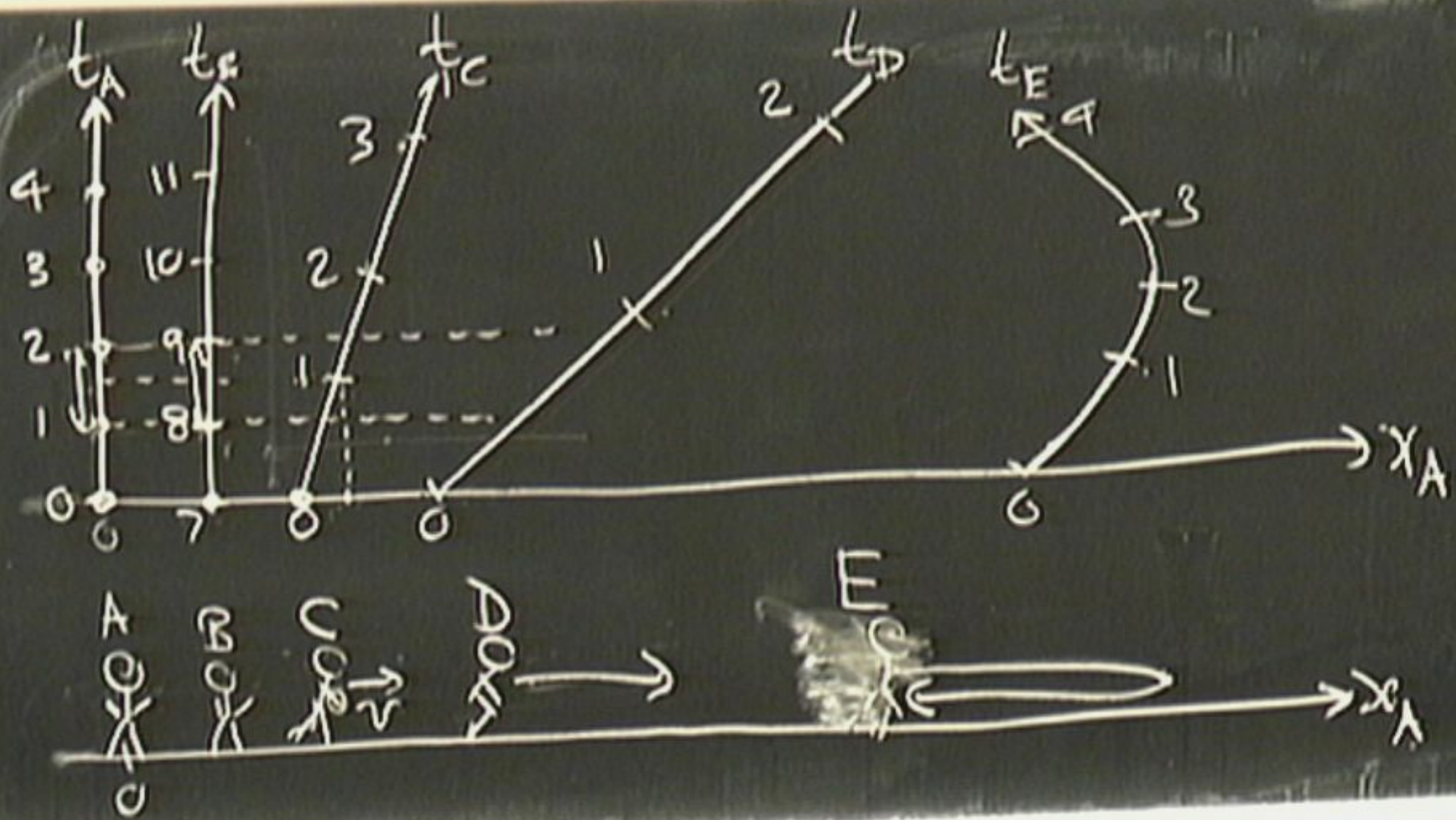


Title: Special Relativity 2 - Spacetime Diagrams for Sound Travelling in Air

Date: Aug 10, 2008 09:00 AM

URL: <http://pirsa.org/08080061>

Abstract: Drawing spacetime diagrams of simple thought experiments involving sound in air as a warm up exercise for light in vacuum.  
Learning Outcomes:   
• Deepening our understanding of how to draw and interpret spacetime diagrams.   
• Measuring space and time in the same units – a first step towards unifying space and time into –spacetime.   
• Why, for an observer at rest with respect to still air, the speed of sound is independent of the motion of the source of sound.



# Sound in Air



→  $\lambda_A$

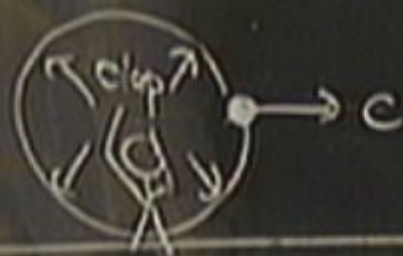


# Sound in Air



→ A

# Sound in Air



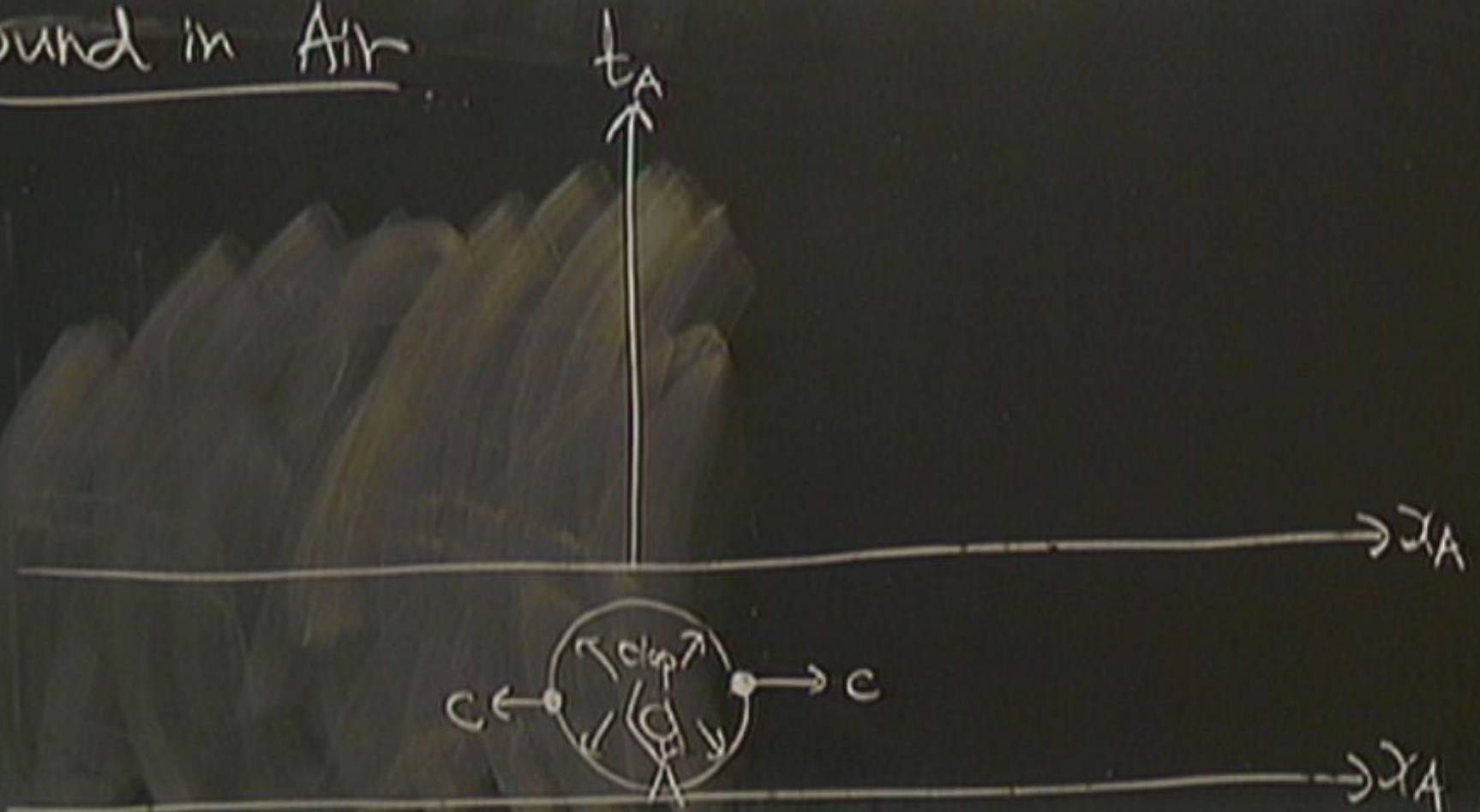
# Sound in Air



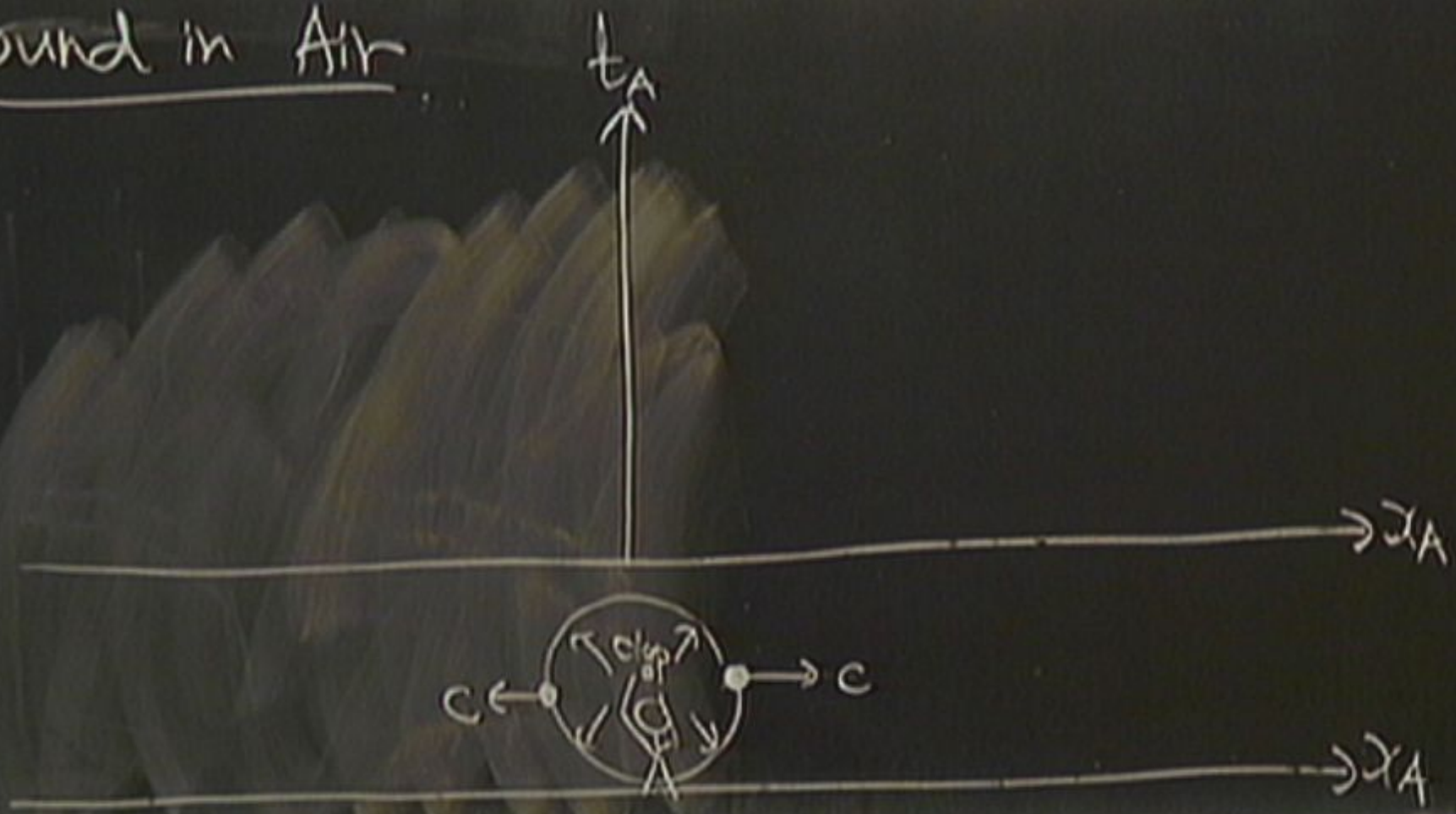
$\lambda_A$



# Sound in Air

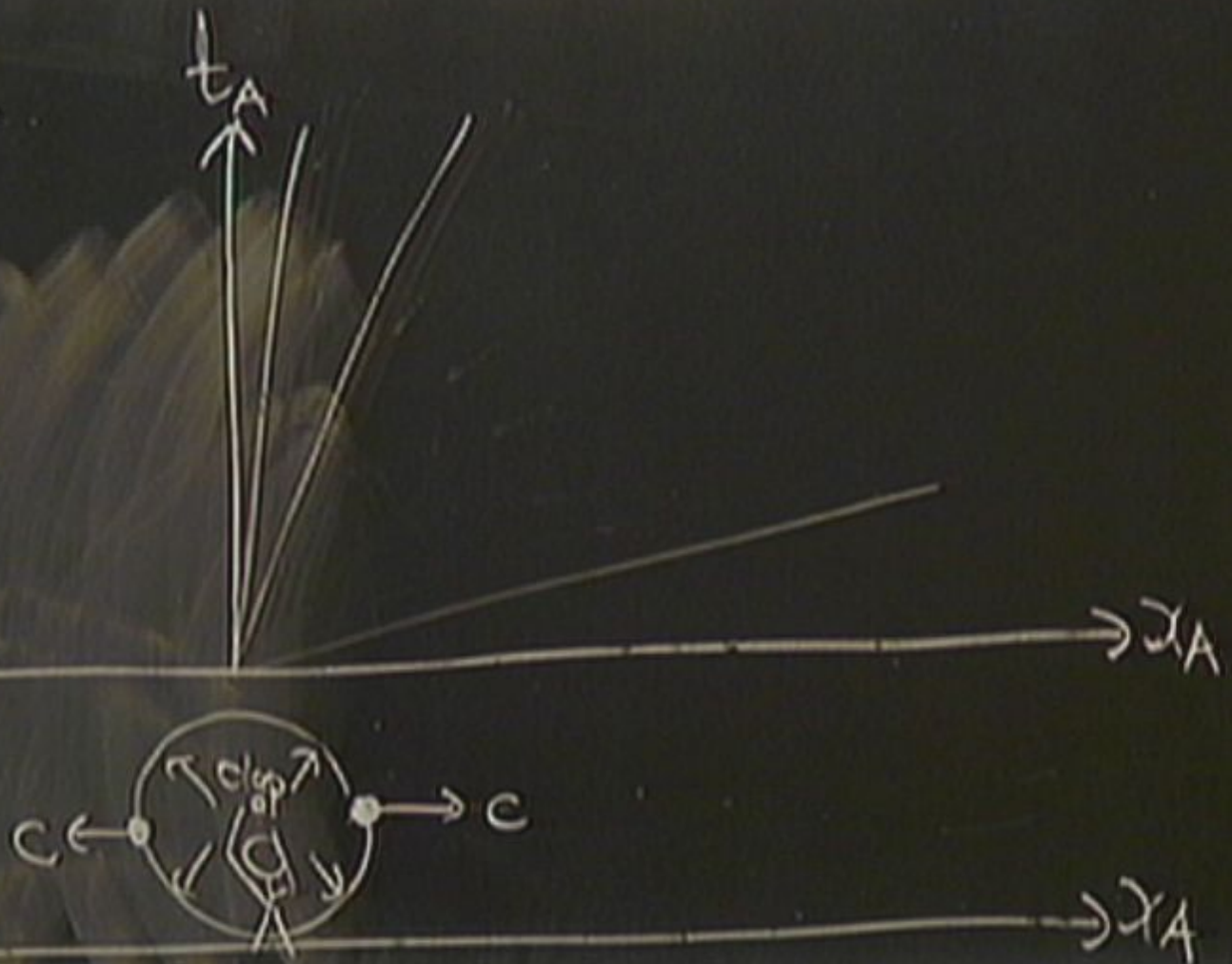


# Sound in Air

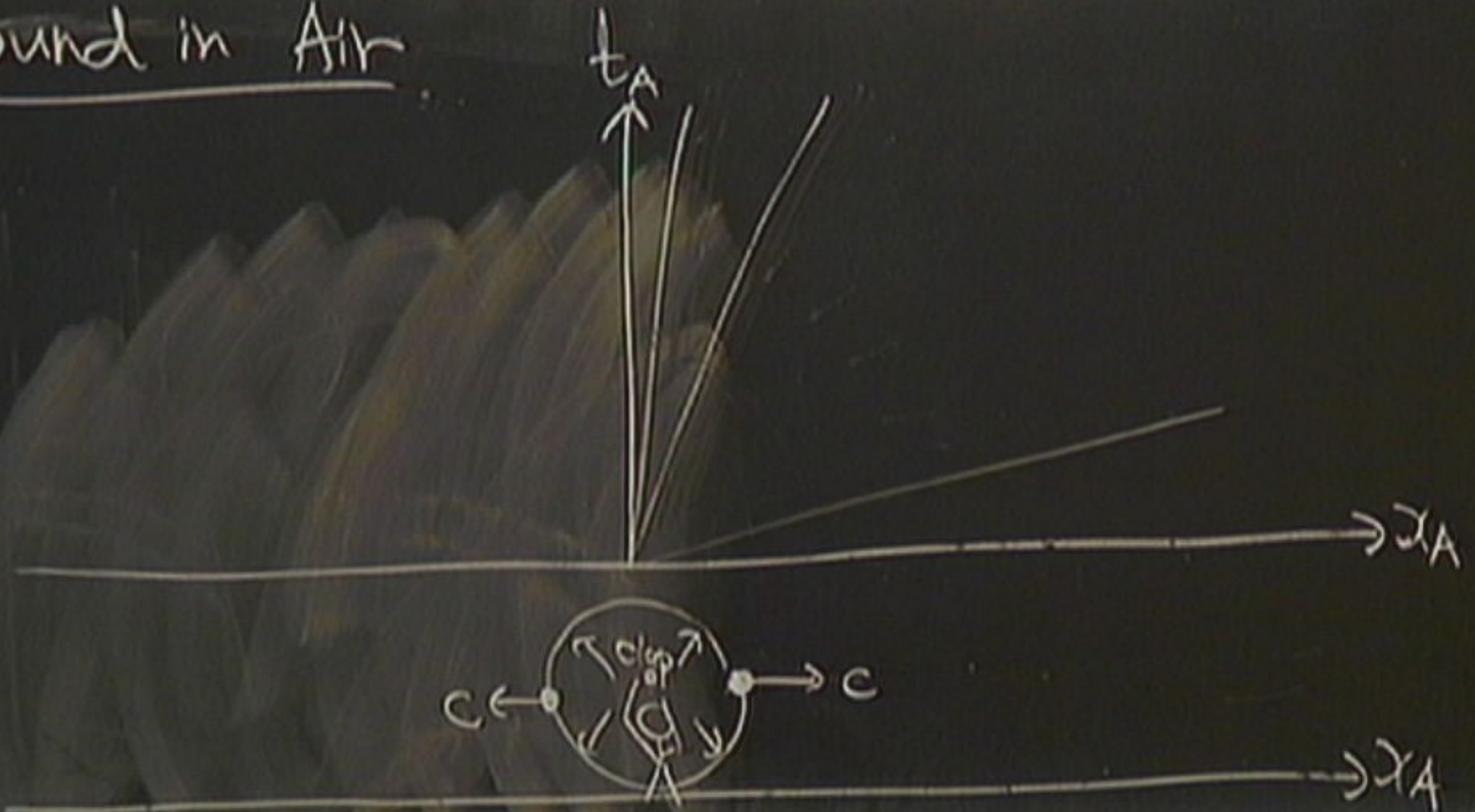




# Sound in Air



# Sound in Air



# Sound in Air

$c_{tA}$

$45^\circ$

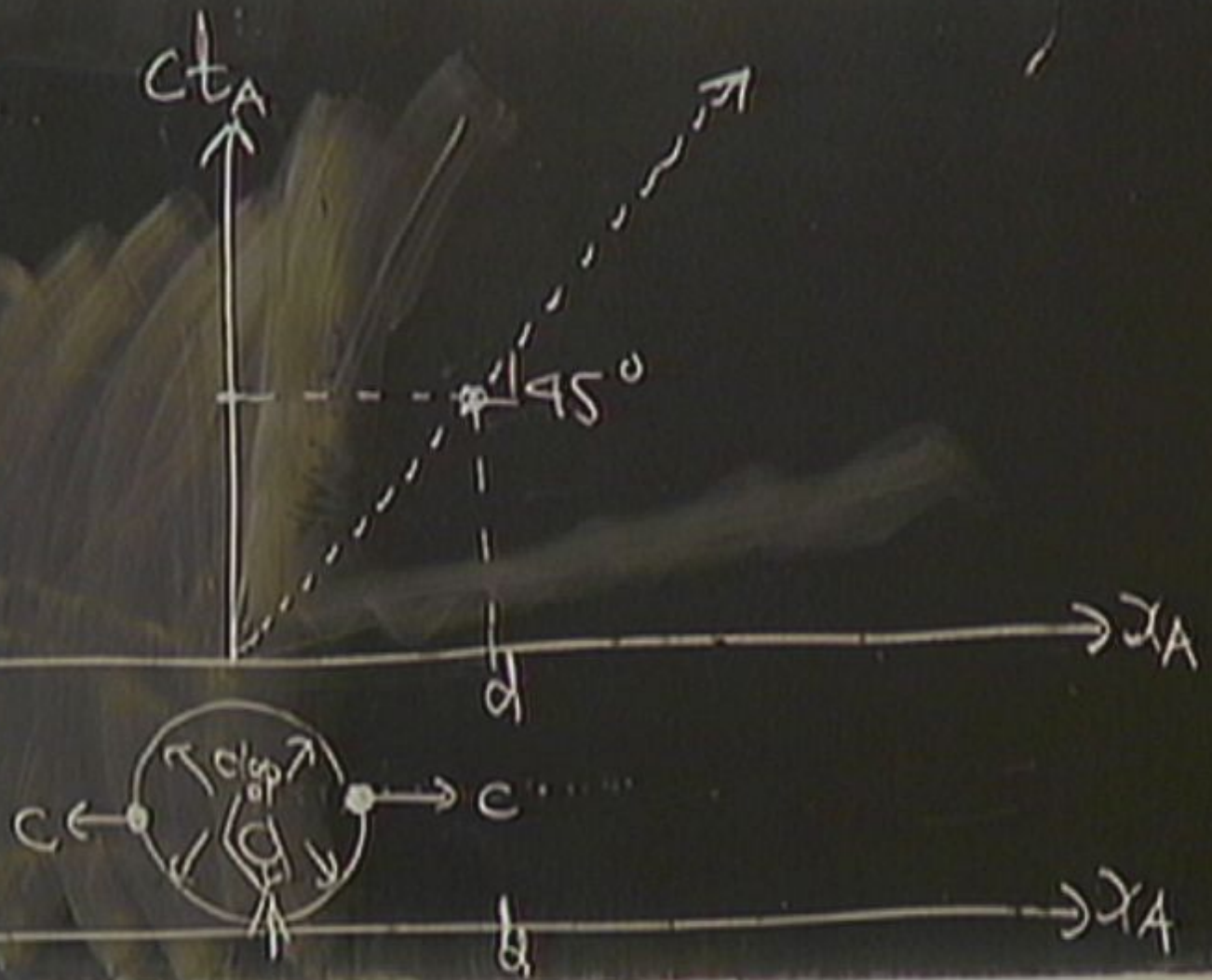
$x_A$



$x_A$



# Sound in Air



# Sound in Air

$t_A =$

$ct_A$

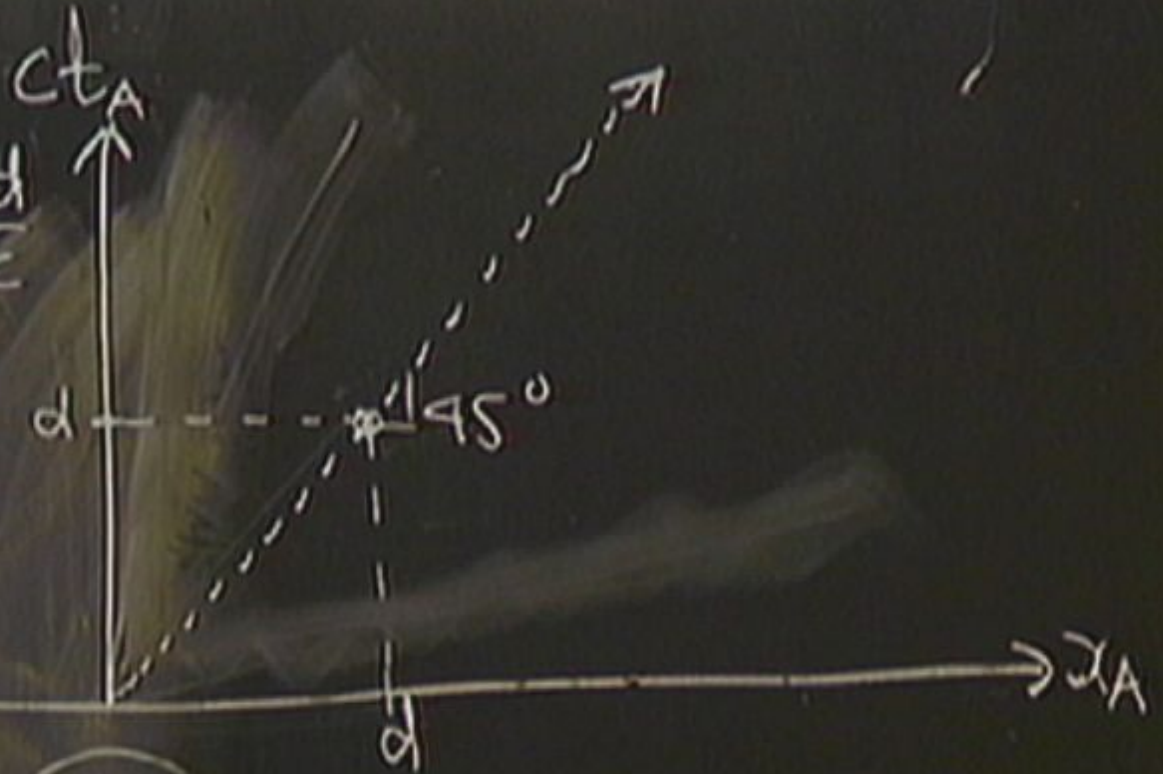
$45^\circ$

$x_A$



# Sound in Air

$$t_A = \frac{\text{dist}}{\text{vel}} = \frac{d}{c}$$
$$ct_A = d$$





# Sound in Air

$$t_A = \frac{\text{dist}}{\text{vel}} = \frac{d}{c}$$

$$ct_A = d$$

45°

$ct_A$

$d$

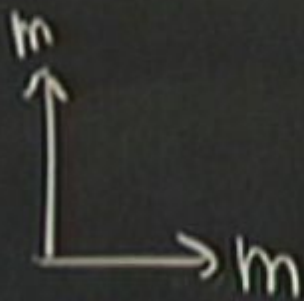
45°

$x_A$



$\left. \begin{matrix} ct_A \\ x_A \end{matrix} \right\}$  same dimension, Length (e.g. metre)

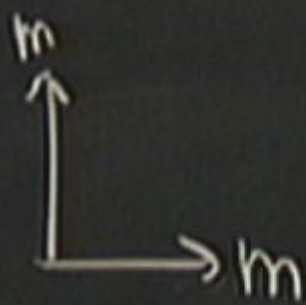
$\left. \begin{matrix} ct_A \\ x_A \end{matrix} \right\}$  same dimension, Length (e.g. metre)



space & time

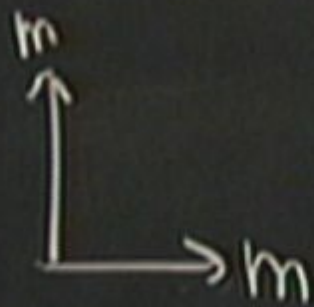


$\left. \begin{matrix} ct_A \\ x_A \end{matrix} \right\}$  same dimension, Length (e.g. metre)



space & time  
↓ ↓  
spacetime

$ct_A$  } same dimension, Length (e.g. metre)  
 $x_A$  }  
abs. abs.



space & time

↓ ↓  
spacetime

abs.



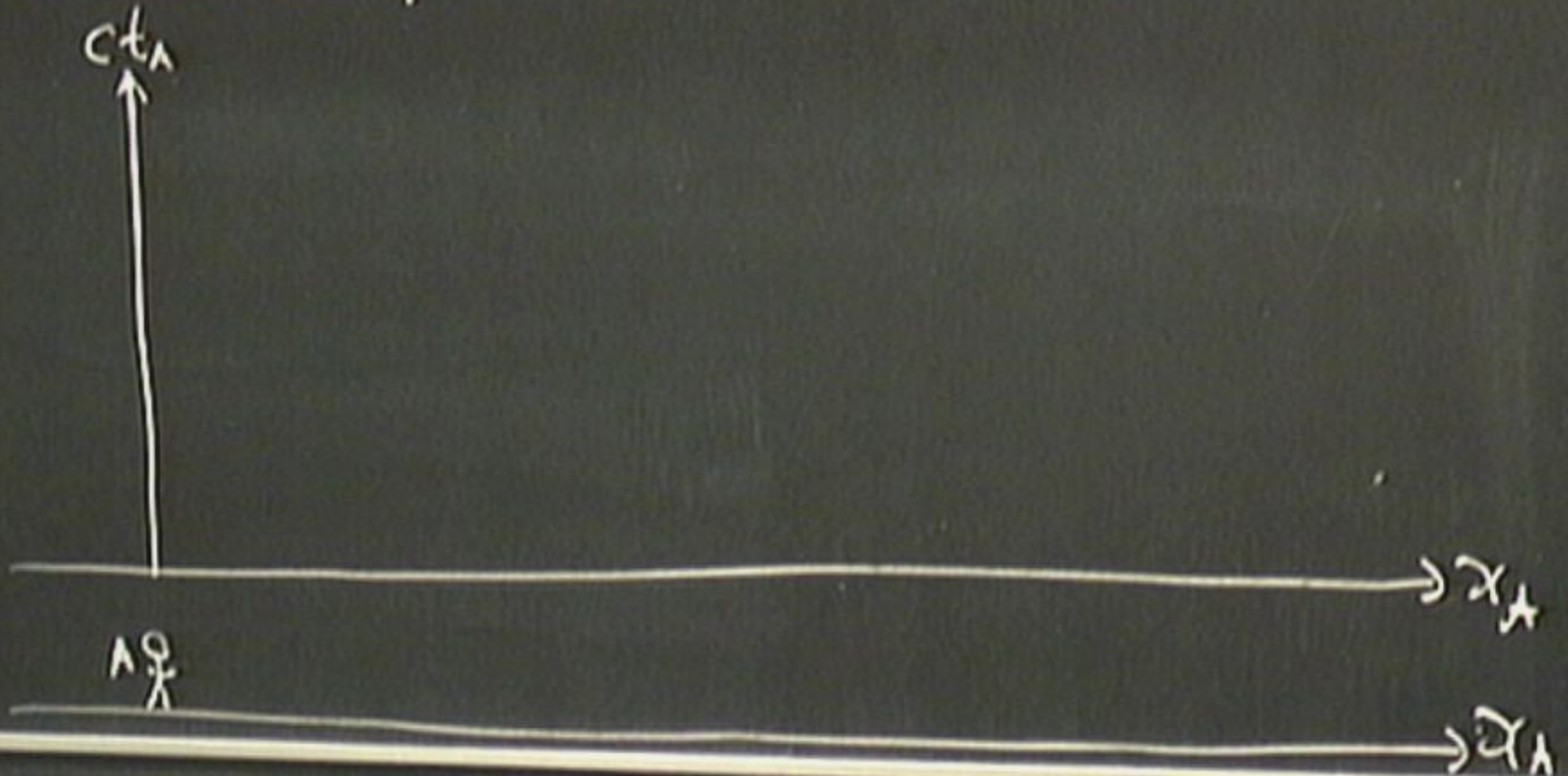
# Thought Experiment

190

→ 190



# Thought Experiment



# Thought Experiment

$ct_A$



$x_A$

AQ  $\rightarrow v$

$x_A$



# Sound in Air

$$t_A = \frac{\text{dist}}{\text{vel}} = \frac{d}{c}$$

$$ct_A = d$$

45°

$ct_A$

Subs

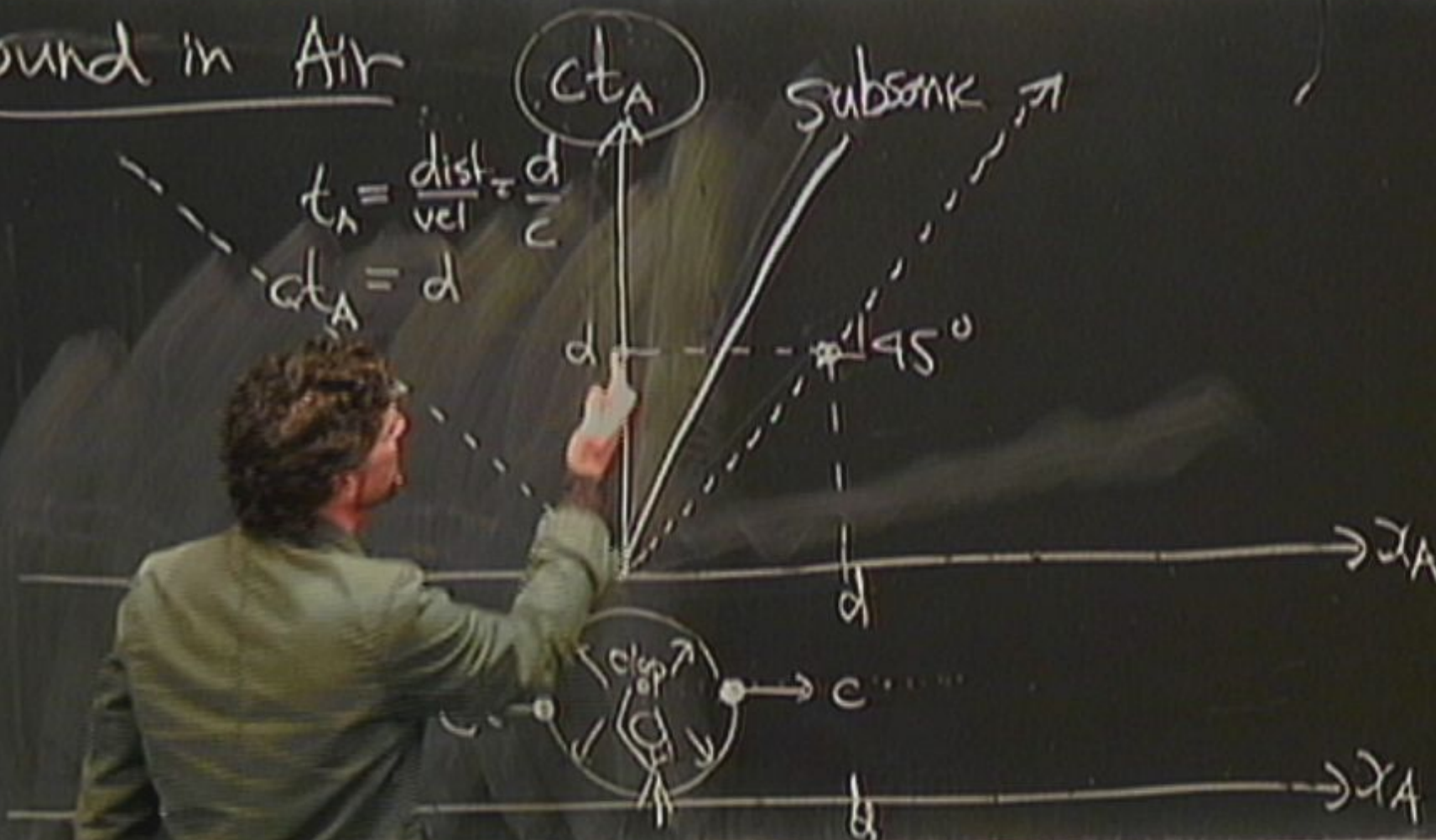
c

$\rightarrow x_A$

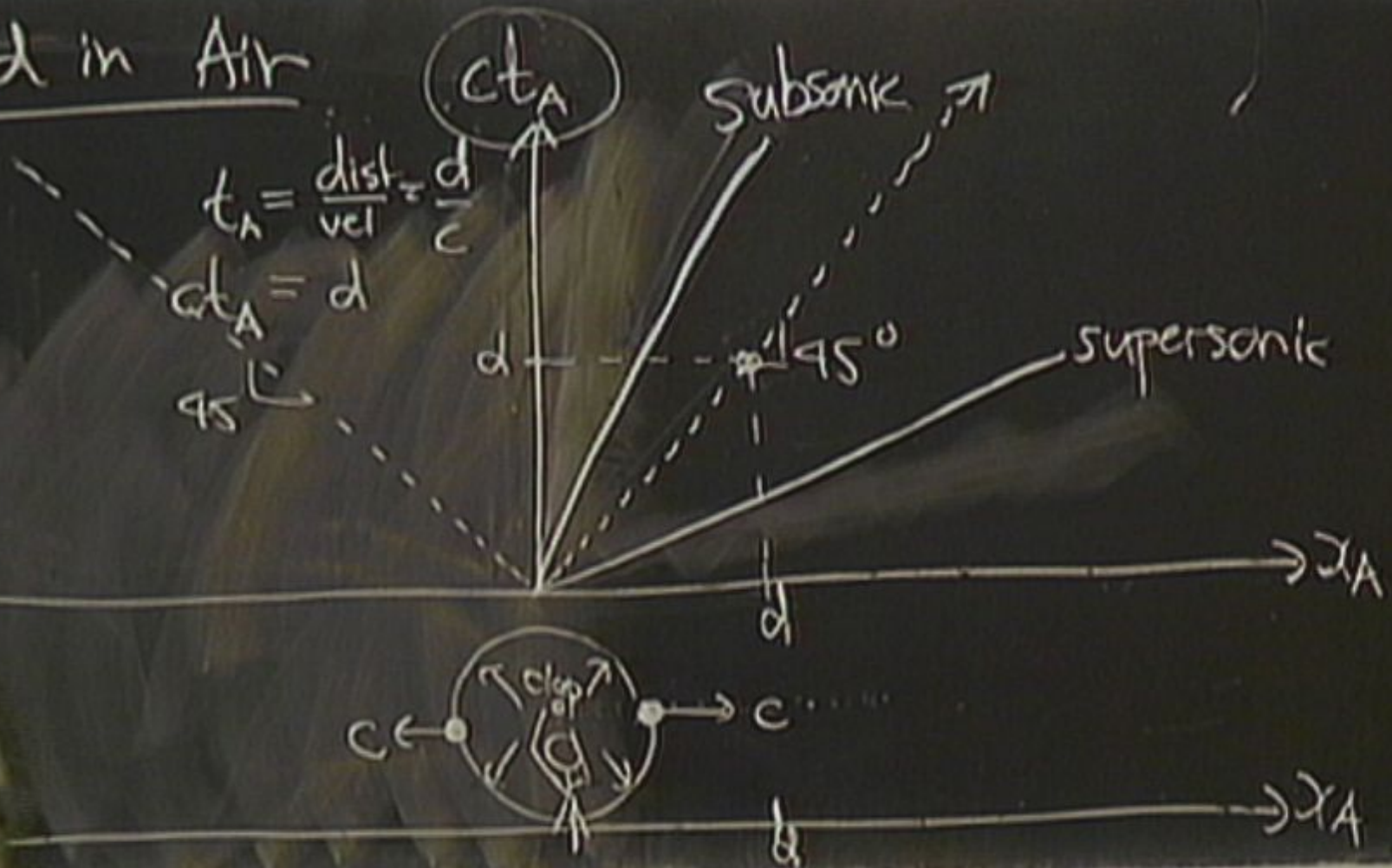
$\rightarrow x_A$



# Sound in Air



# Sound in Air





# Thought Experiment

$c t_A$



$v \ll c$

$x_A$

$x_A$



# Thought Experiment

$ct_A$   $ct_B$

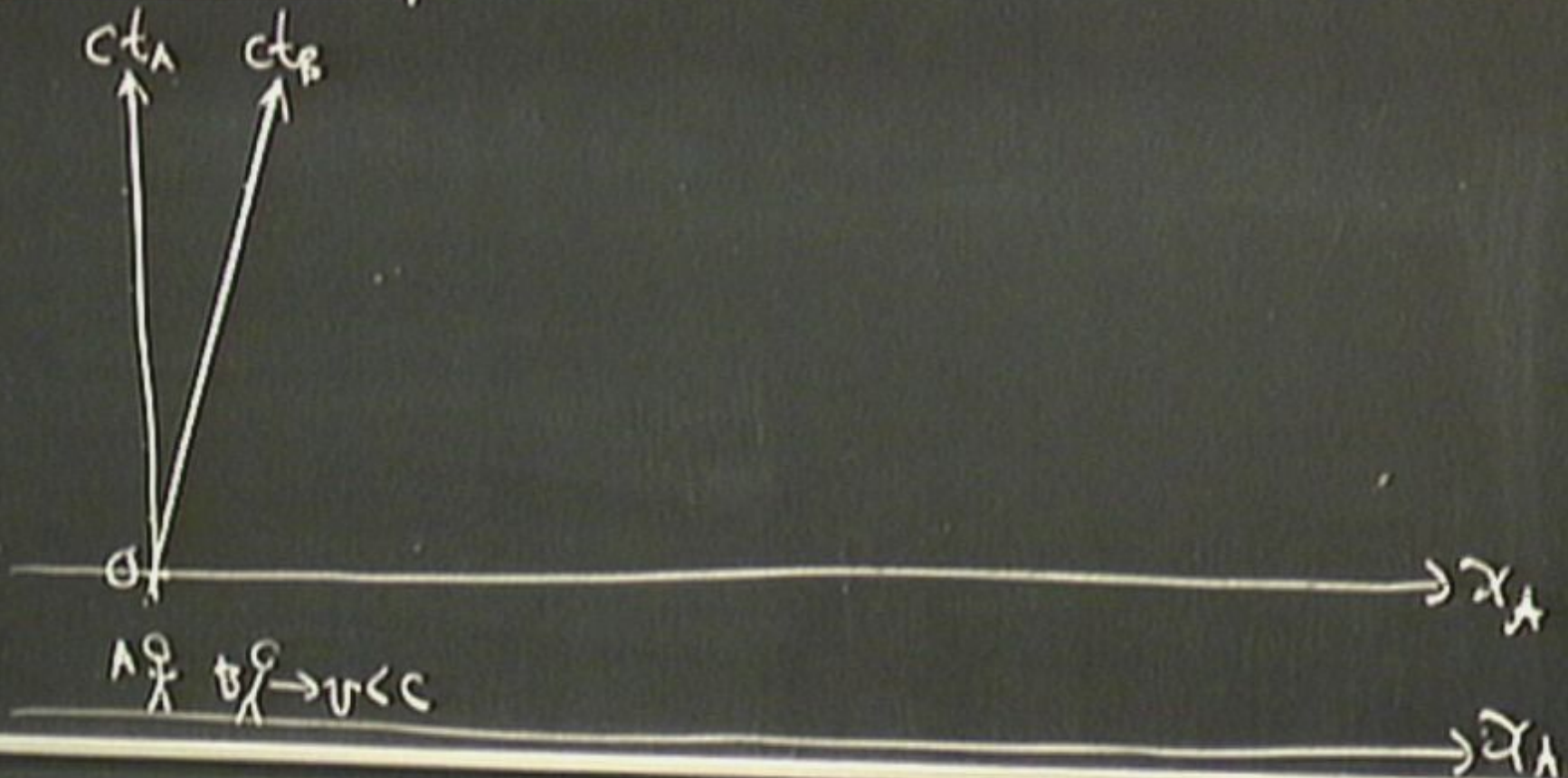
$O$

$A \rightarrow B \rightarrow v < c$

$x_A$

$x_A$

# Thought Experiment





# Thought Experiment



①  $\frac{v}{c} \rightarrow v < c$

T

$\rightarrow x_A$

$\rightarrow x_A$



\* For observers at rest w.r.t. air,  
speed of sound is independent of  
the motion of the source.

## An Example of Doppler Effect

An emergency ambulance with switched on siren passes a person who is standing at the street.



Note: This applet is not very realistic in one respect: As the Doppler effect should be seen as clearly as possible, the sound waves have a smaller velocity than in reality.

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