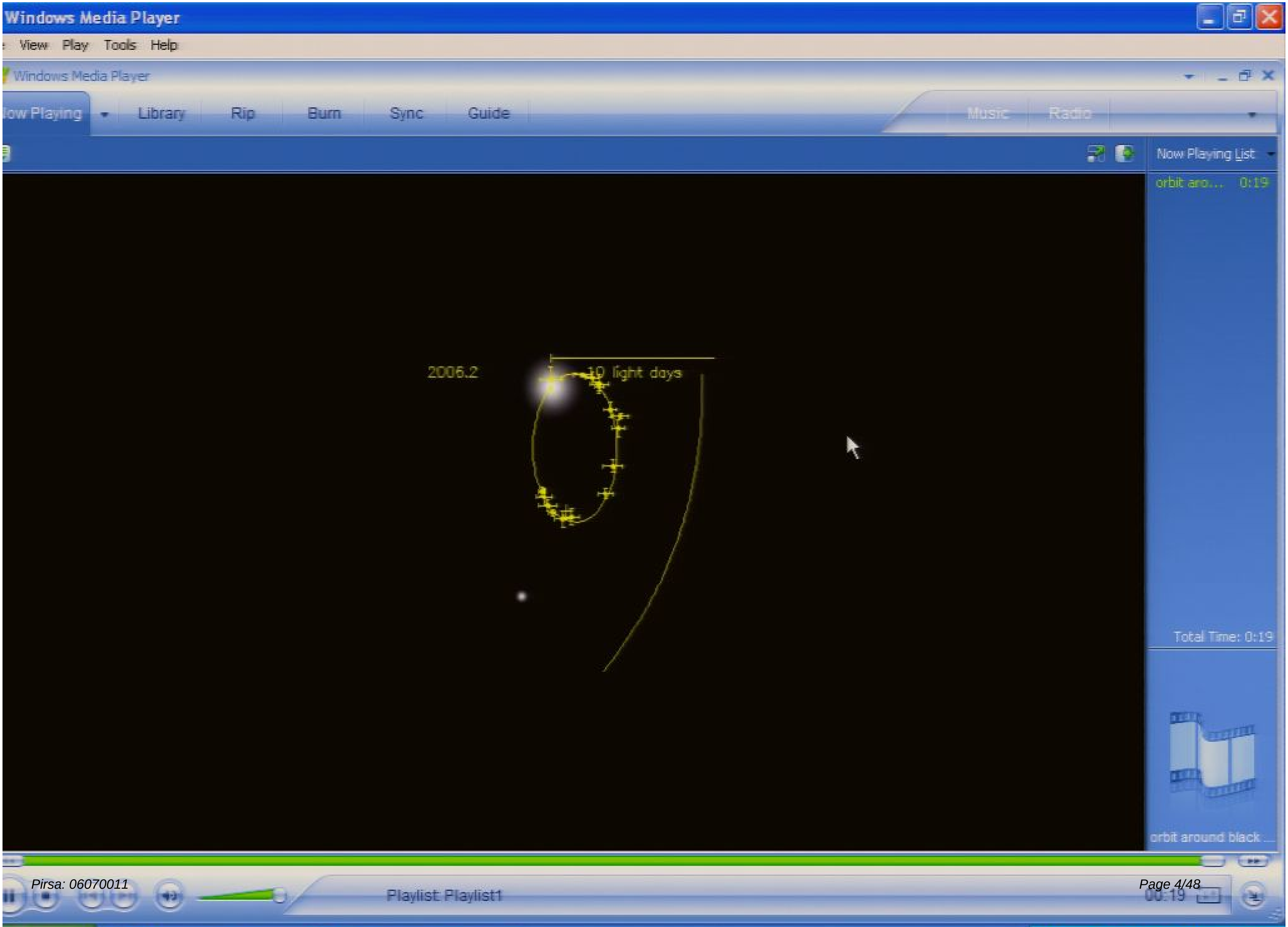
View Play Tools Help
Windows Media Player
Now Playing
Library
Rip
Burn
Sync
Guide
Music
Radio
Now Playing List
orbit aro... 0:19
1994.4
10 light days
Total Time: 0:19
orbit around black ...
Playlist: Playlist1
00:05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Windows Media Player
Library
Rip
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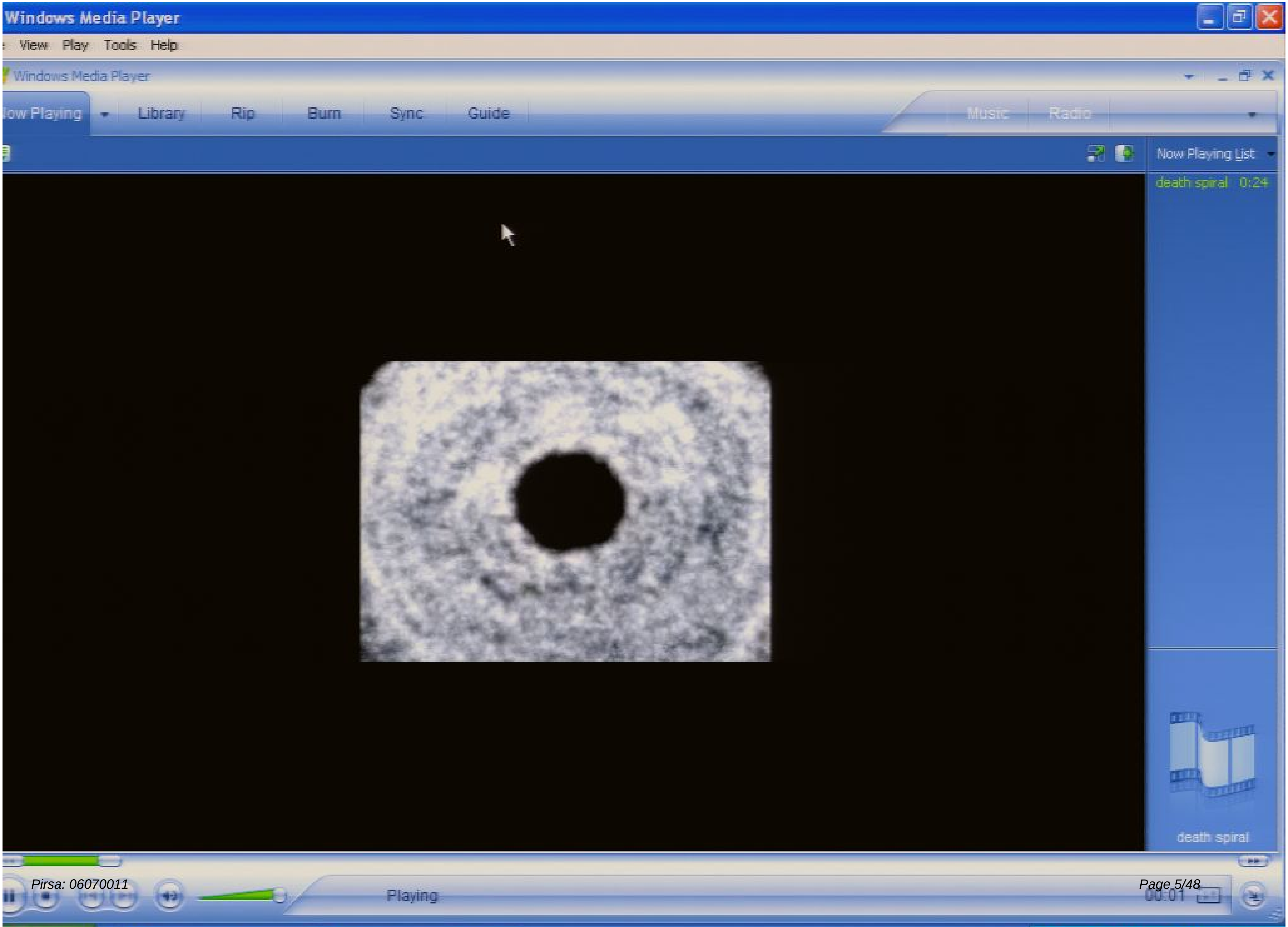
orbit aro... 0:19
2006.2
10 light days
Total Time: 0:19
orbit around black ...
Playlist: Playlist1
00:19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Burn
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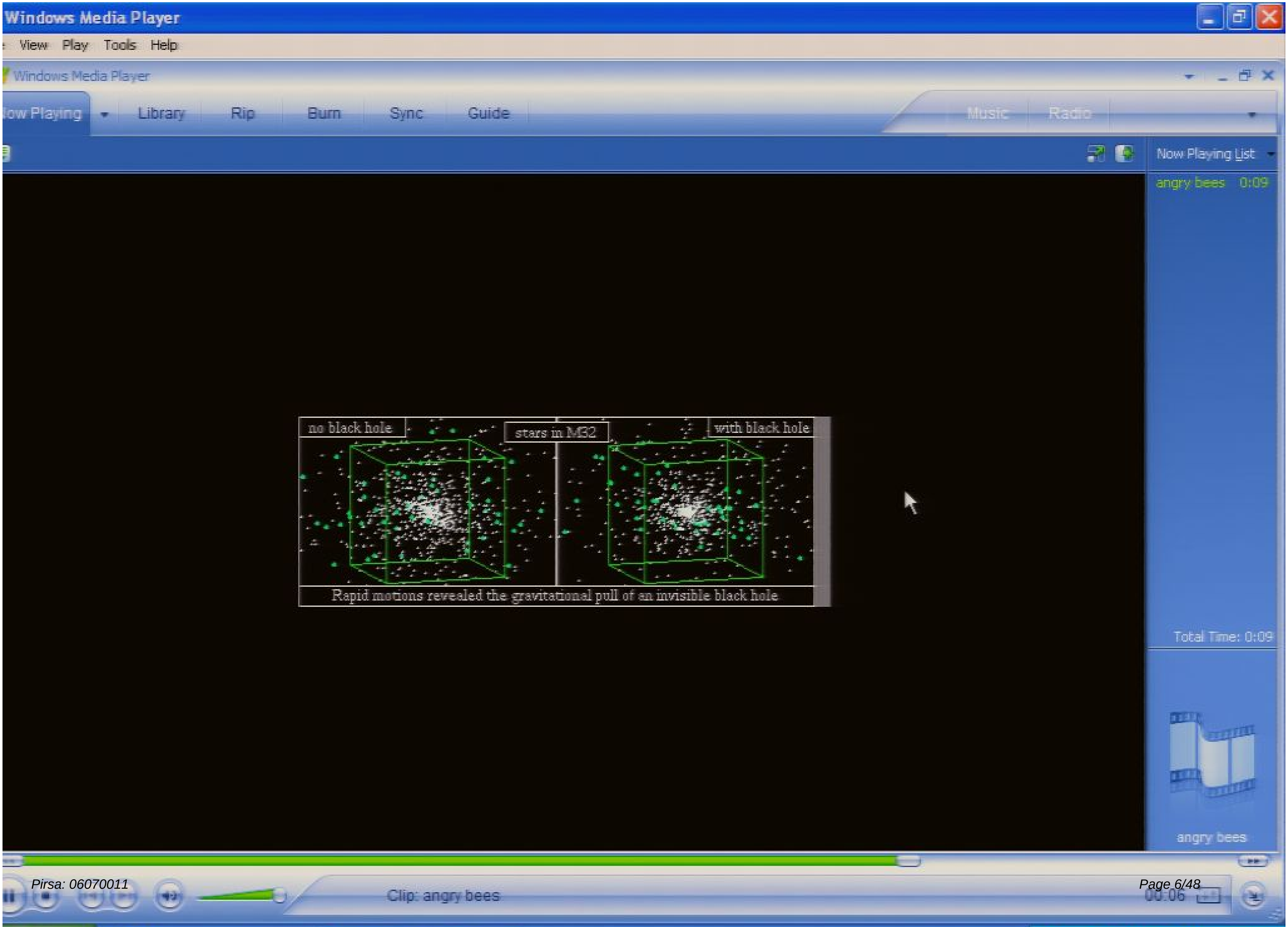
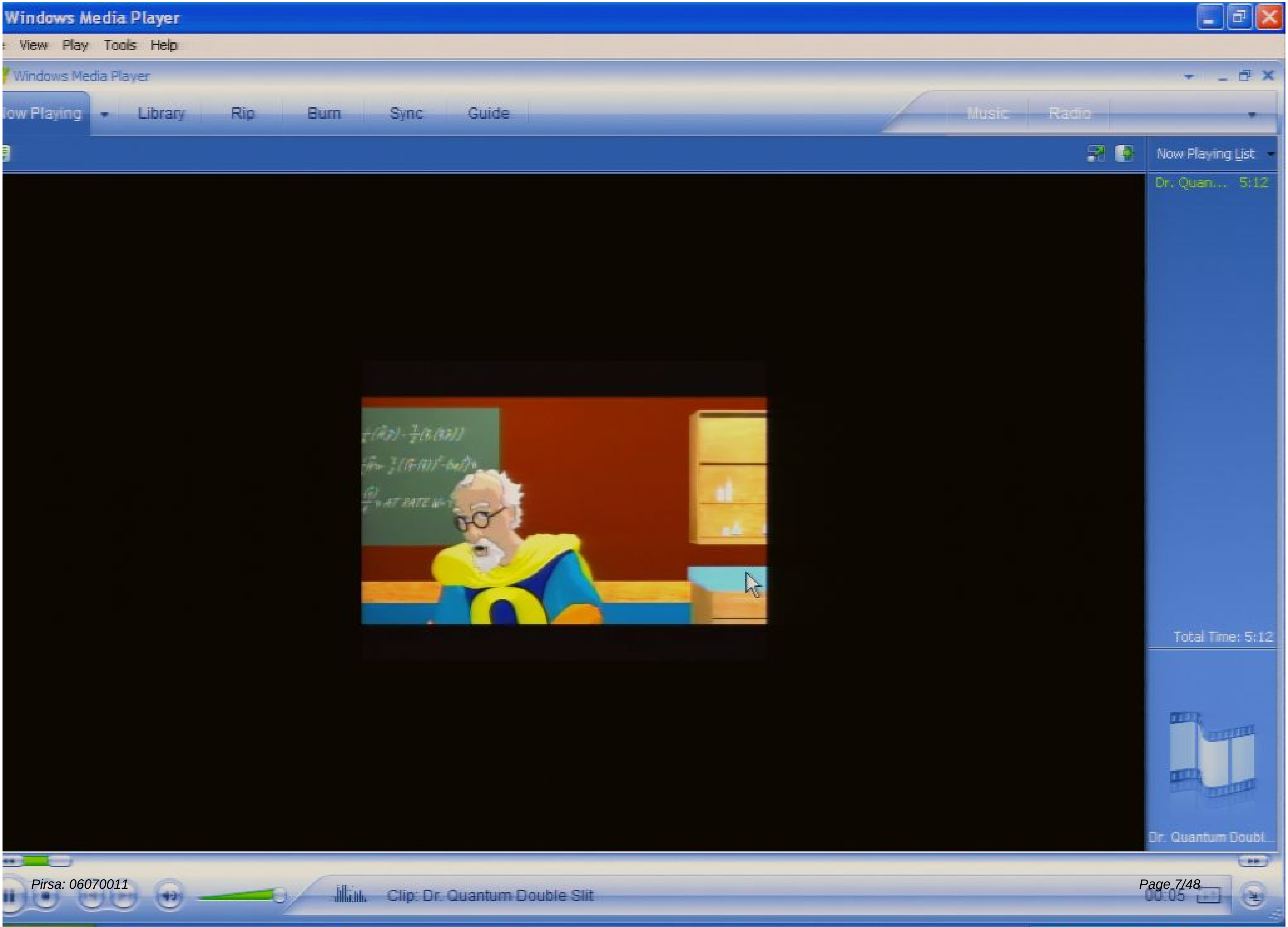
Music
Radio
Now Playing List
death spiral 0:24
death spiral
Playing
00:01


Windows Media Player
View Play Tools Help
Windows Media Player
Library
Rip
Burn
Sync
Guide
Music
Radio
Now Playing List
angry bees 0:09
no black hole
stars in M32
with black hole
Rapid motions revealed the gravitational pull of an invisible black hole
Total Time: 0:09
angry bees
Clip: angry bees
00:06


Windows Media Player
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Windows Media Player
Now Playing
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Rip
Burn
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Guide
Music
Radio
Now Playing List
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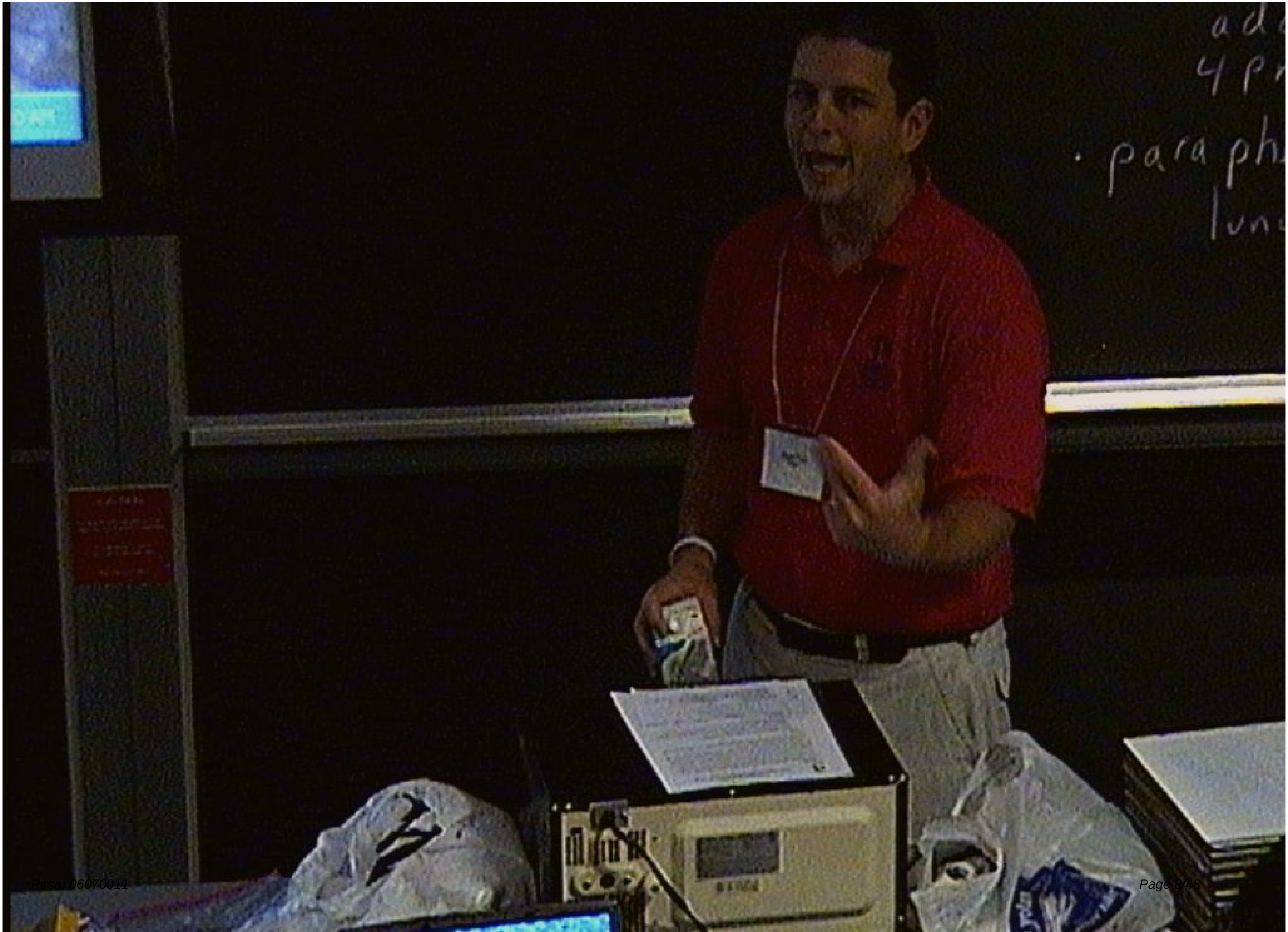
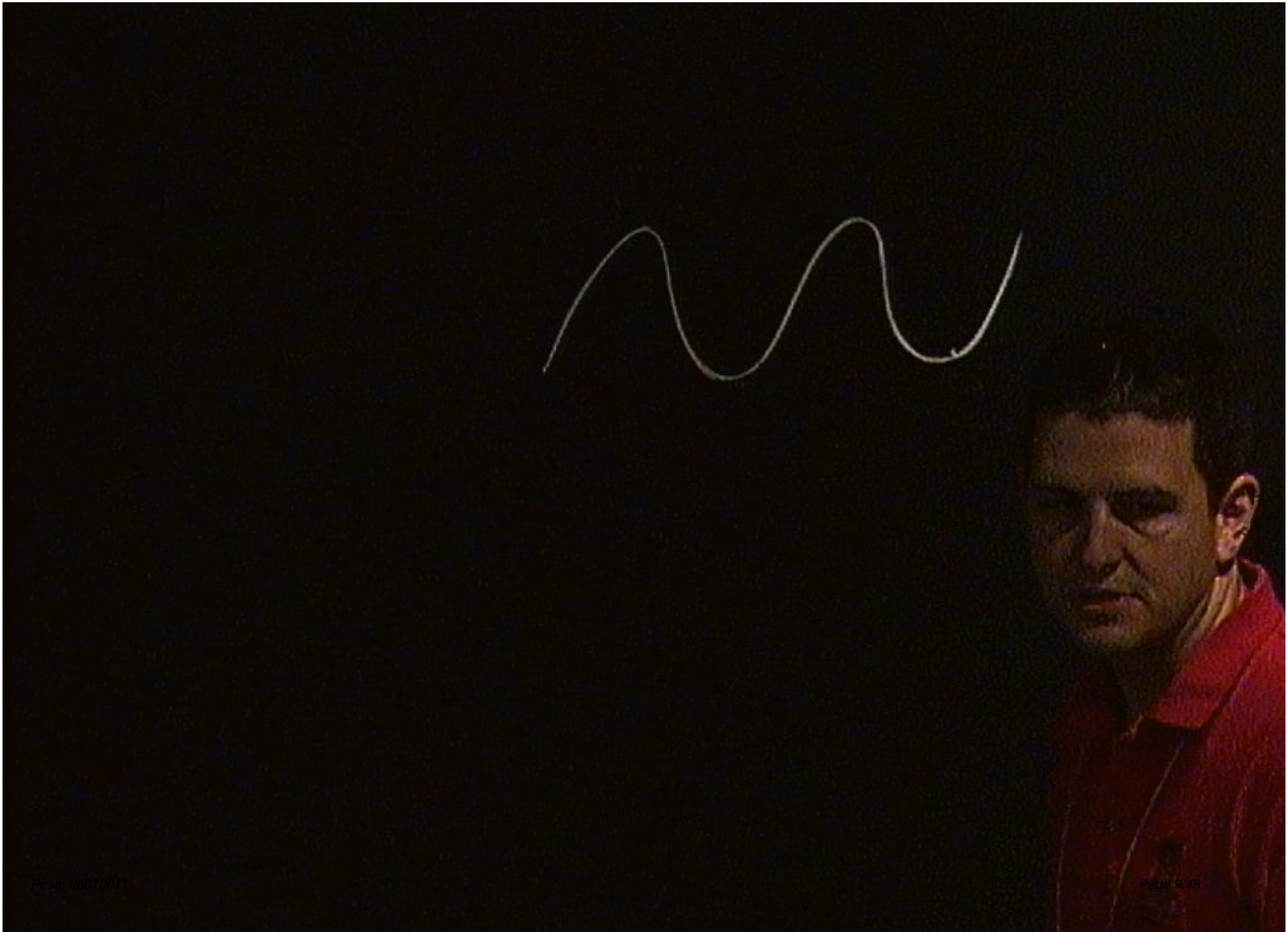
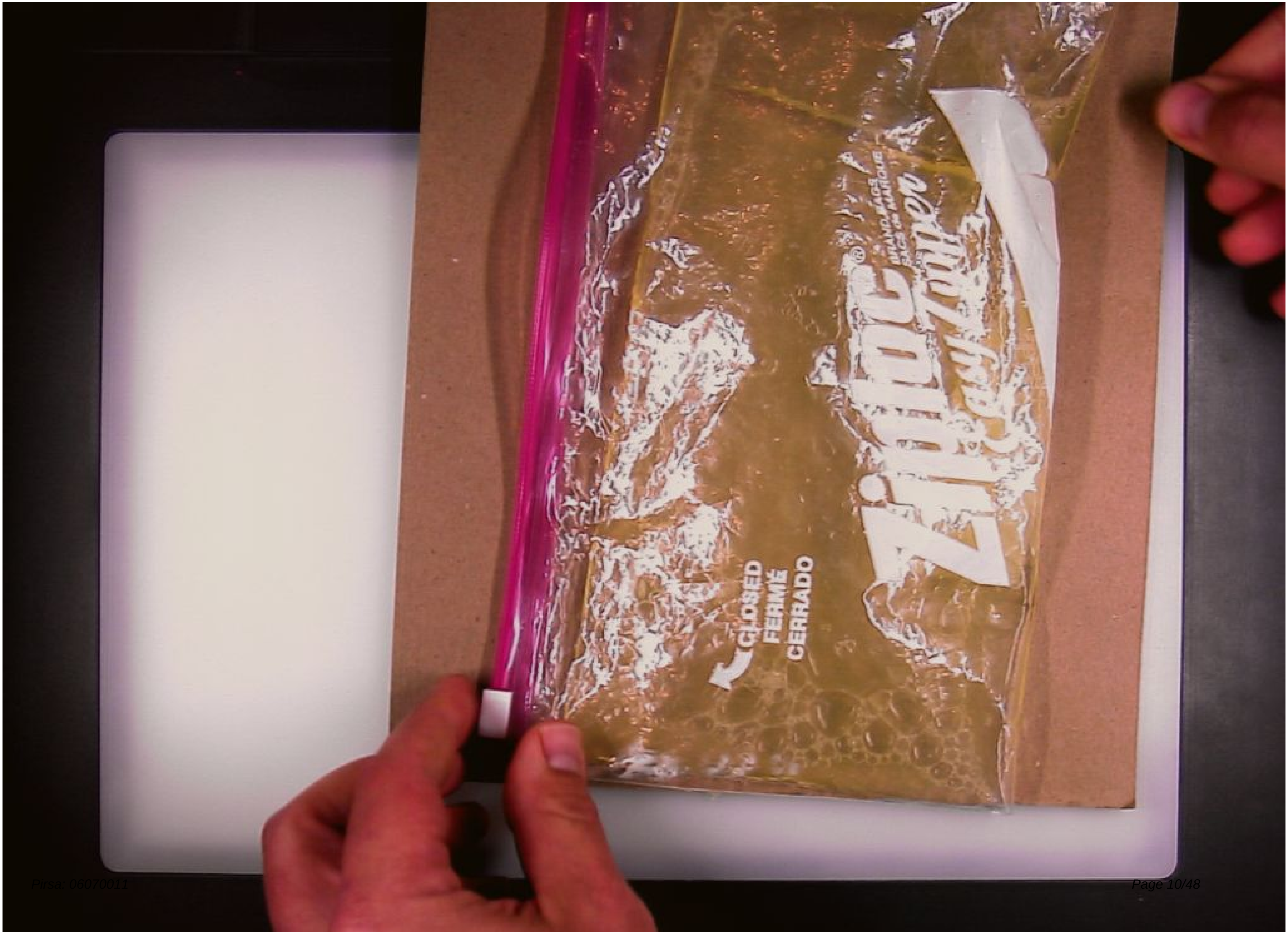
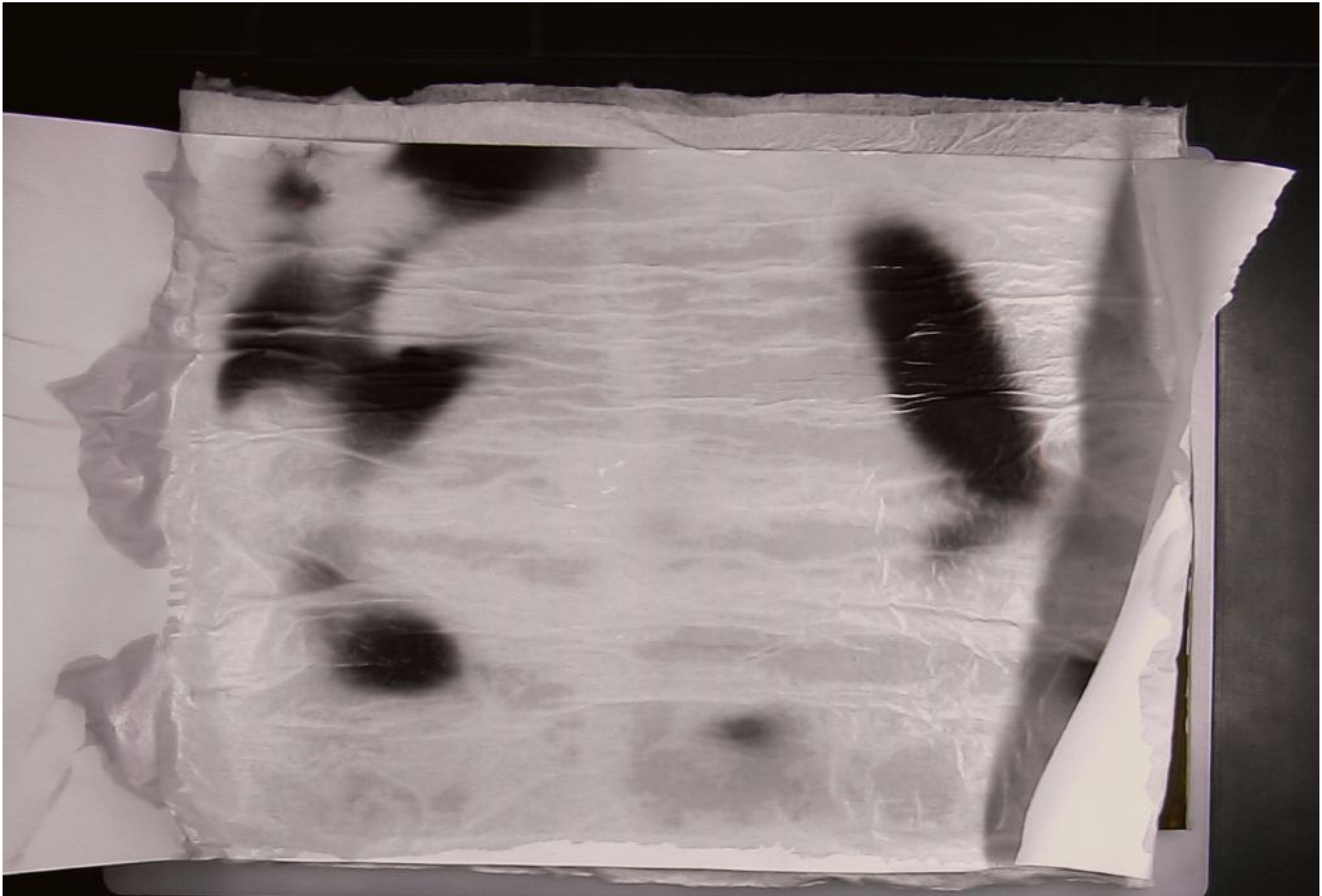
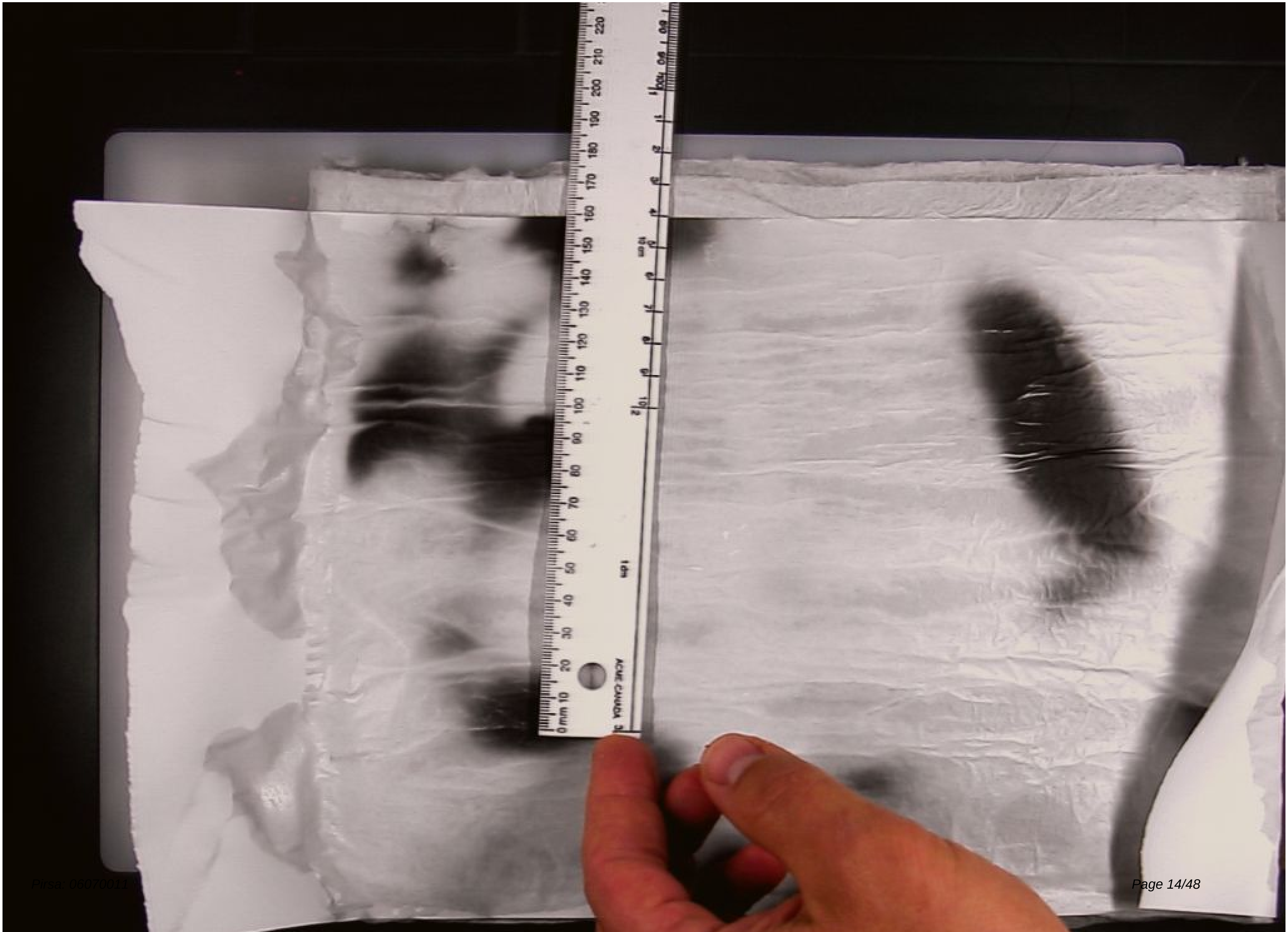
Dr. Quantum Doubl...
Clip: Dr. Quantum Double Slit
00:05

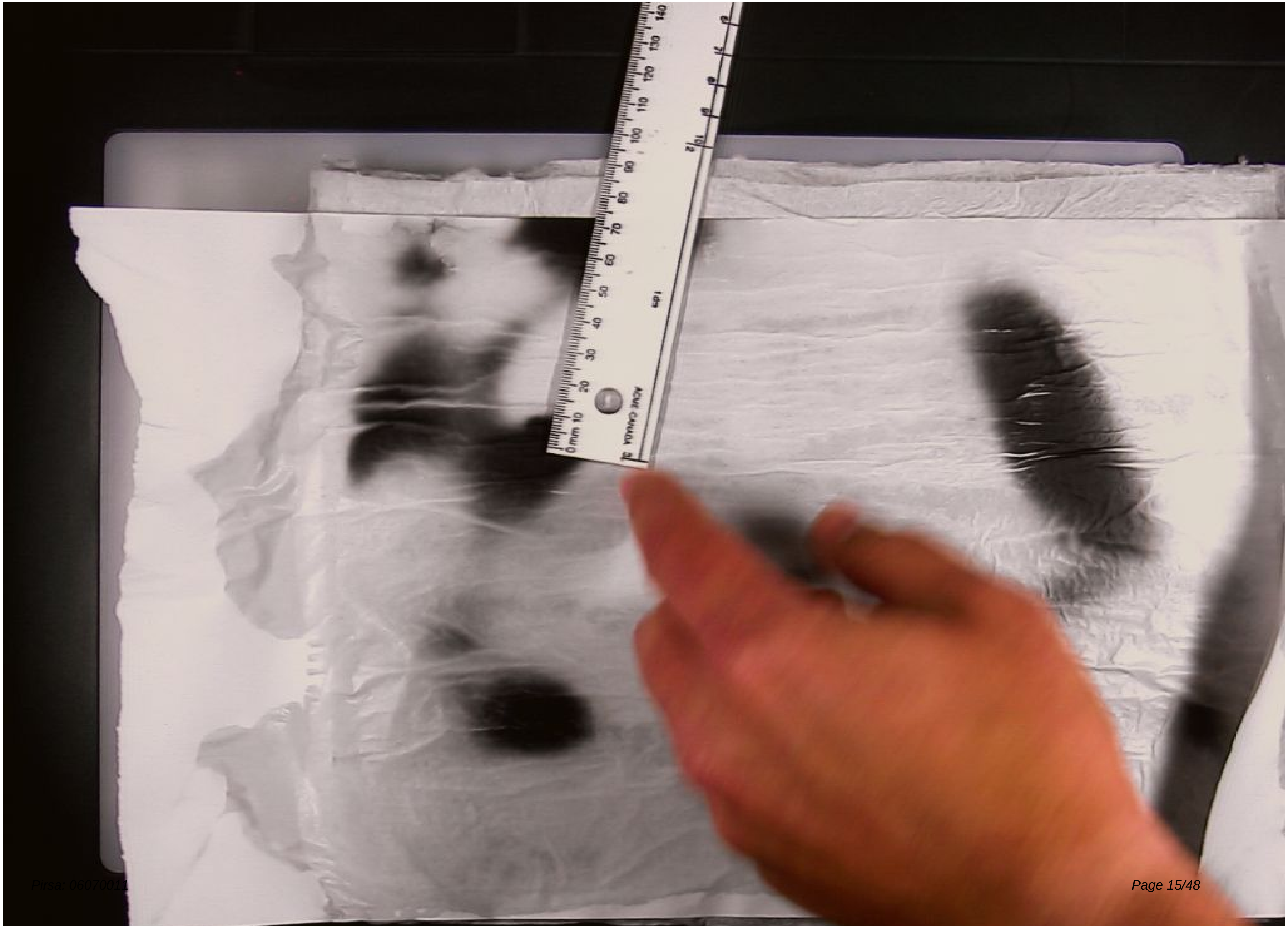


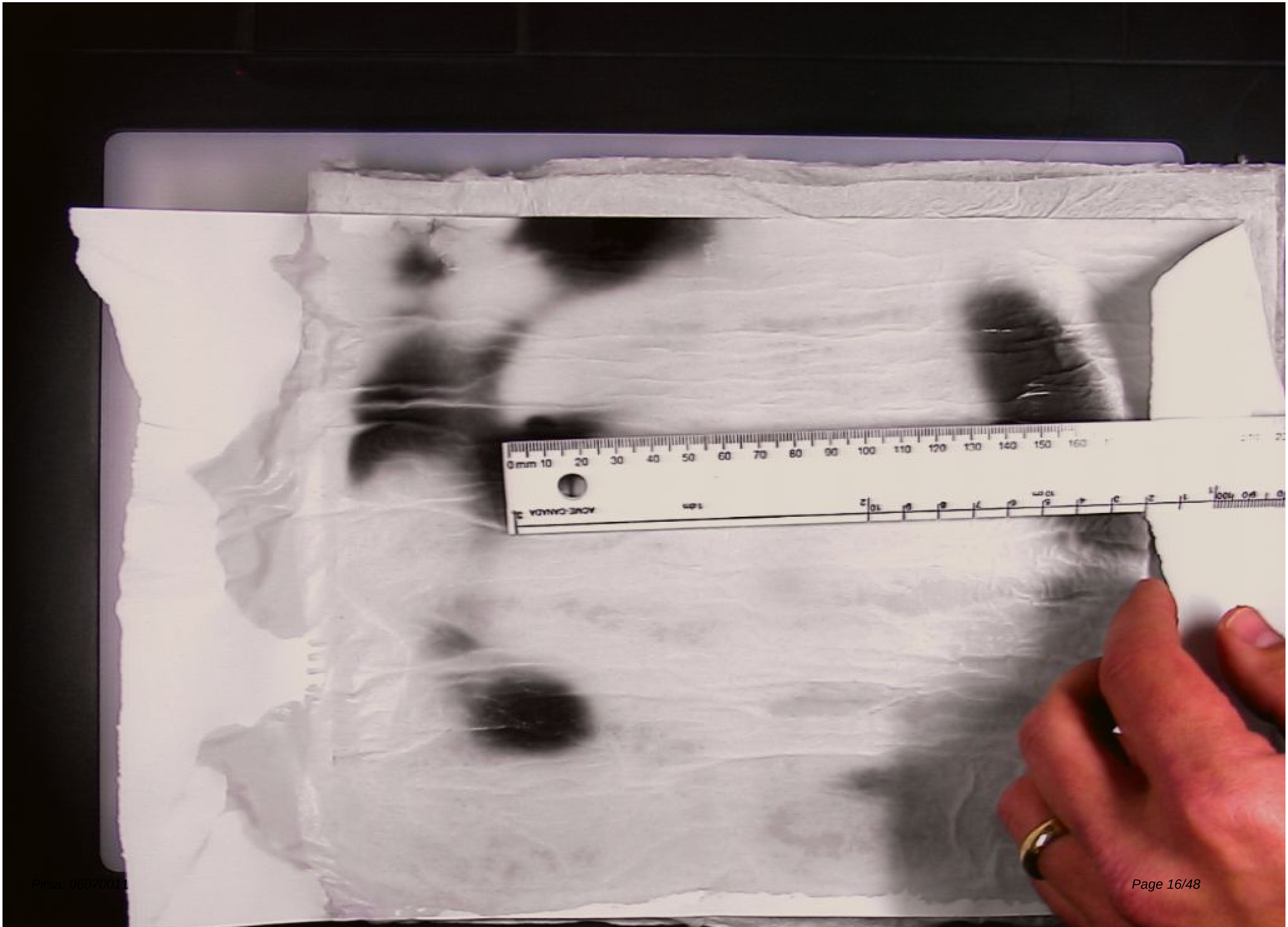



Ziploc
CLOSED
FERMÉ
CERRADO





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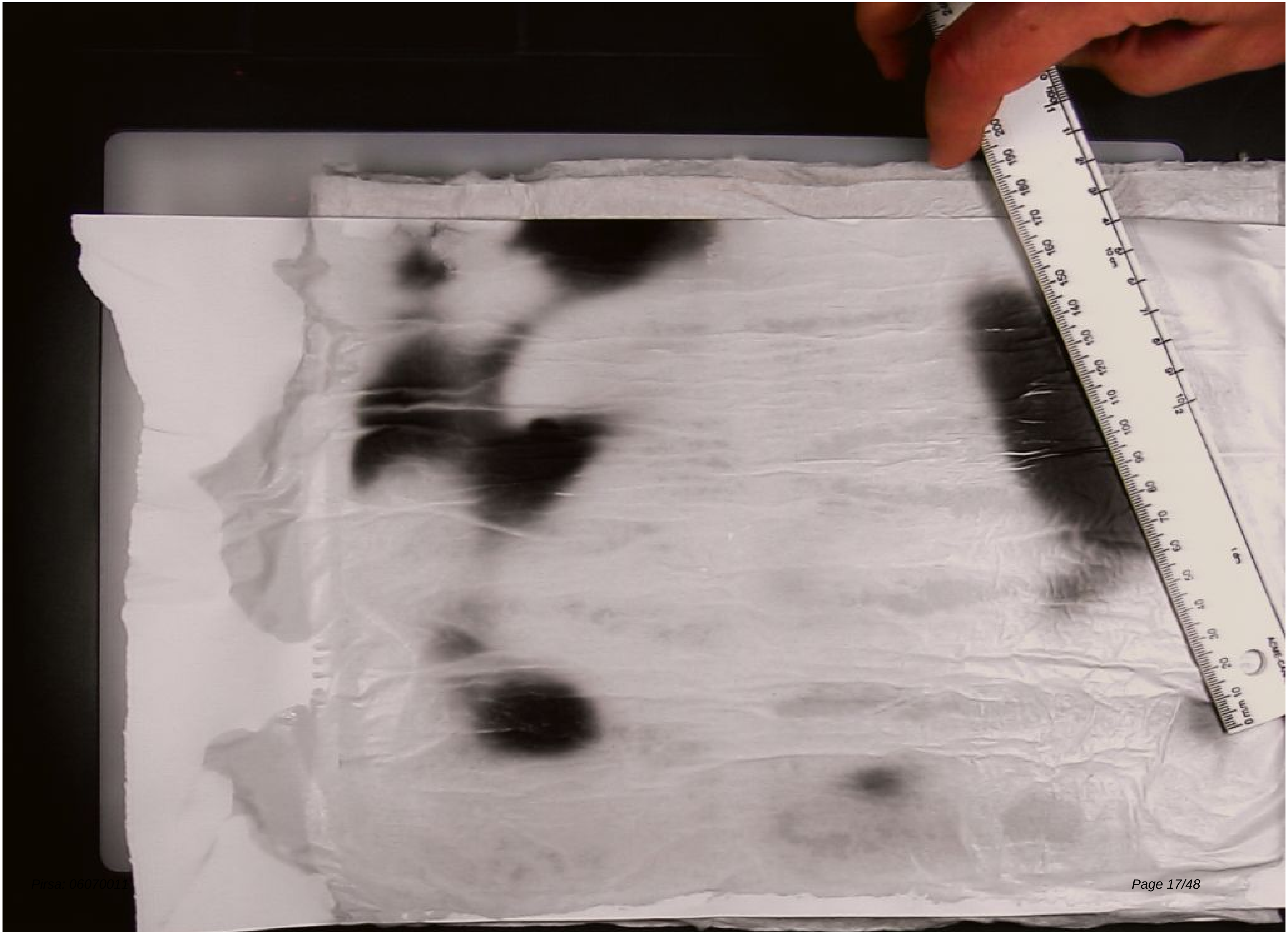
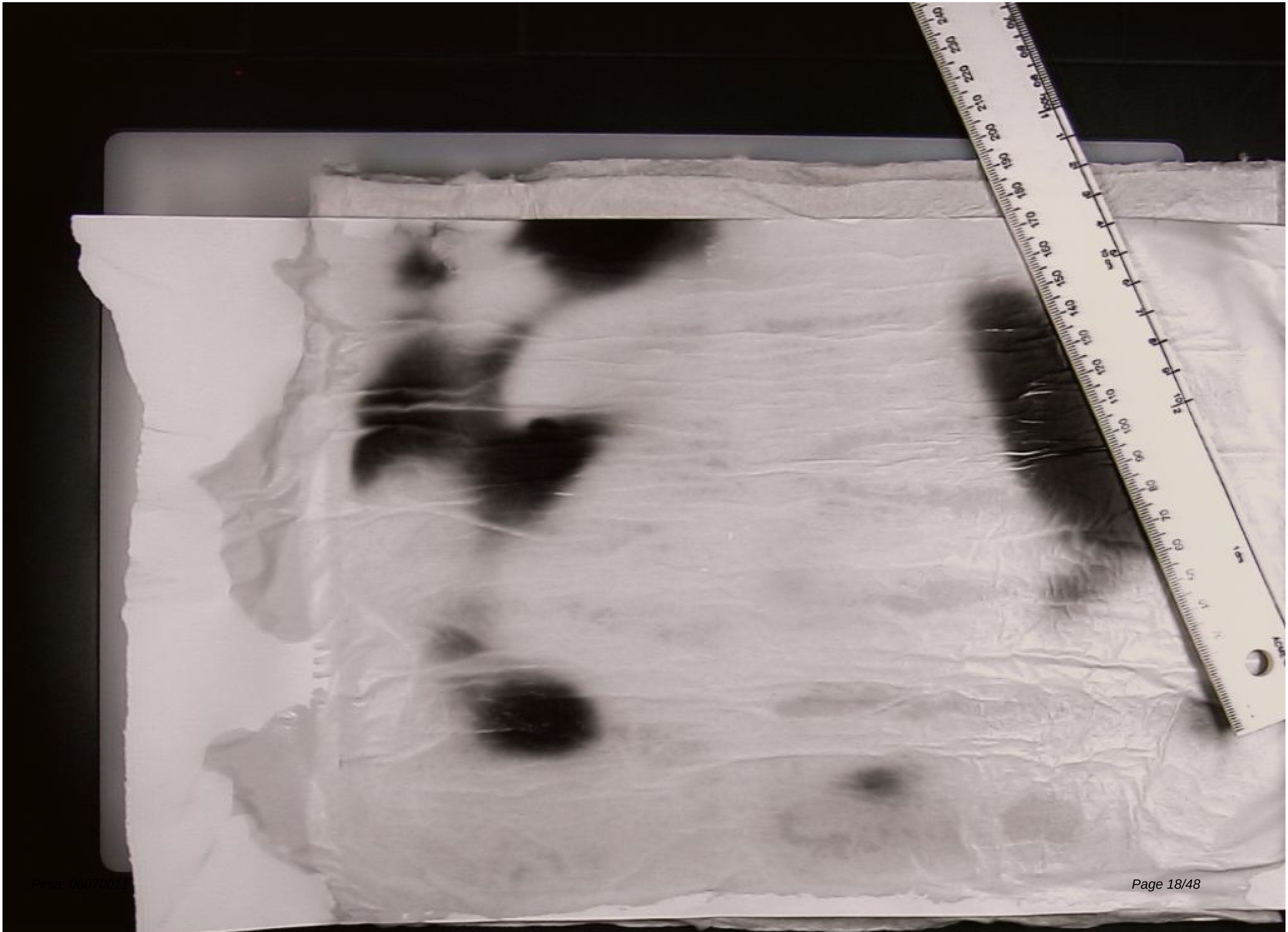
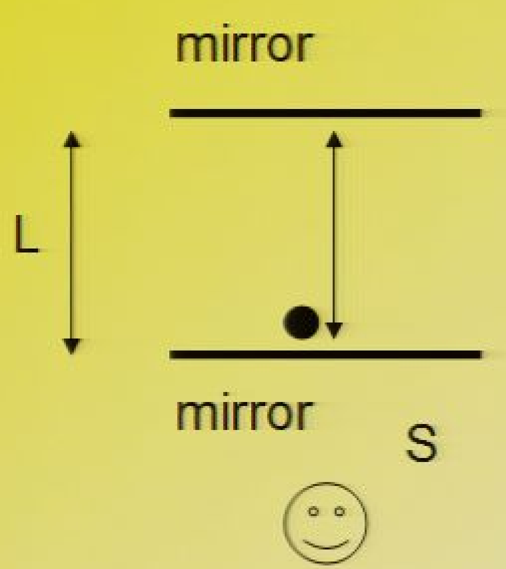


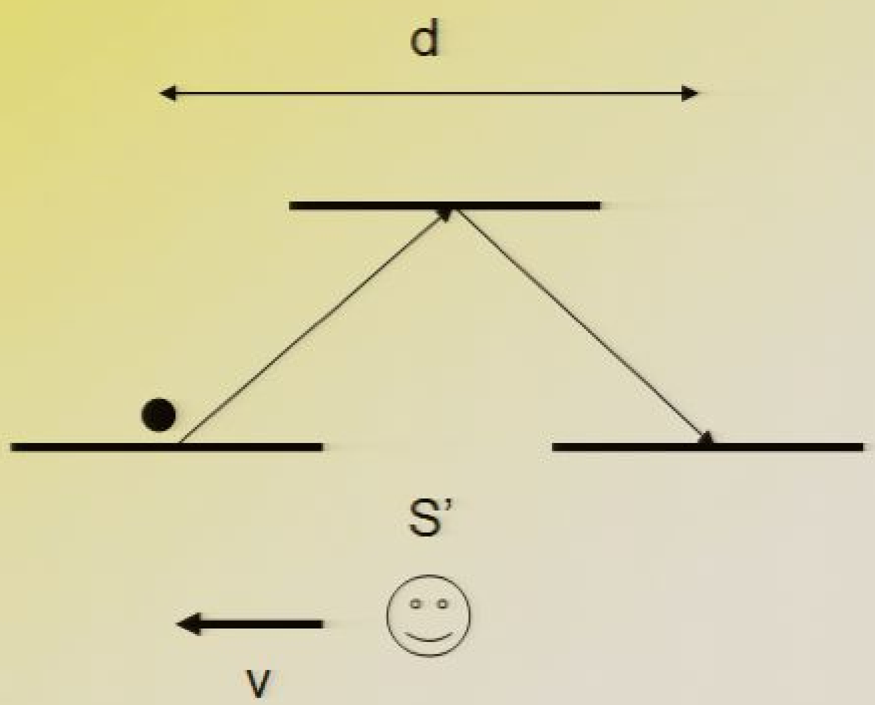


Core concepts of special relativity, Part 2

Time dilation

- Light clock



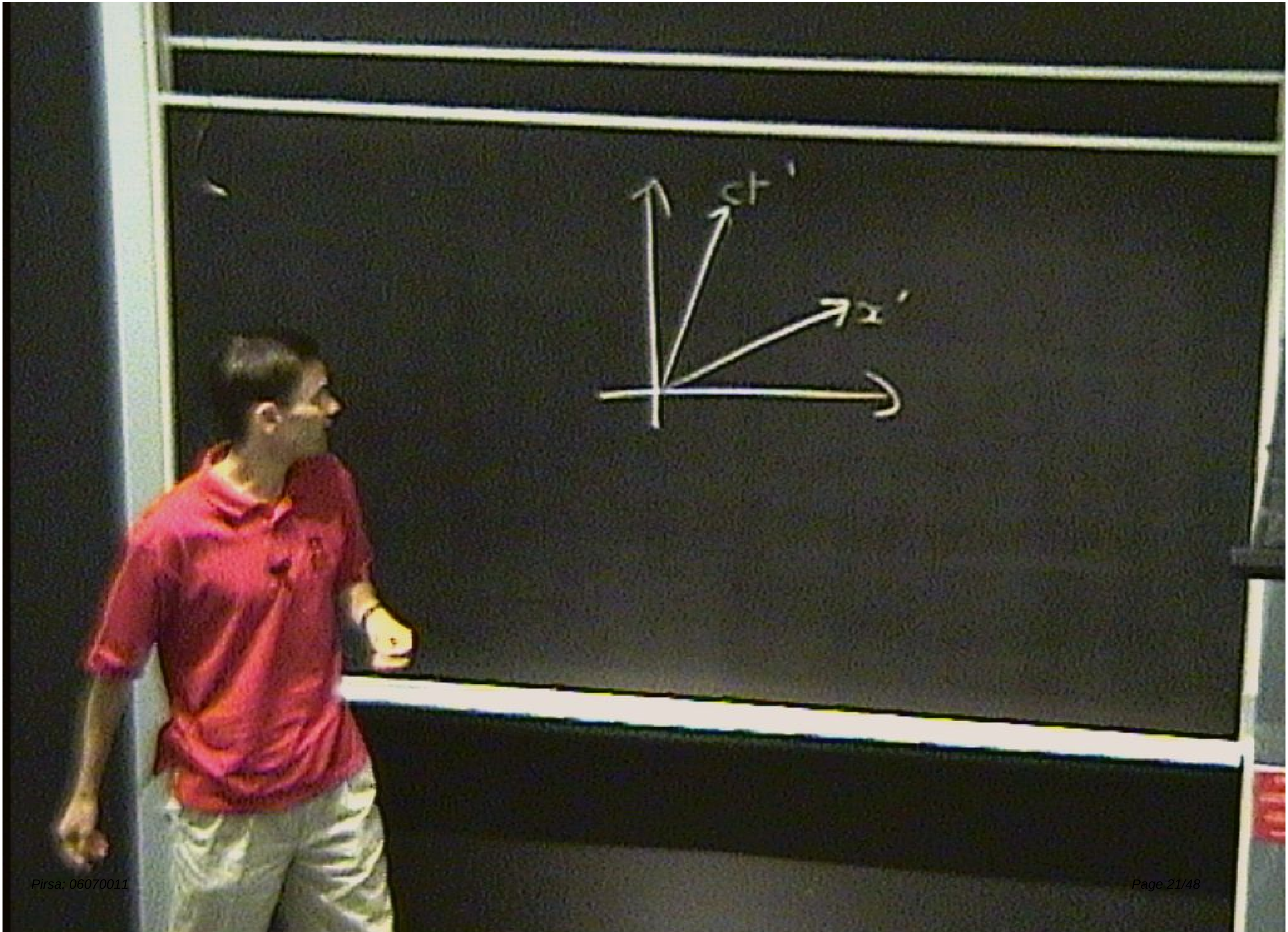


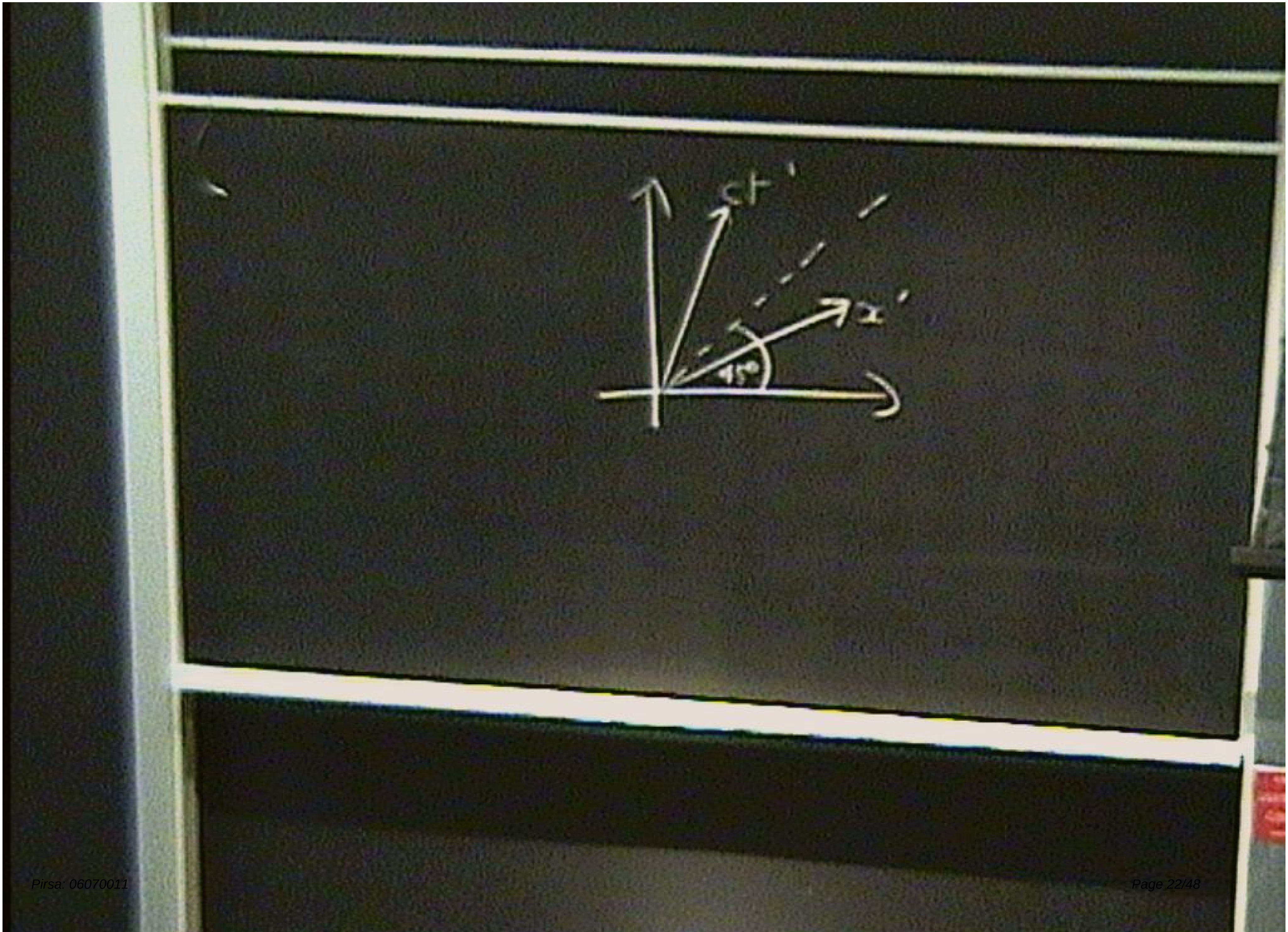
- A and B are the events corresponding to a photon hitting the bottom mirror on two successive occasions.

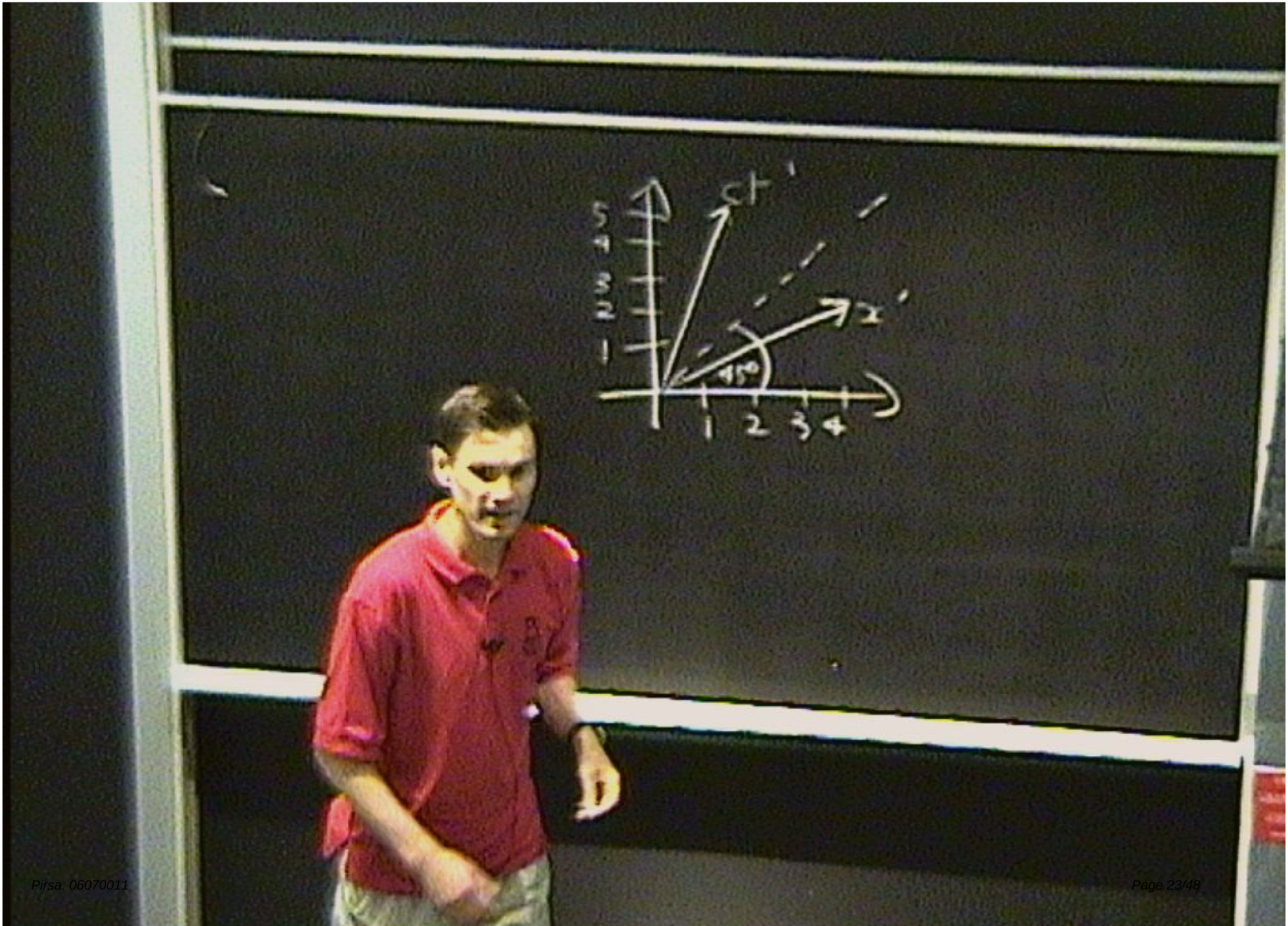
$$\Delta t = 2L / c$$

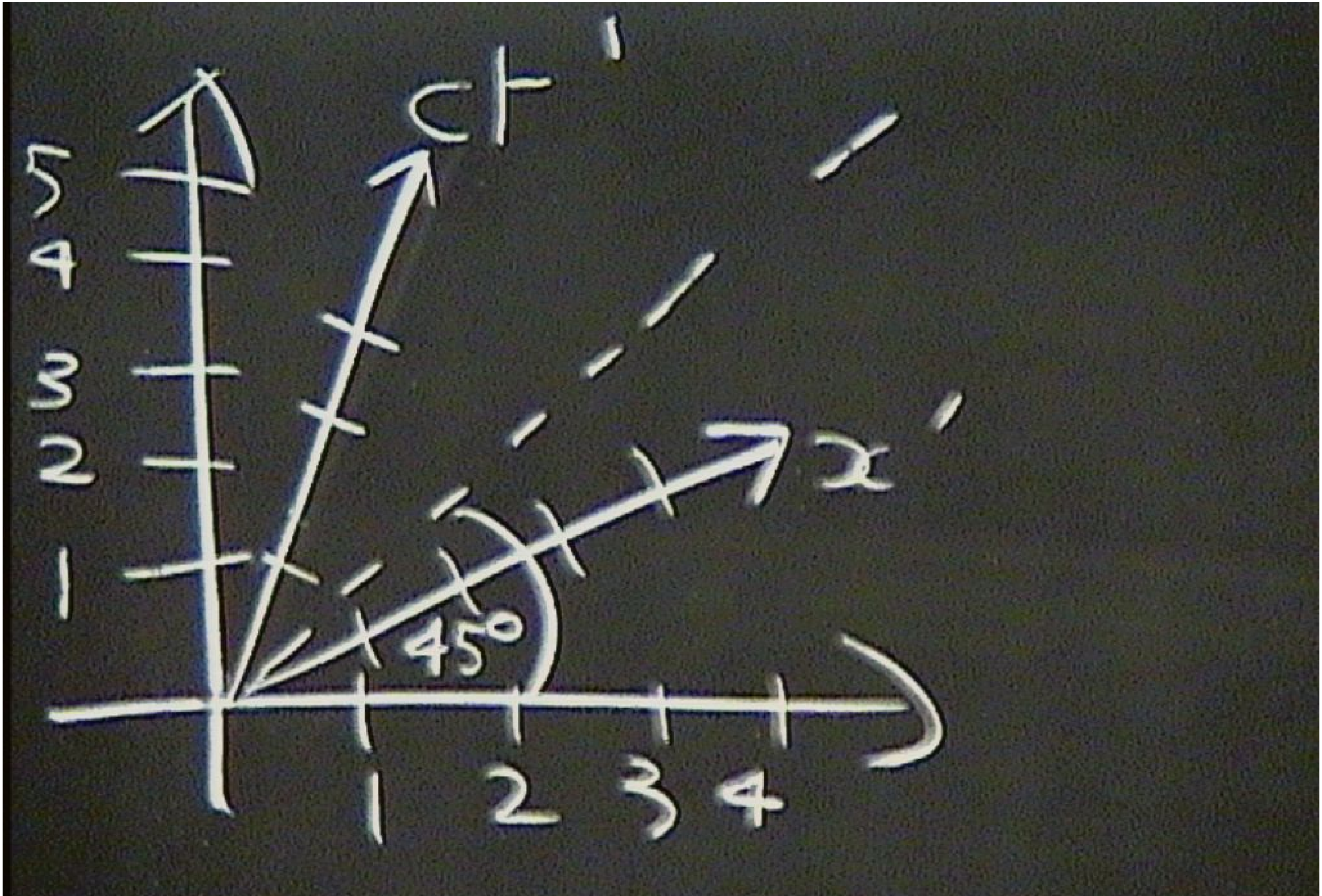
$$\Delta t' = \frac{\text{distance}}{\text{speed}} = \frac{2\sqrt{L^2 + \left(\frac{d}{2}\right)^2}}{c}$$

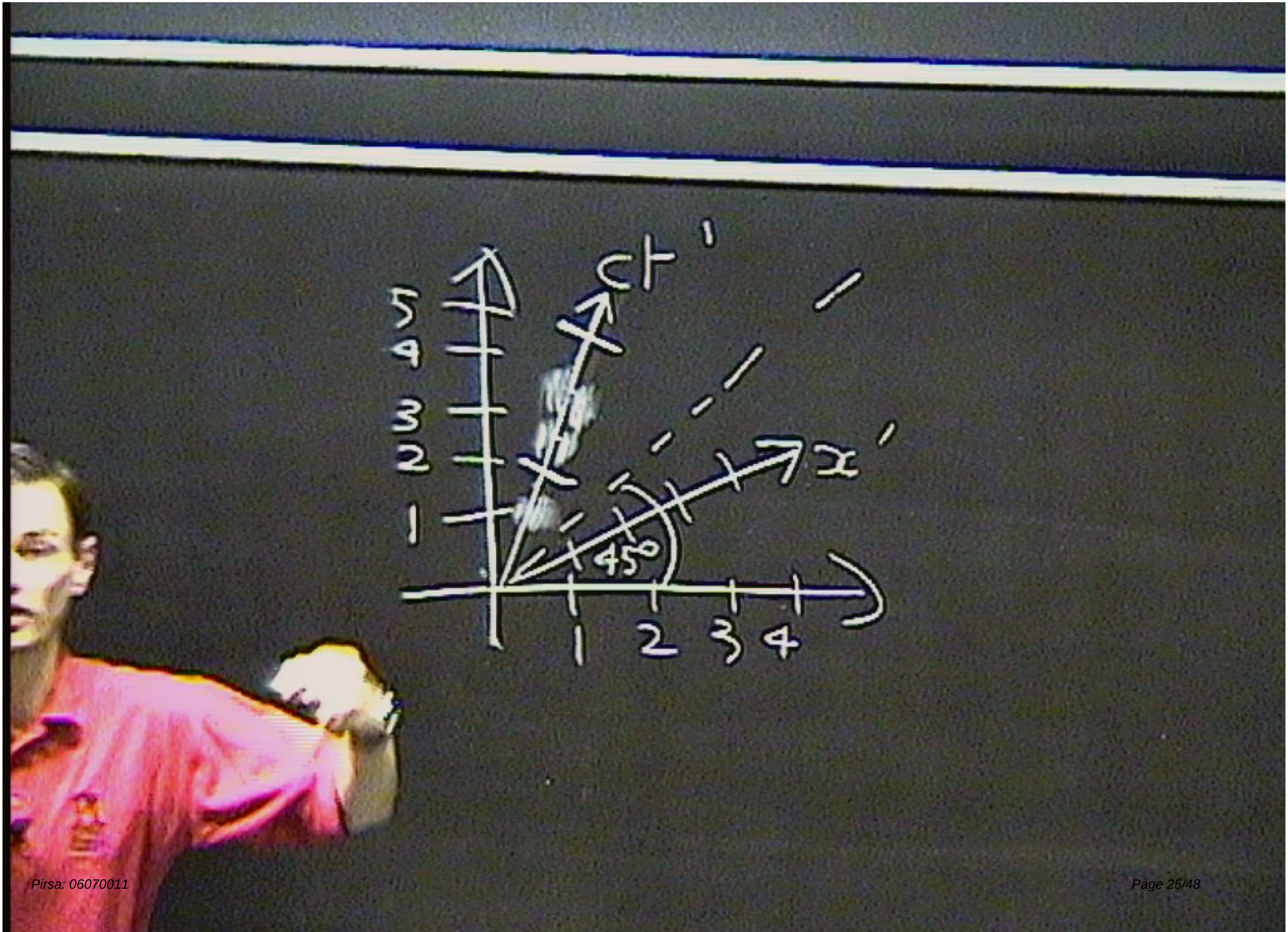
$$d = vt'$$

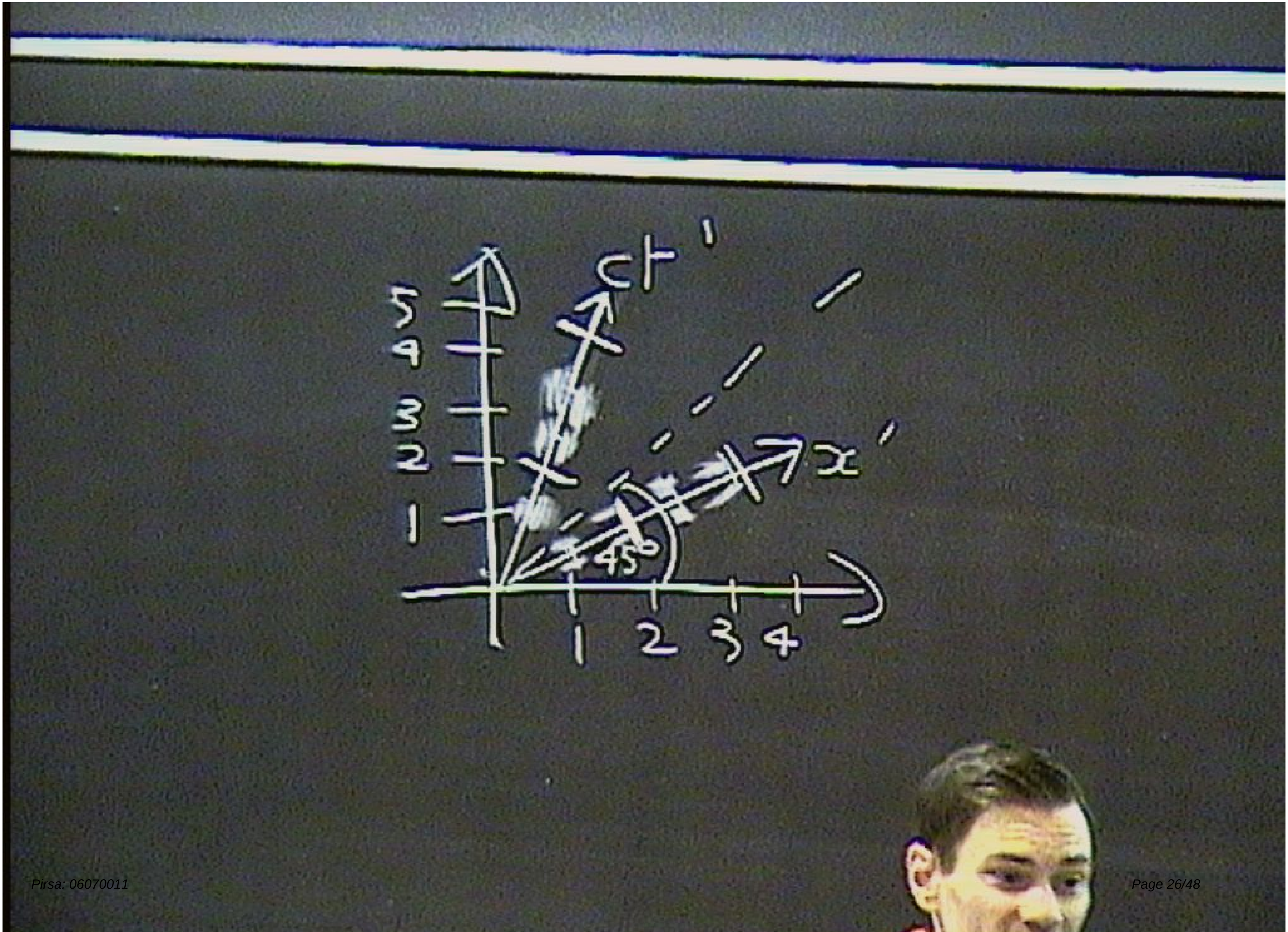

ct'
x'


ct'
x'
45°

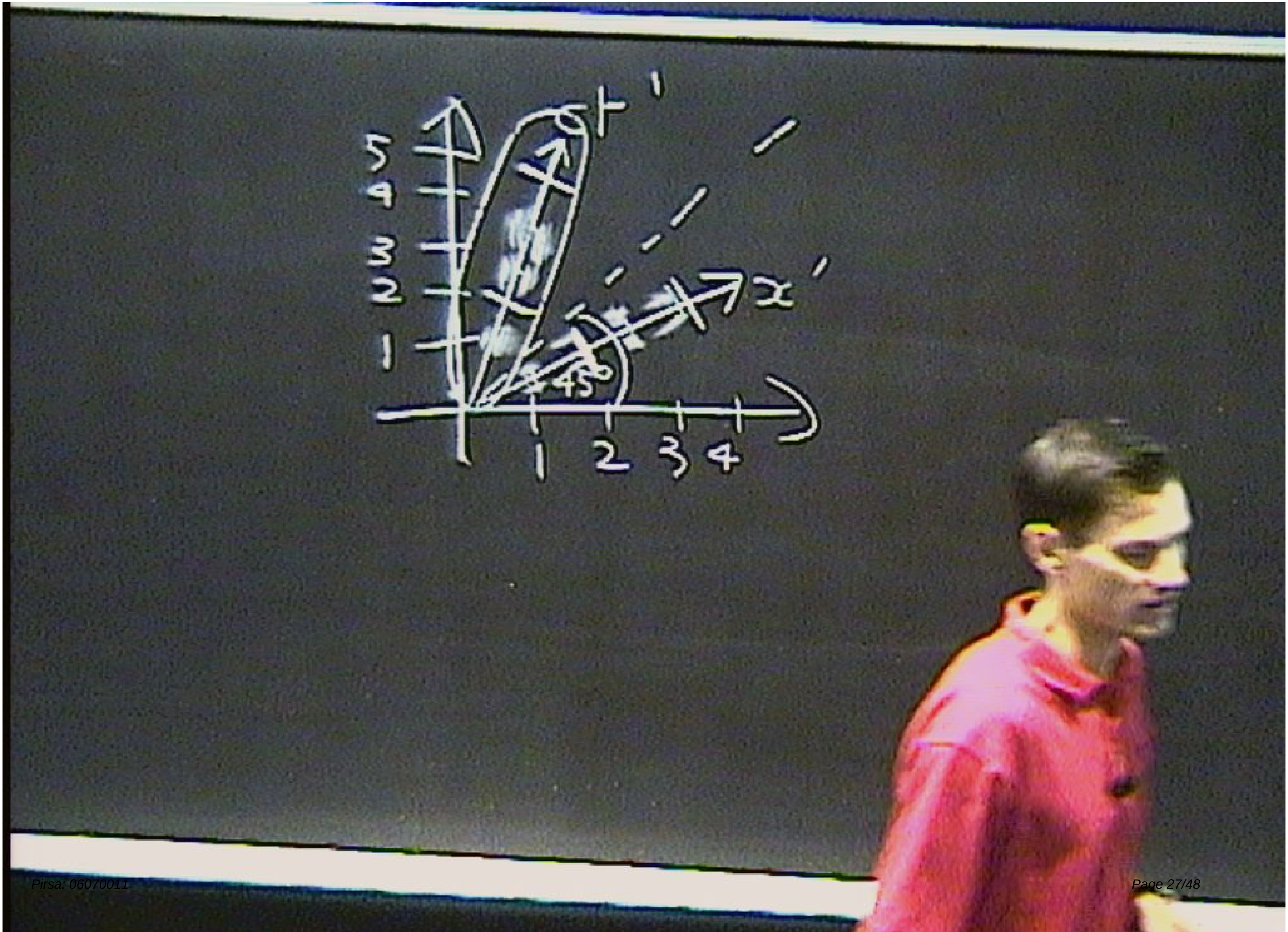

ct'
x'
45°
5
4
3
2
1
1 2 3 4


ct'
x'
45°
1
2
3
4
5
1
2
3
4


ct'
x'
45°
1
2
3
4
5
1
2
3
4

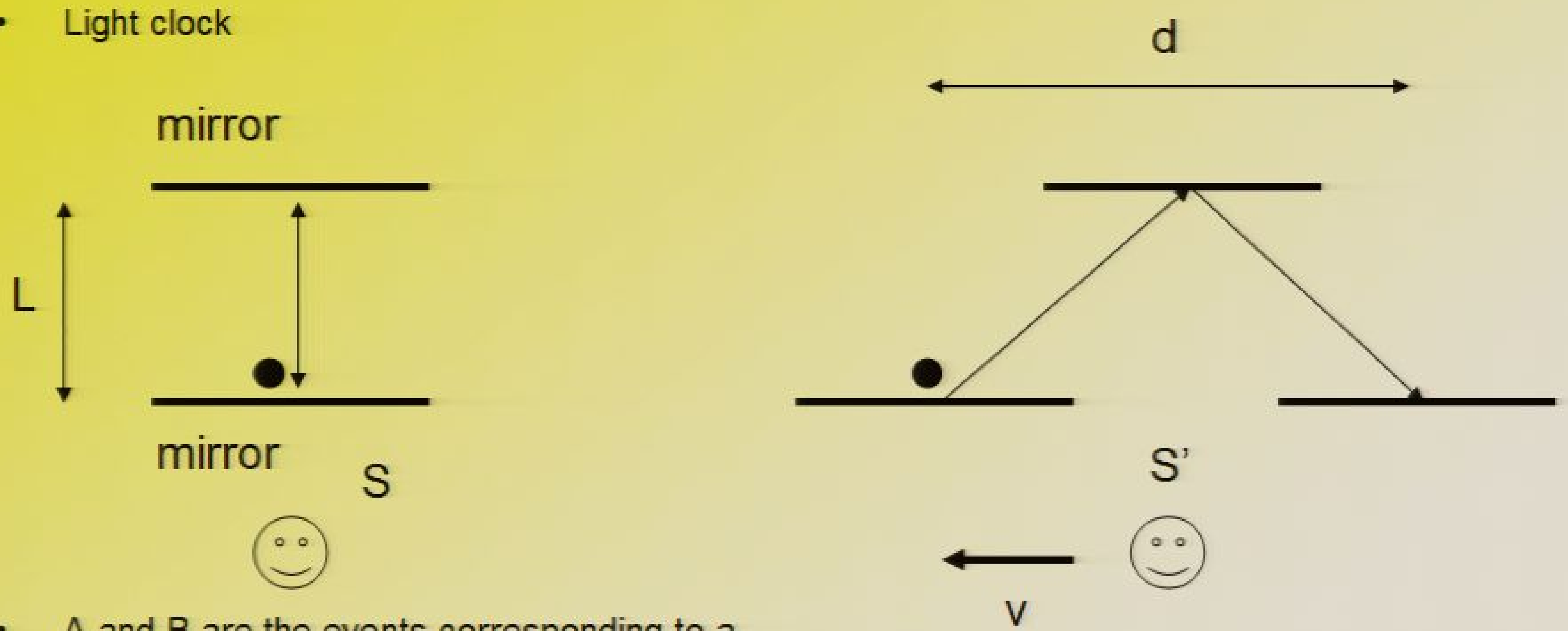


ct'
x'
45°
1
2
3
4
5


t'
x'
5
4
3
2
1
1 2 3 4
45°

Time dilation

- Light clock



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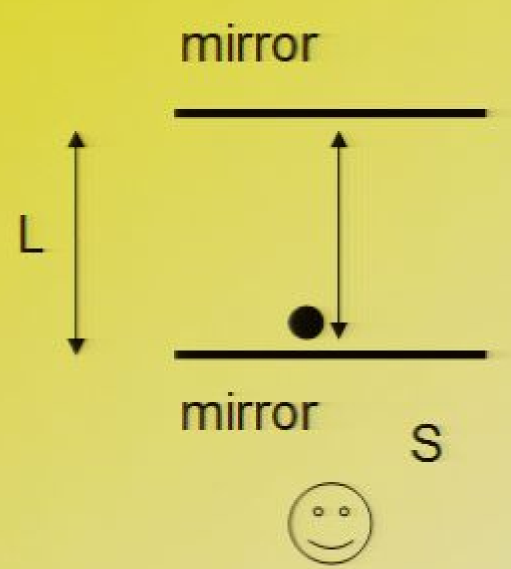

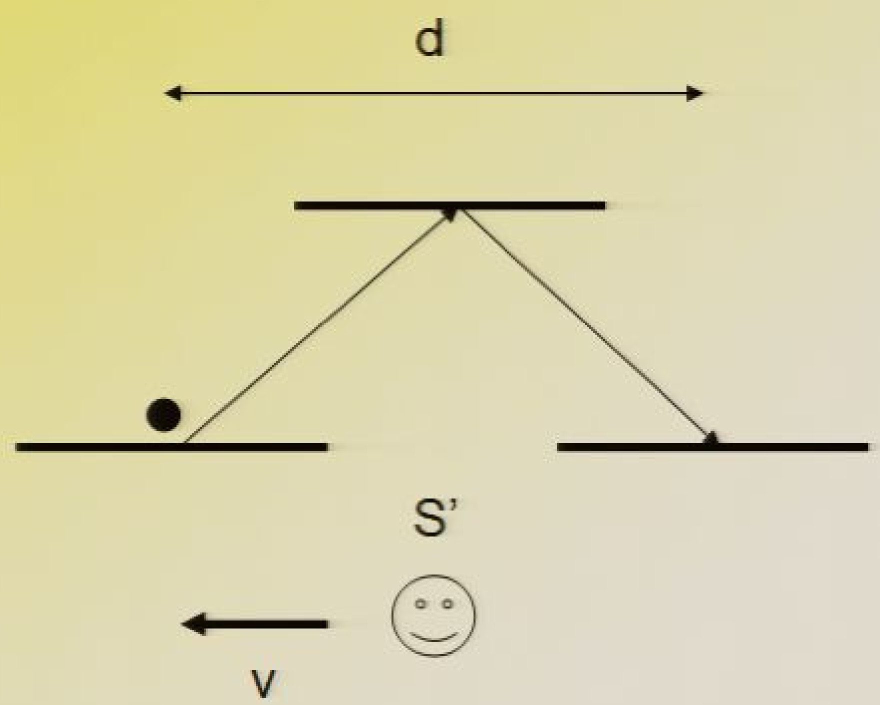

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$$(c\Delta t')^2 = 4(L^2 + ((v\Delta t')^2 / 4))$$

$$\therefore 4L^2 = \Delta t'^2 (c^2 - v^2)$$

But $(c\Delta t)^2 = 4L^2$

$$\text{gives } (\Delta t' / \Delta t)^2 = c^2 / (c^2 - v^2)$$

$$\therefore \Delta t' / \Delta t = 1 / \sqrt{1 - (v / c)^2}$$

$$\therefore \Delta t' = \gamma \Delta t$$

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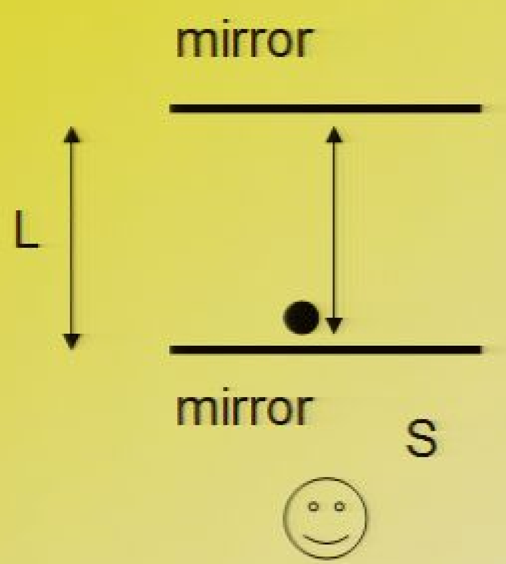

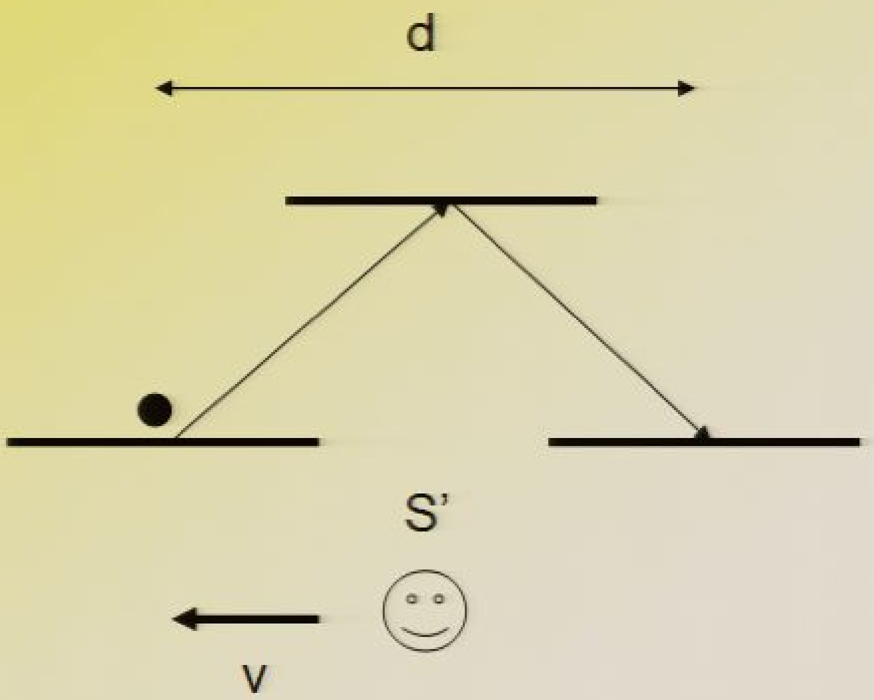

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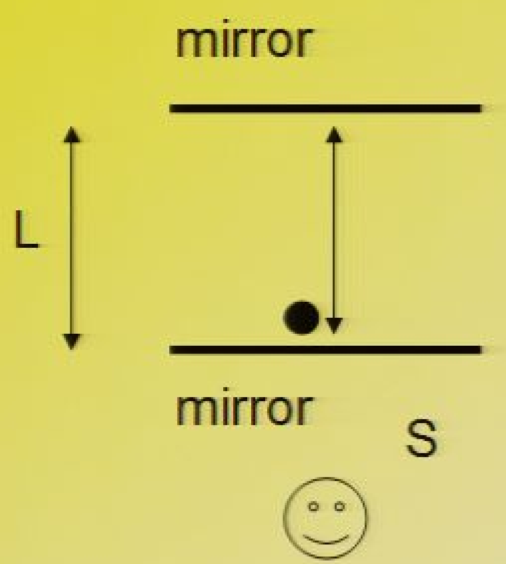

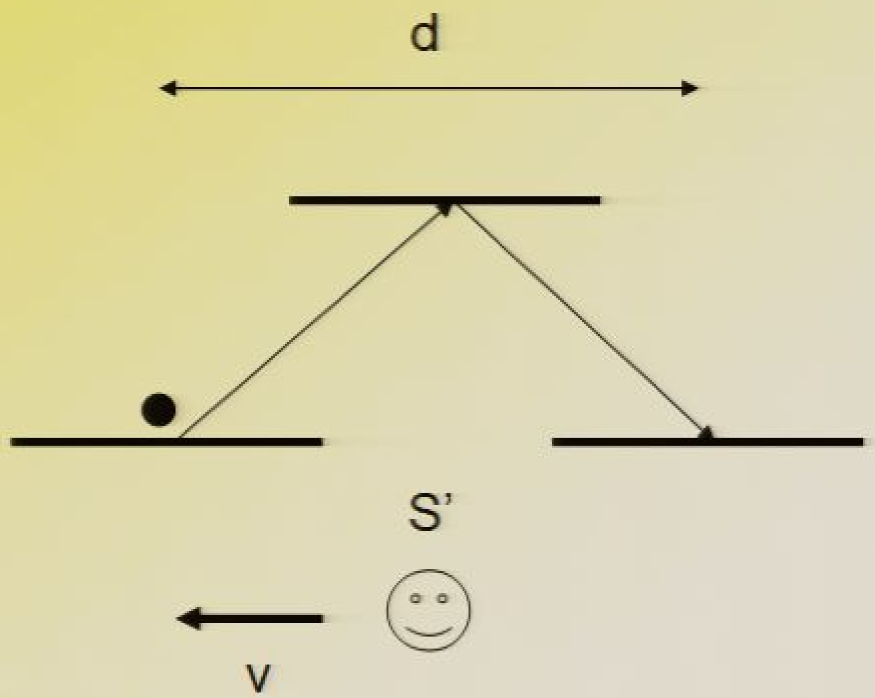

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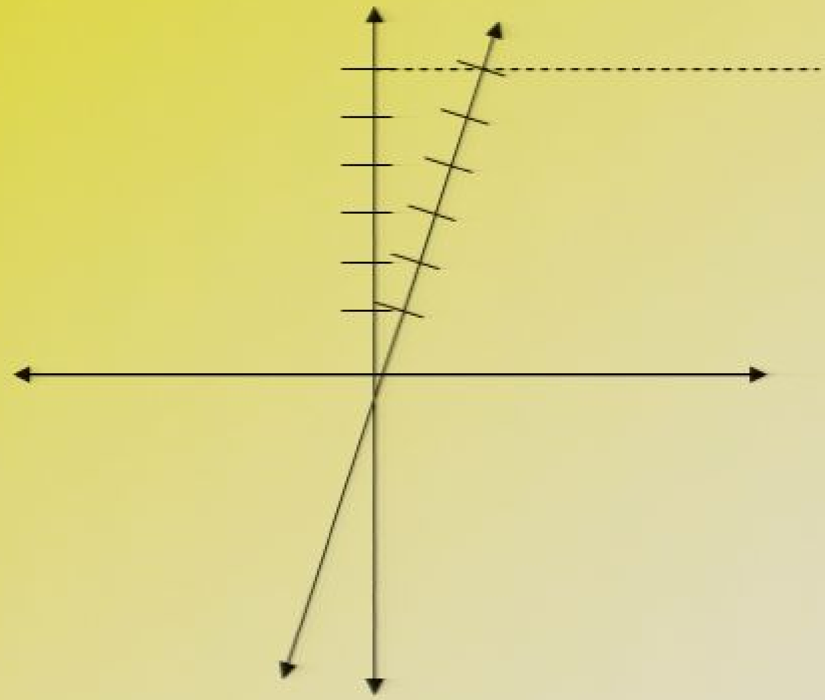
Scales on time and x axes

- ct' axis: Due to time dilation, it must be stretched out.



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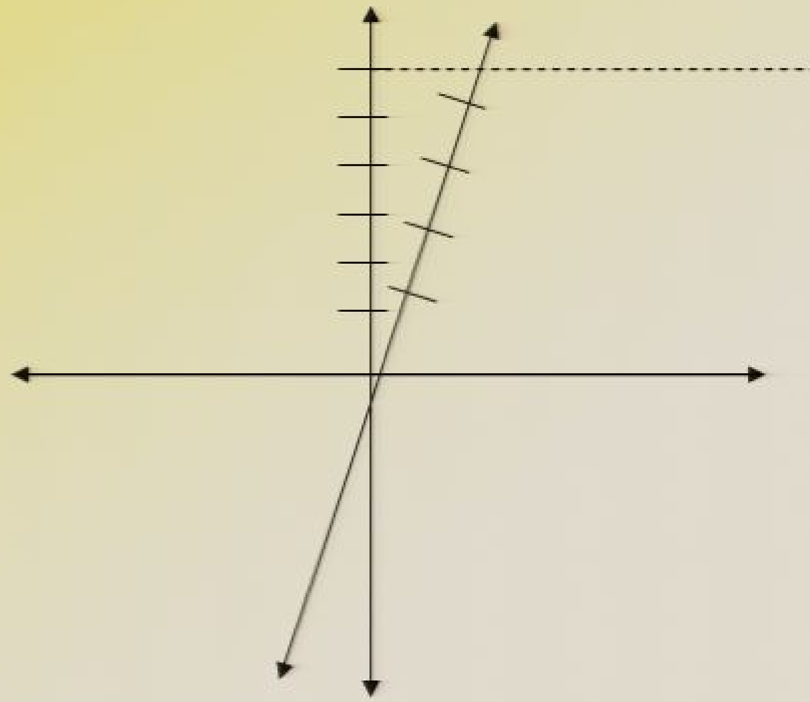
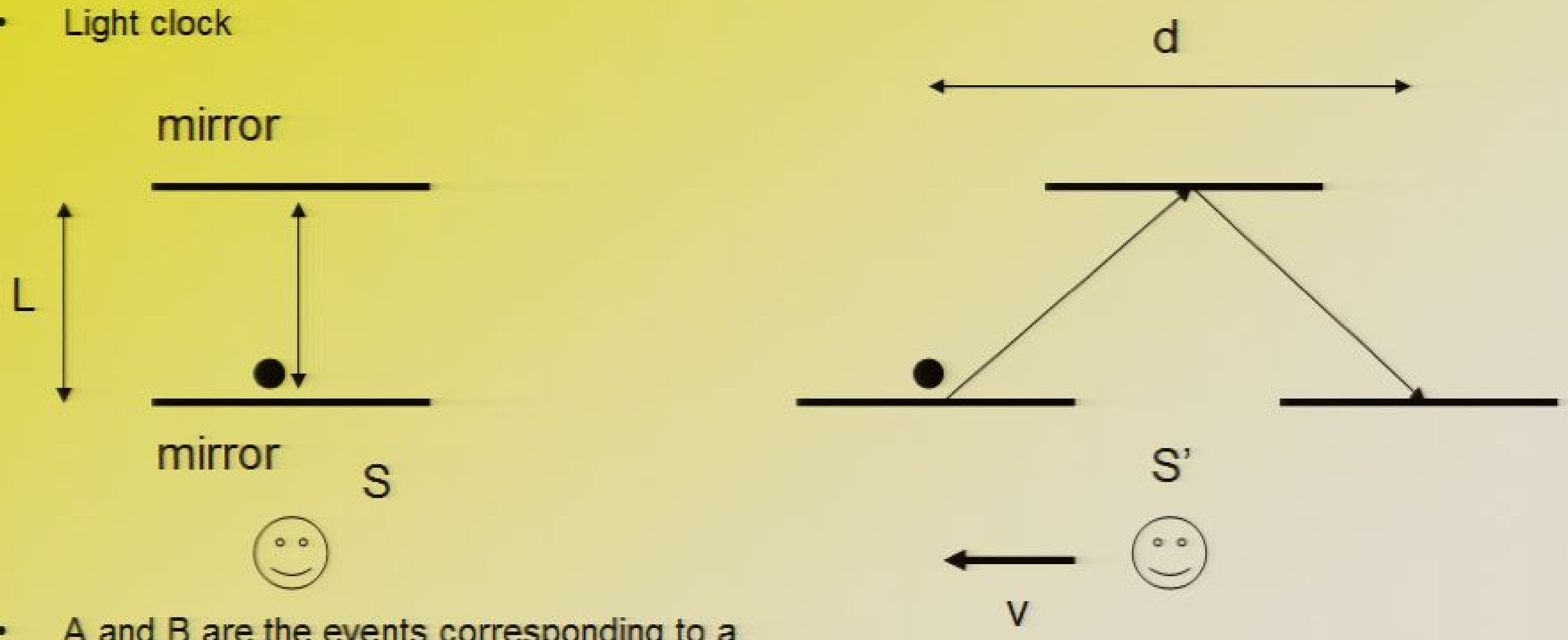


right

Time dilation

- Light clock



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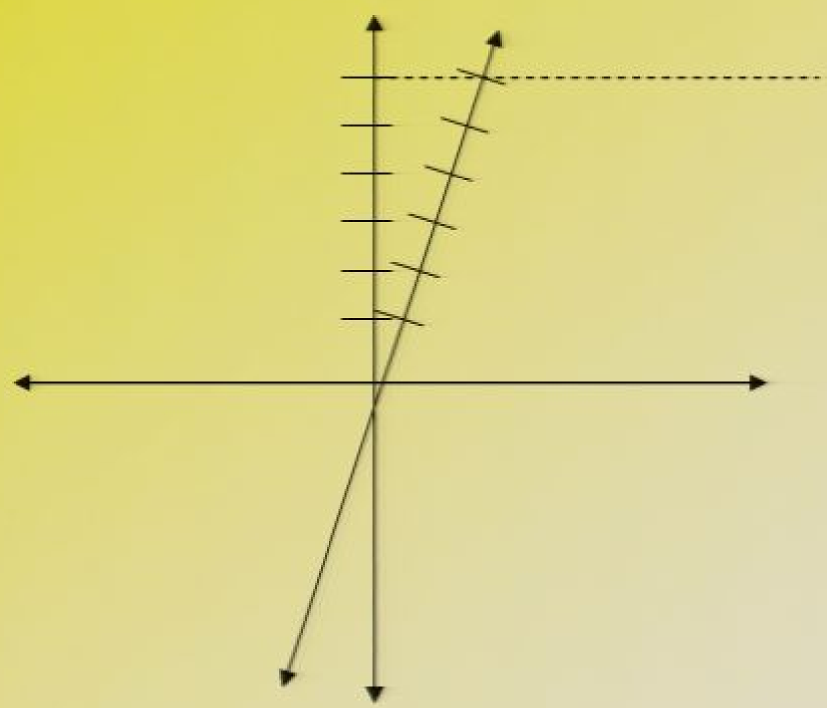

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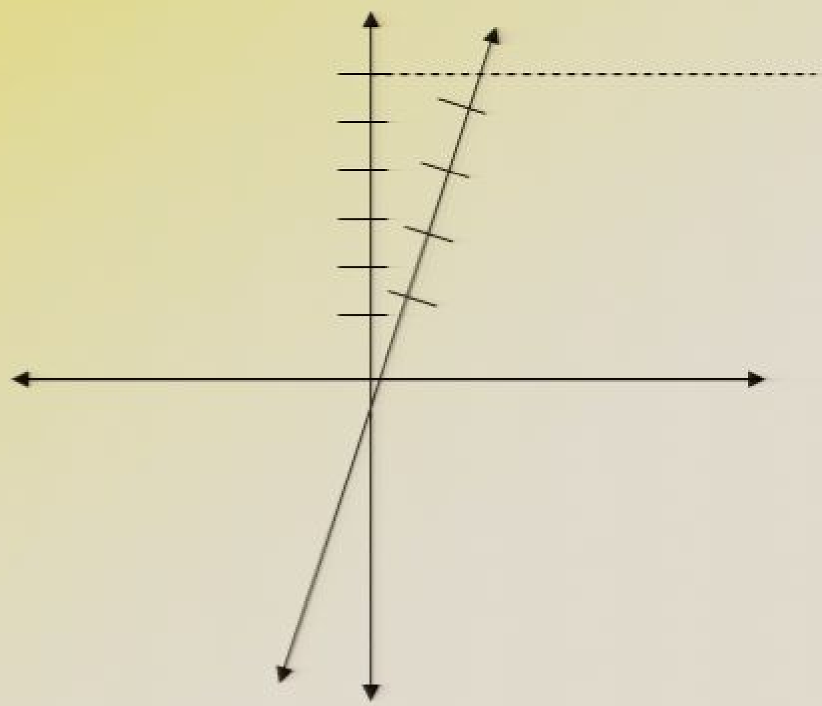
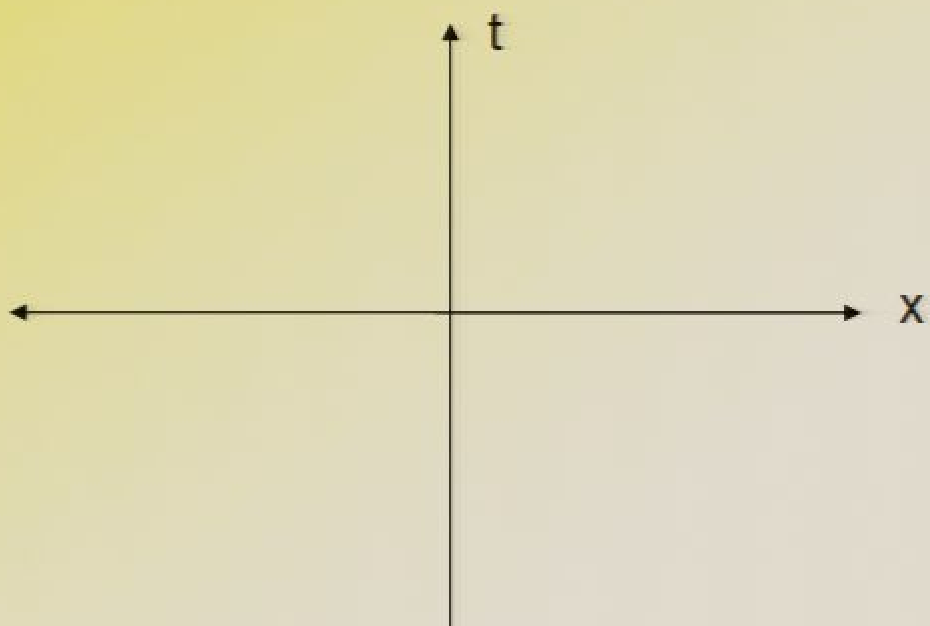


right

Time dilation

- Consider a black spaceship travelling at 0.5c past the earth. At one point, the Klingon on it starts typing into her computer (event A). Some time later, she is finished (event B).

- Assuming A happens in the spaceship's frame time t=0 and x=0 and B at t=T, plot A and B on the spacetime diagram below:



time dilation

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$$\therefore 4L^2 = \Delta t'^2(c^2 - v^2)$$

But $(c\Delta t)^2 = 4L^2$

gives $(\Delta t'/\Delta t)^2 = c^2/(c^2 - v^2)$

$$\therefore \Delta t'/\Delta t = 1/\sqrt{1-(v/c)^2}$$

$$\therefore \Delta t' = \gamma\Delta t$$

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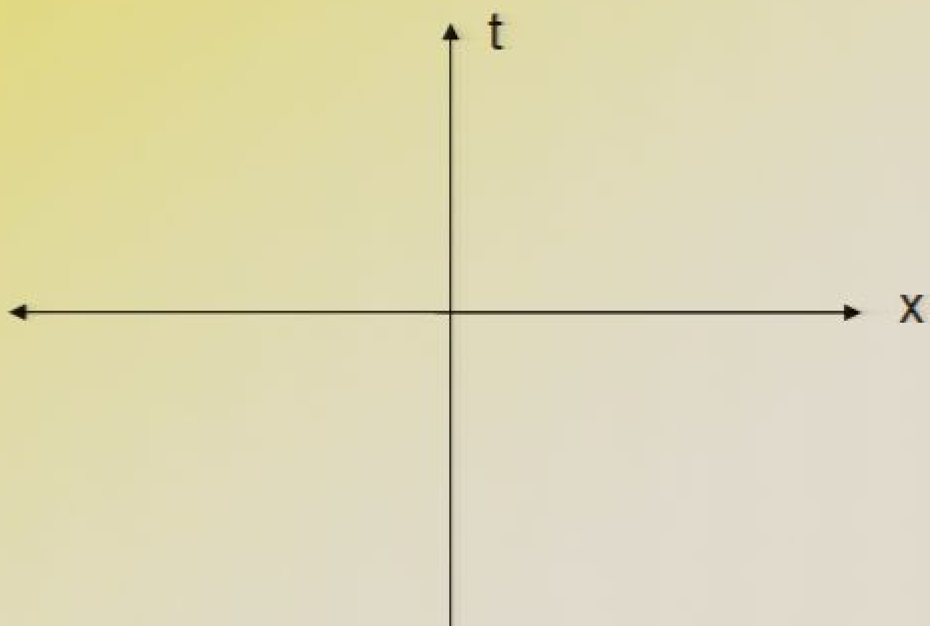
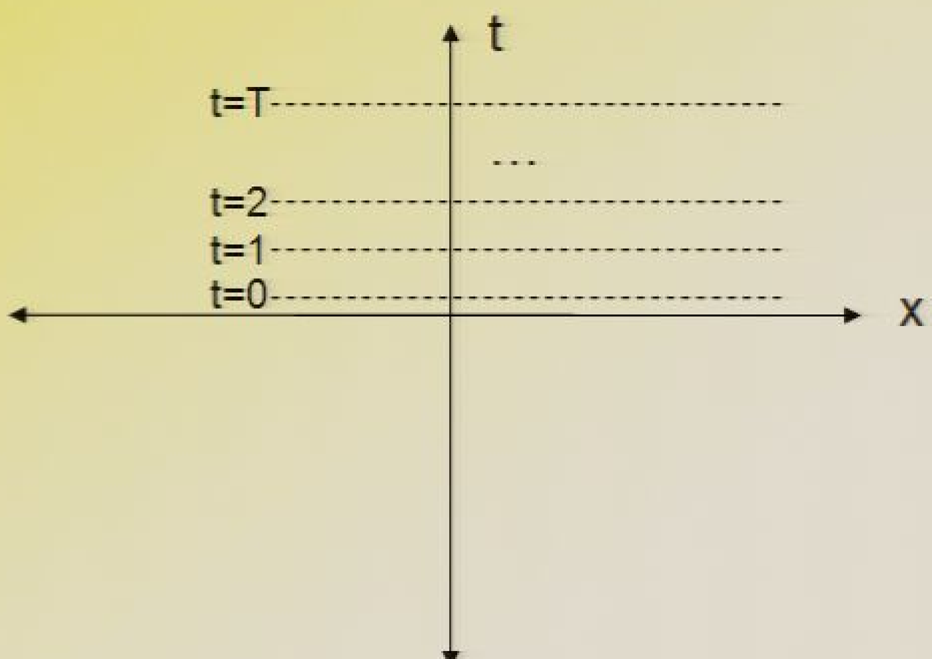
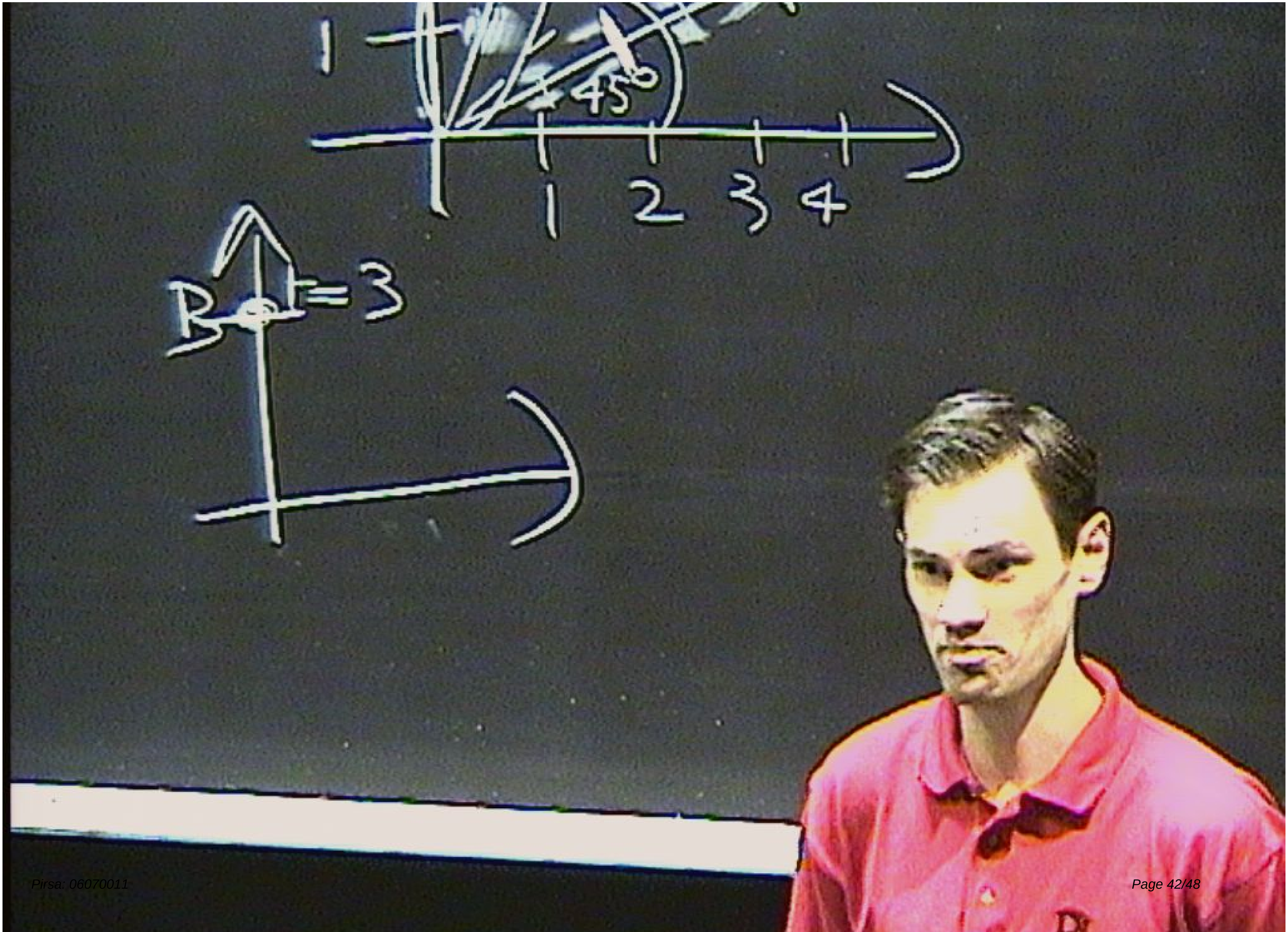
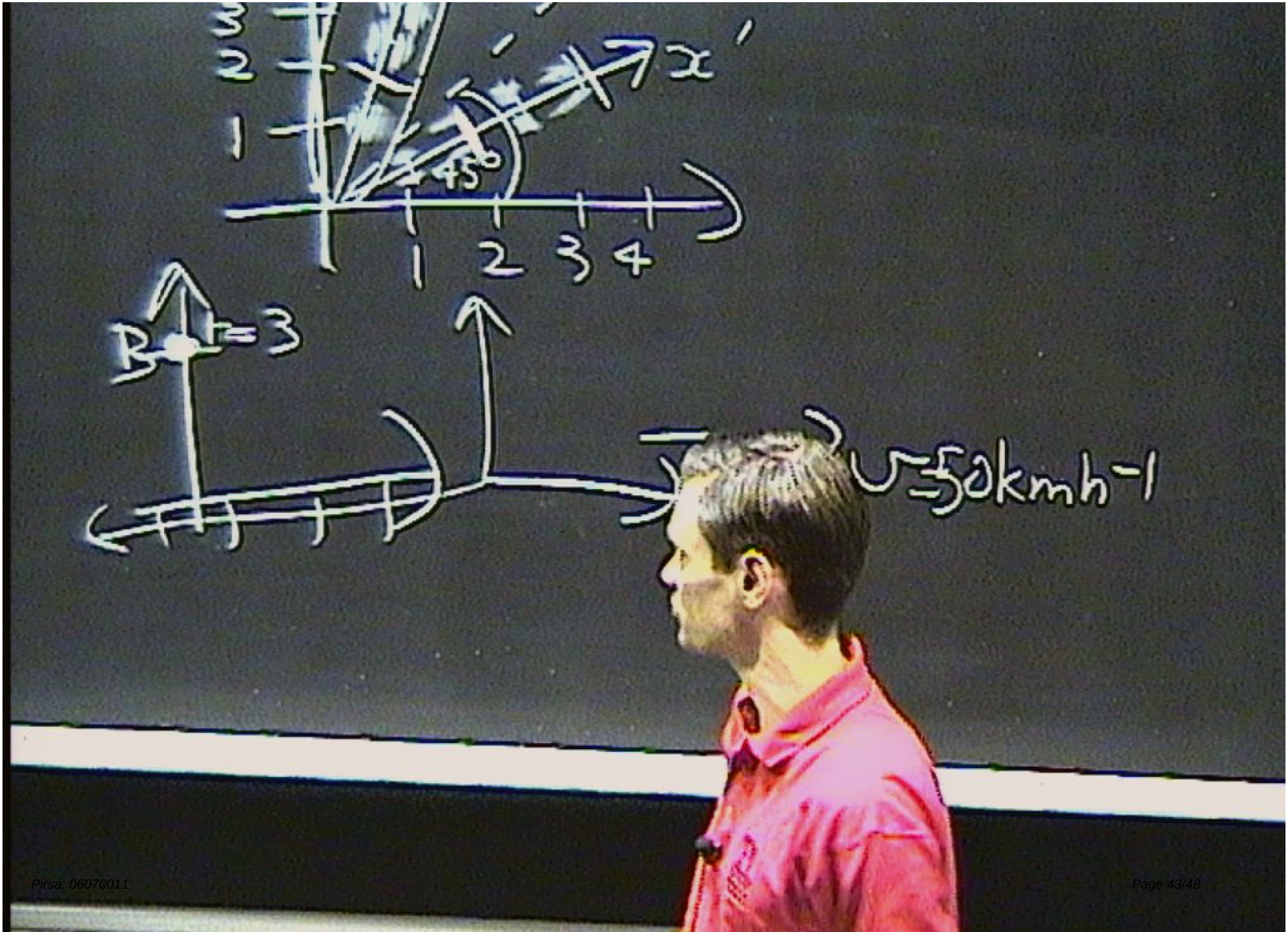


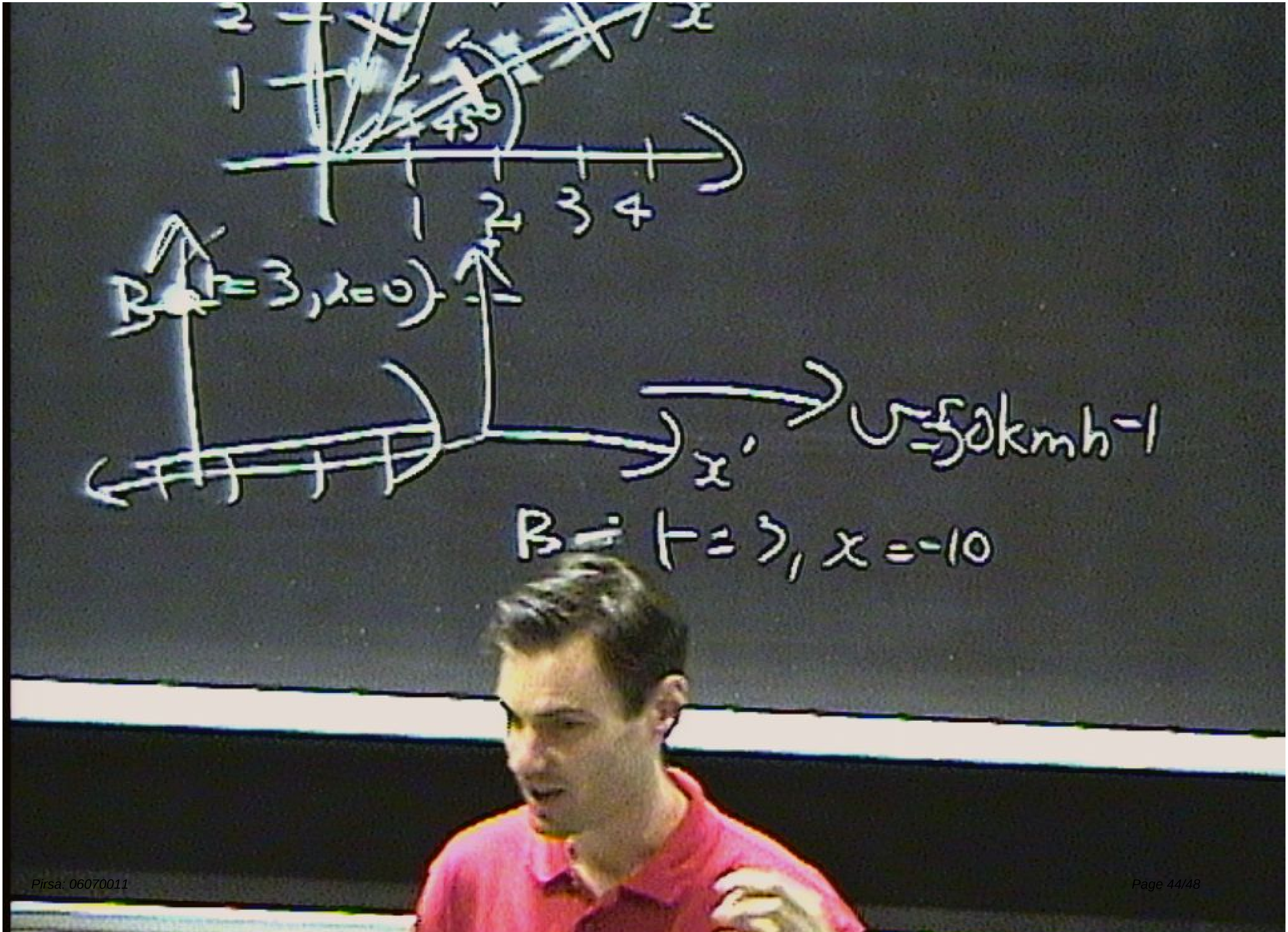
- If we did not know that $\Delta t_S = T$, then we could determine it from the graph through the following procedure:

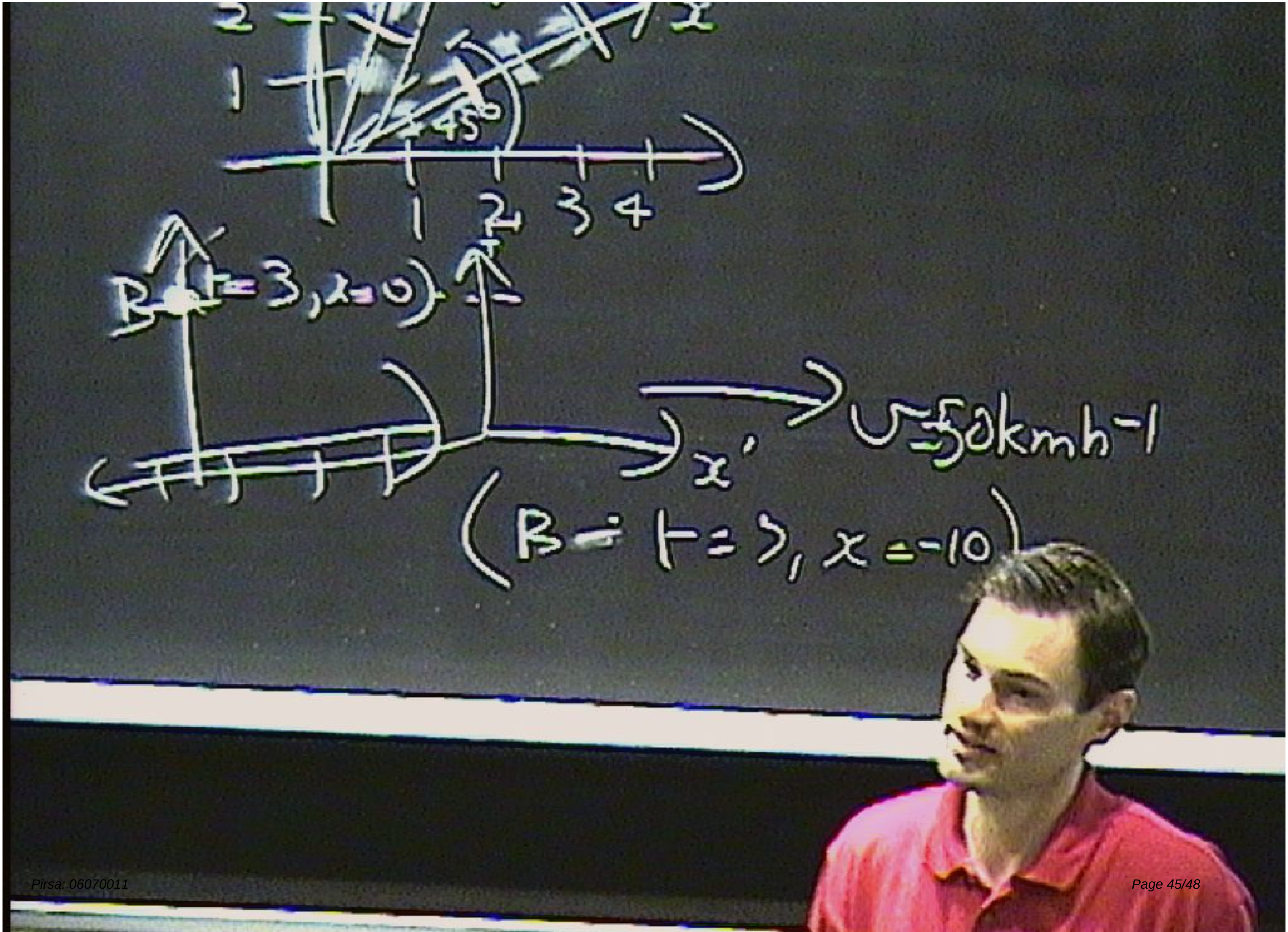
- Start at A and draw a line of constant time (t=0). Continue to draw lines of constant time (t=1,2,3…) — these are parallel to the x axis — until we draw one that intersects with B. The time for this line is T.

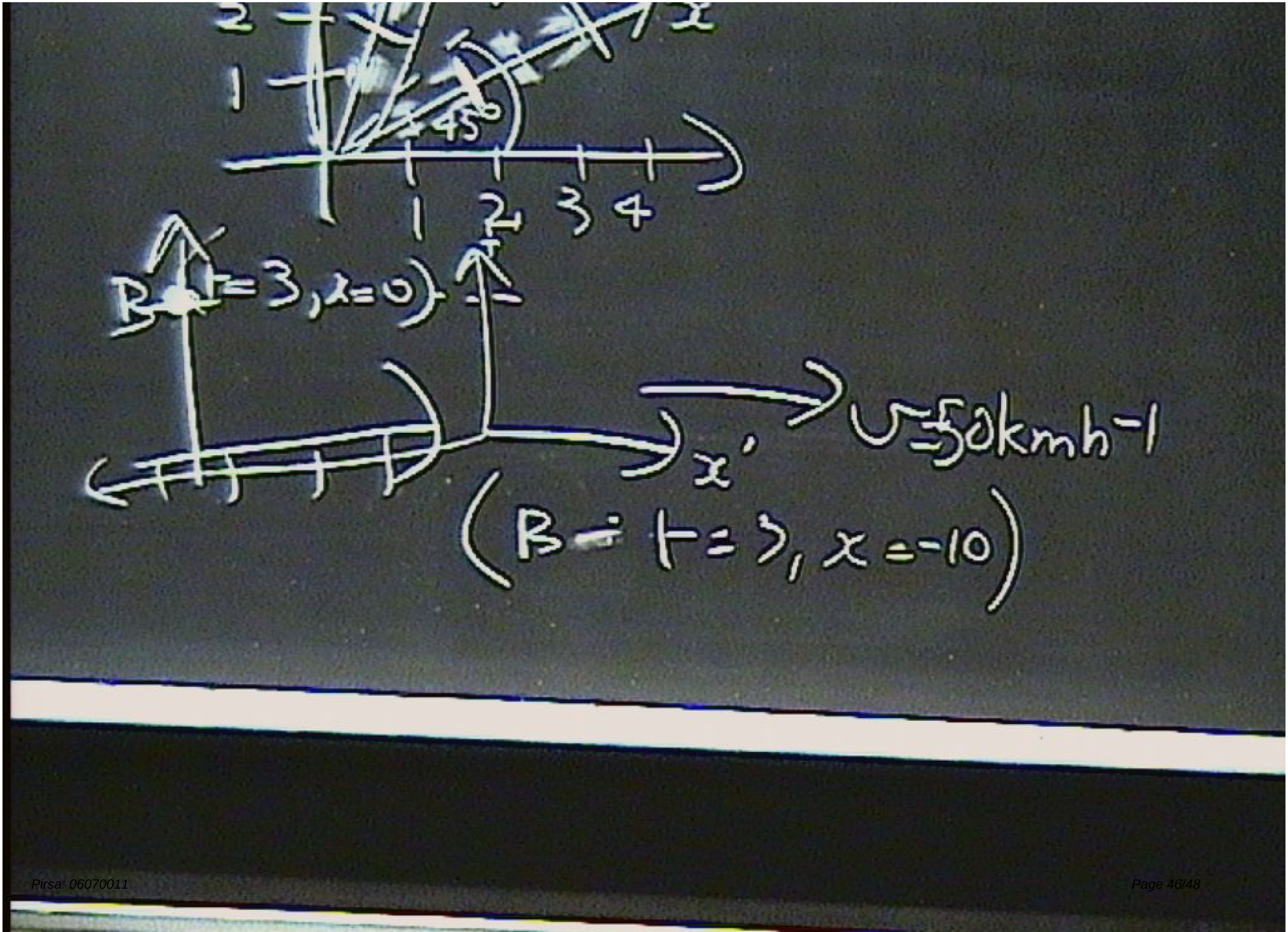



1
45°
1 2 3 4
t=3


x'
45°
1 2 3 4
B
t=3
v=50kmh-1

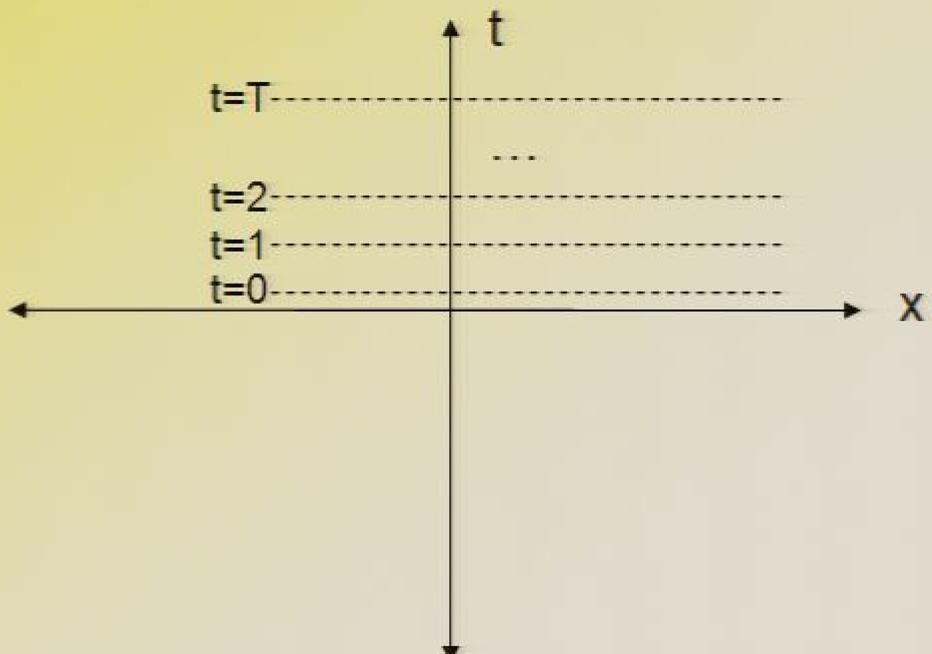

45°
1 2 3 4
B : (t=3, x=0)
x'
v=50kmh-1
B : t=3, x=-10


45°
1 2 3 4
B (t=3, x=0)
x'
v=50kmh-1
(B : t=3, x=-10)


45°
1 2 3 4
B (t=3, x=0)
x'
v=50kmh-1
(B : t=3, x=-10)

- If we did not know that Δt_S=T, then we could determine it from the graph through the following procedure:

- Start at A and draw a line of constant time (t=0). Continue to draw lines of constant time (t=1,2,3…) — these are parallel to the x axis — until we draw one that intersects with B. The time for this line is T.



- To determine the time interval between A and B as measured in Earth's reference frame E. Let us follow an analogous procedure.
- 1. The x' axis corresponds to the line t'=0 and so it is the first line.
- 2. Draw another line parallel to the first that corresponds to t'=1. i.e. one unit of time upwards.
- 3. Continue this procedure until you draw a line that intersects B.