

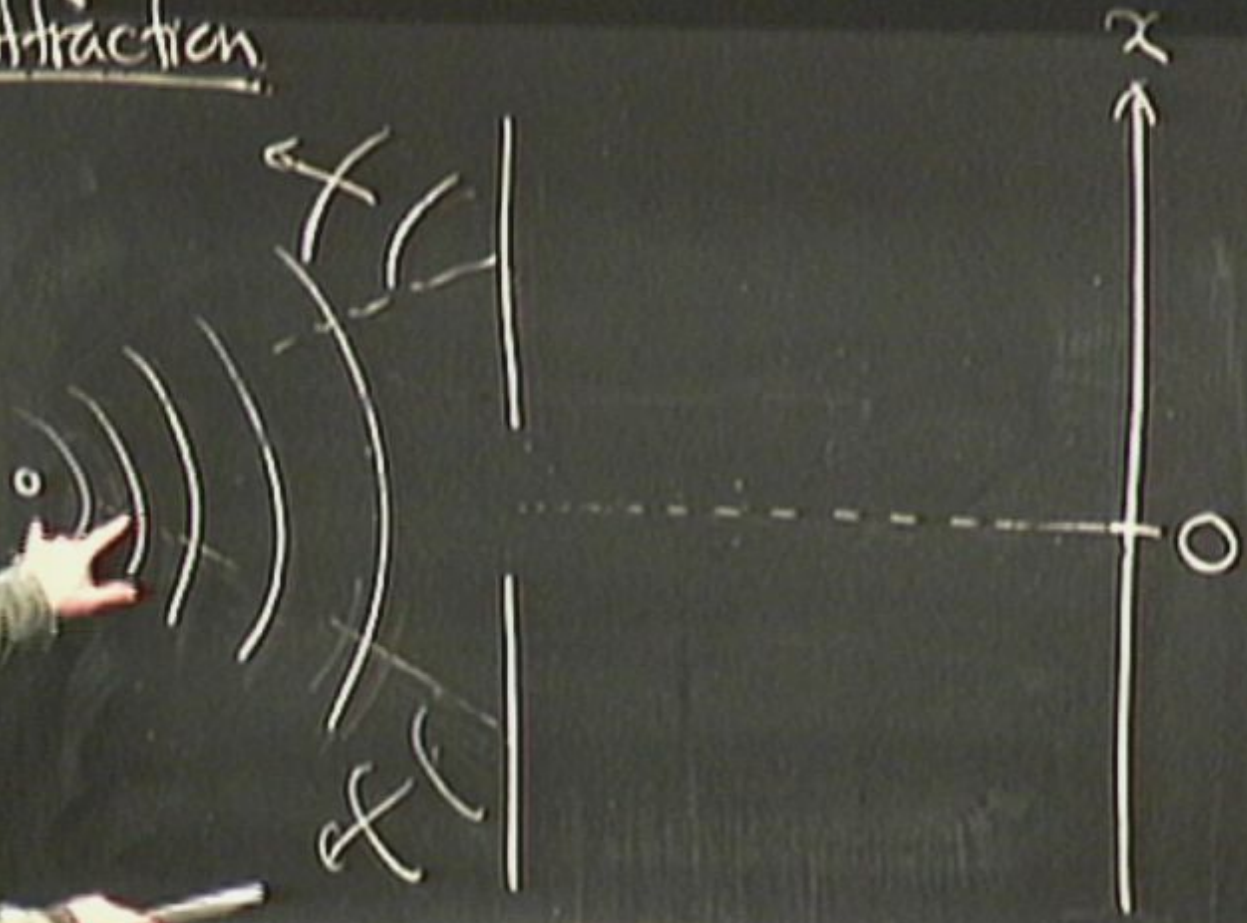
Title: Quantum Mechanics 2 - The de Broglie Relationship

Date: Aug 10, 2008 10:30 AM

URL: <http://pirsa.org/08080077>

Abstract: Making the connection between particle probability patterns and wave intensity patterns, leading to the famous de Broglie relationship.
Learning Outcomes:
• Repeating the single slit experiment with waves instead of particles. Seeing that the particle probability pattern is the same as the wave intensity pattern.
• Same as above, but for the double slit experiment.
• Putting it all together to derive the de Broglie relationship between the momentum of a particle and the wavelength of a corresponding wave.

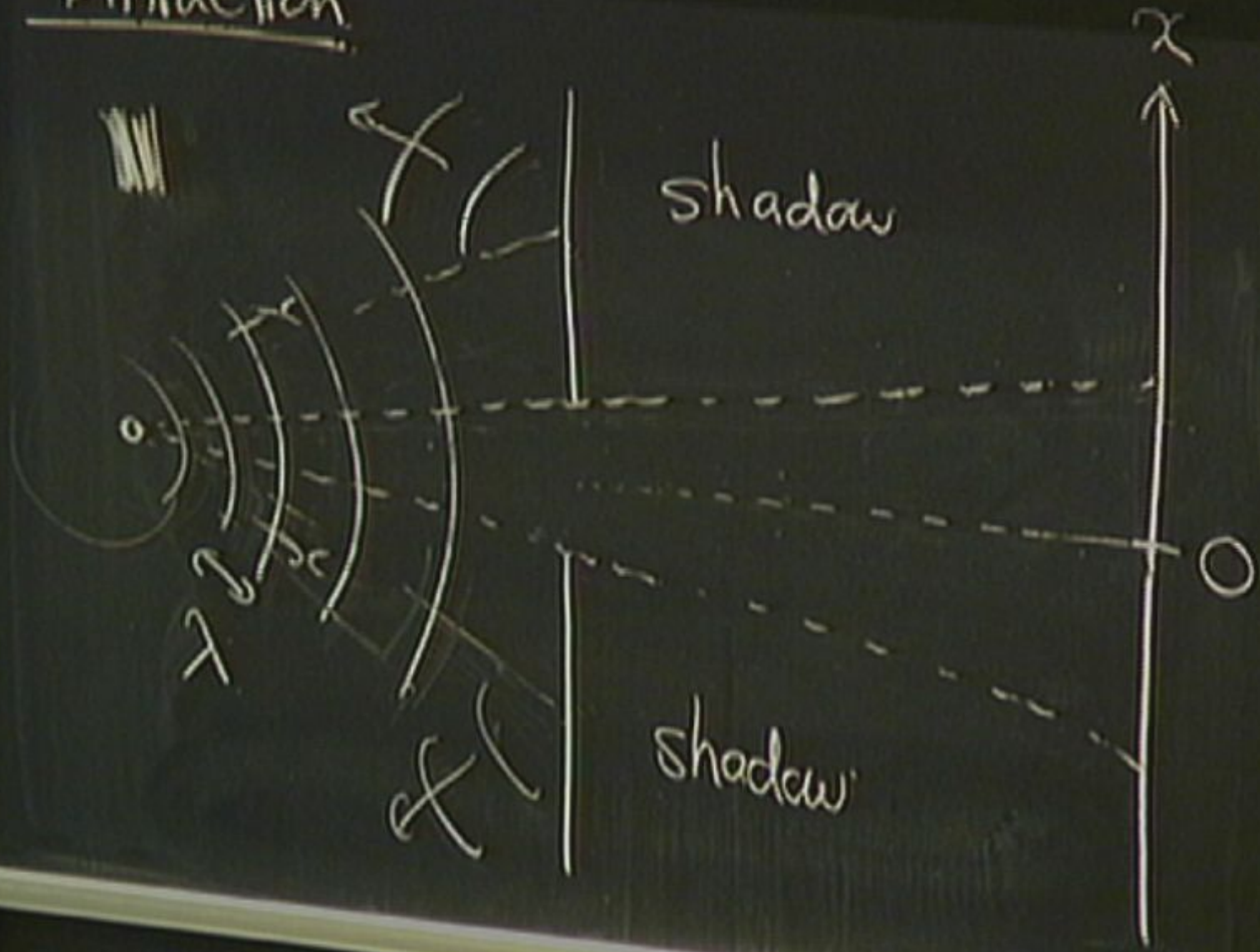
Diffraction



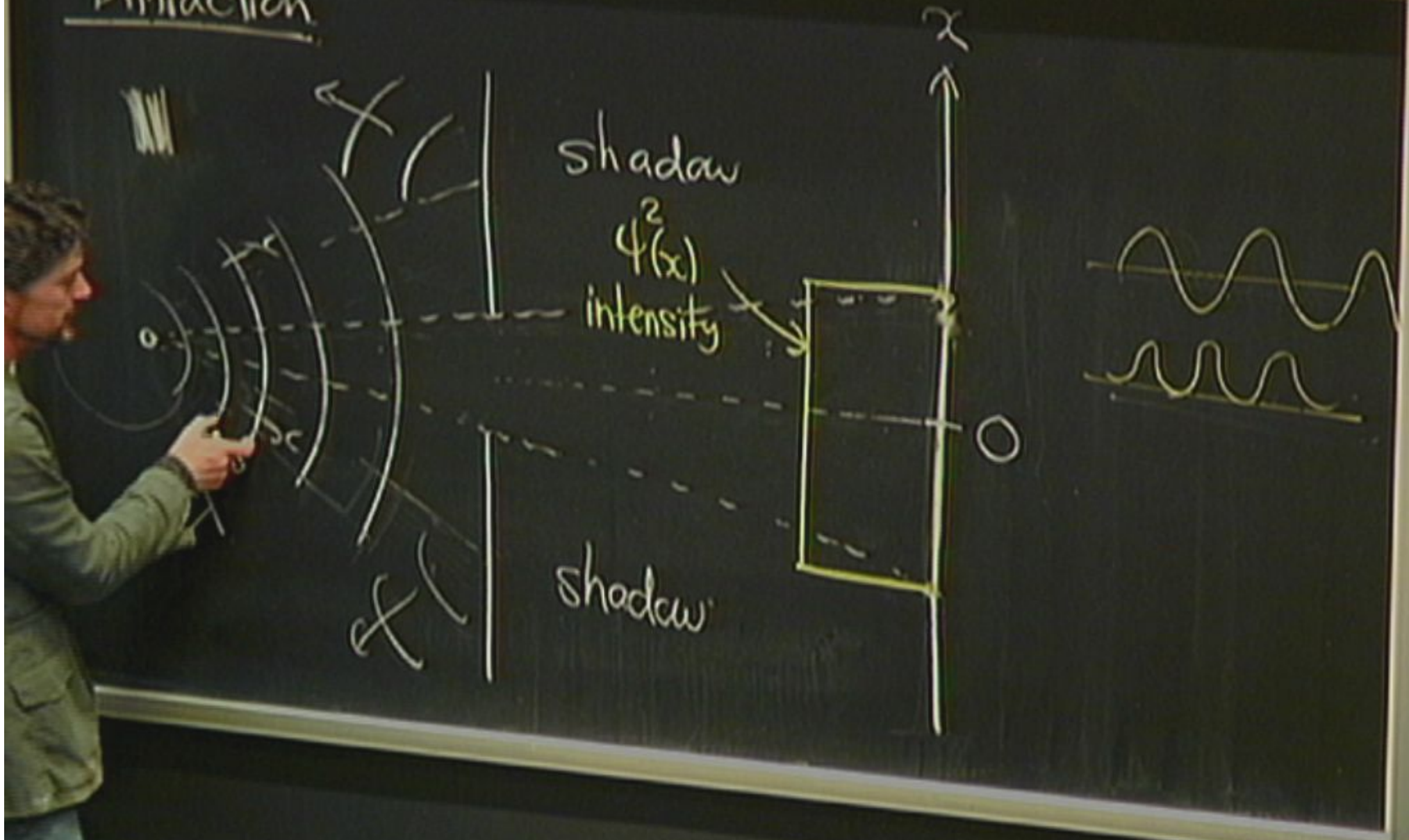
Diffraction



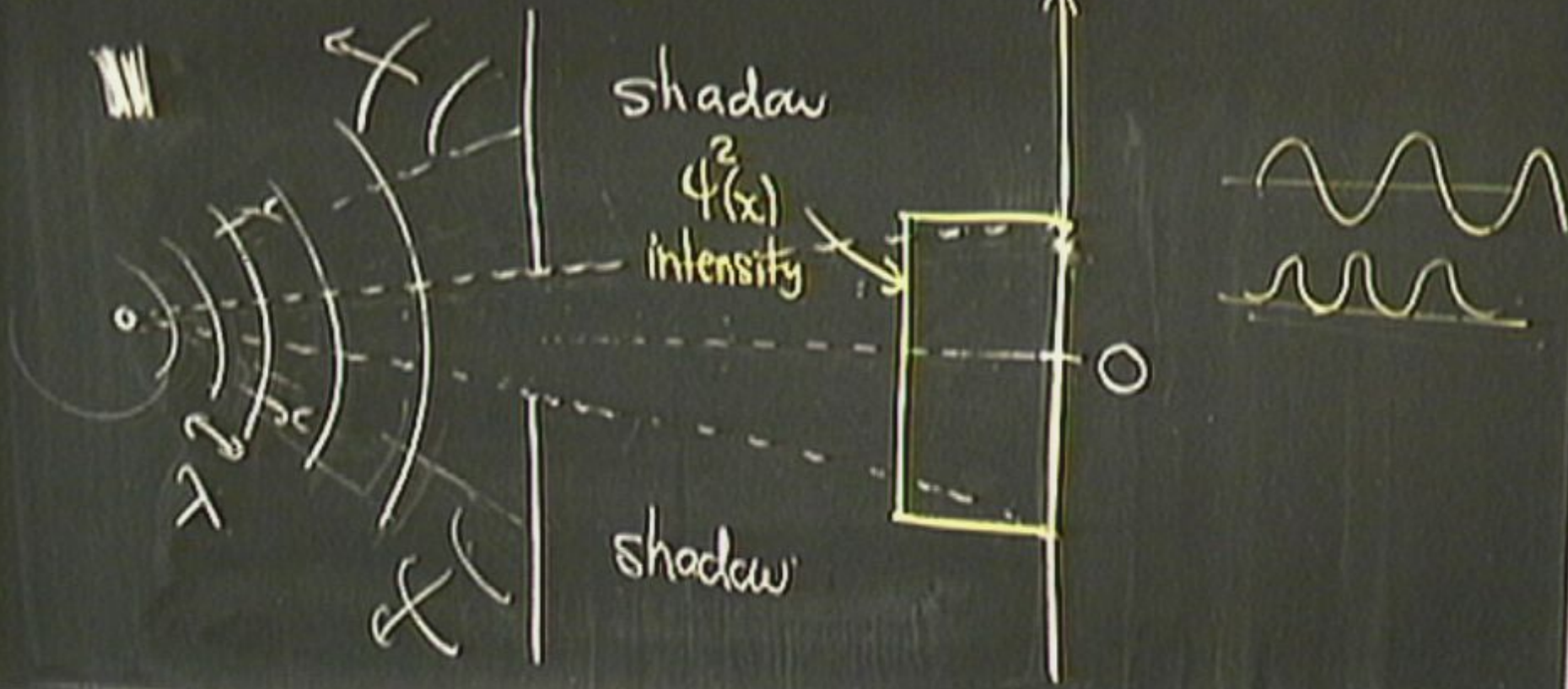
Diffraction



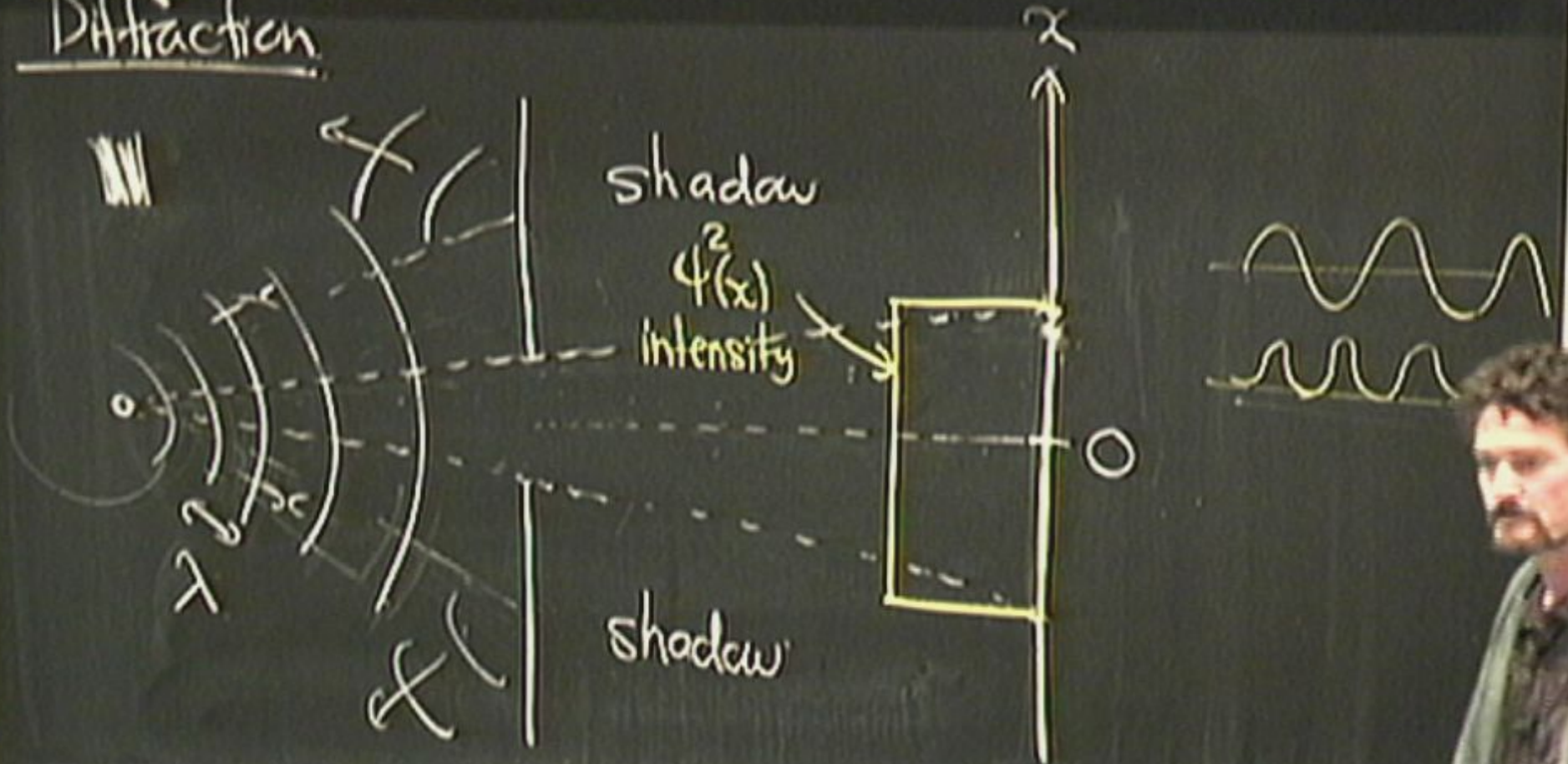
Diffraction



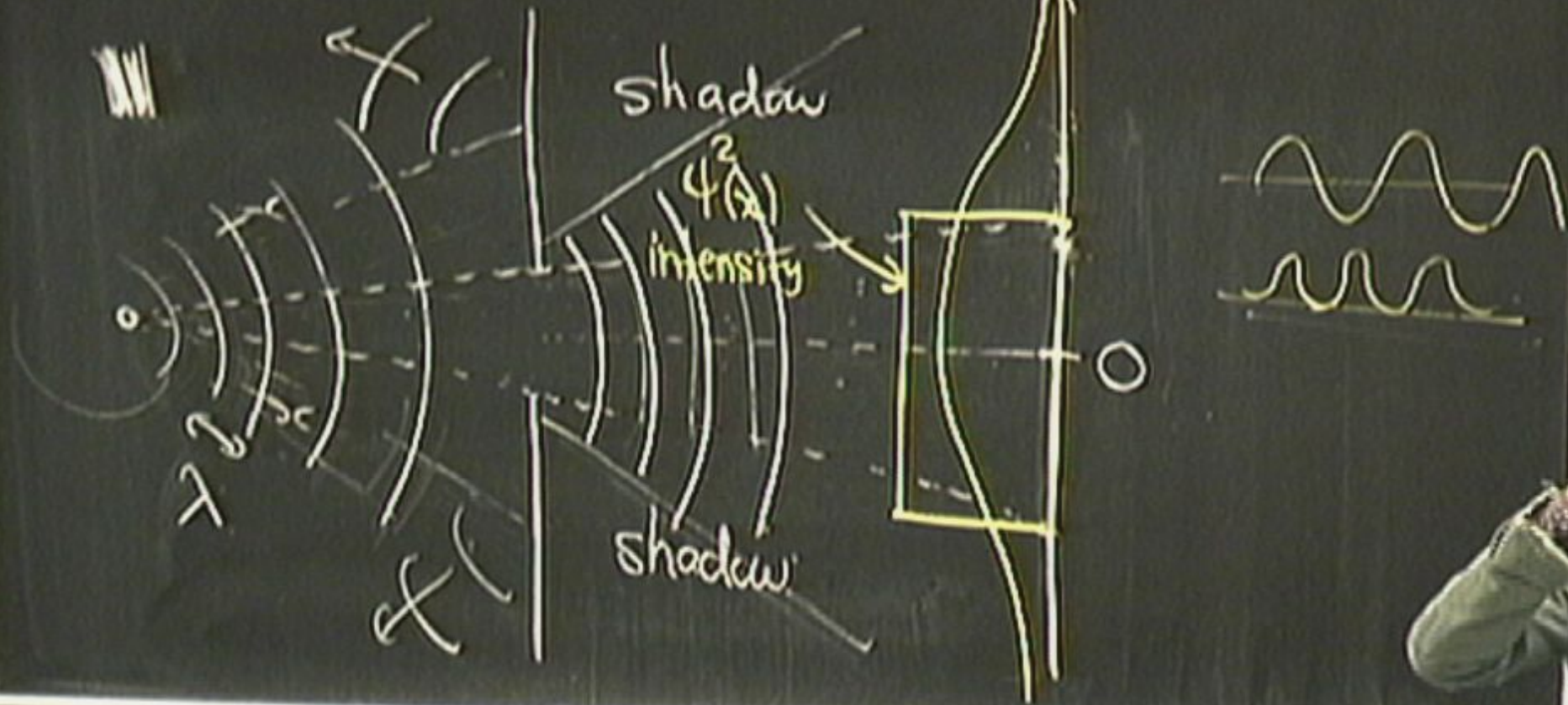
Diffraction



Diffraction



Diffraction



* Huygens.



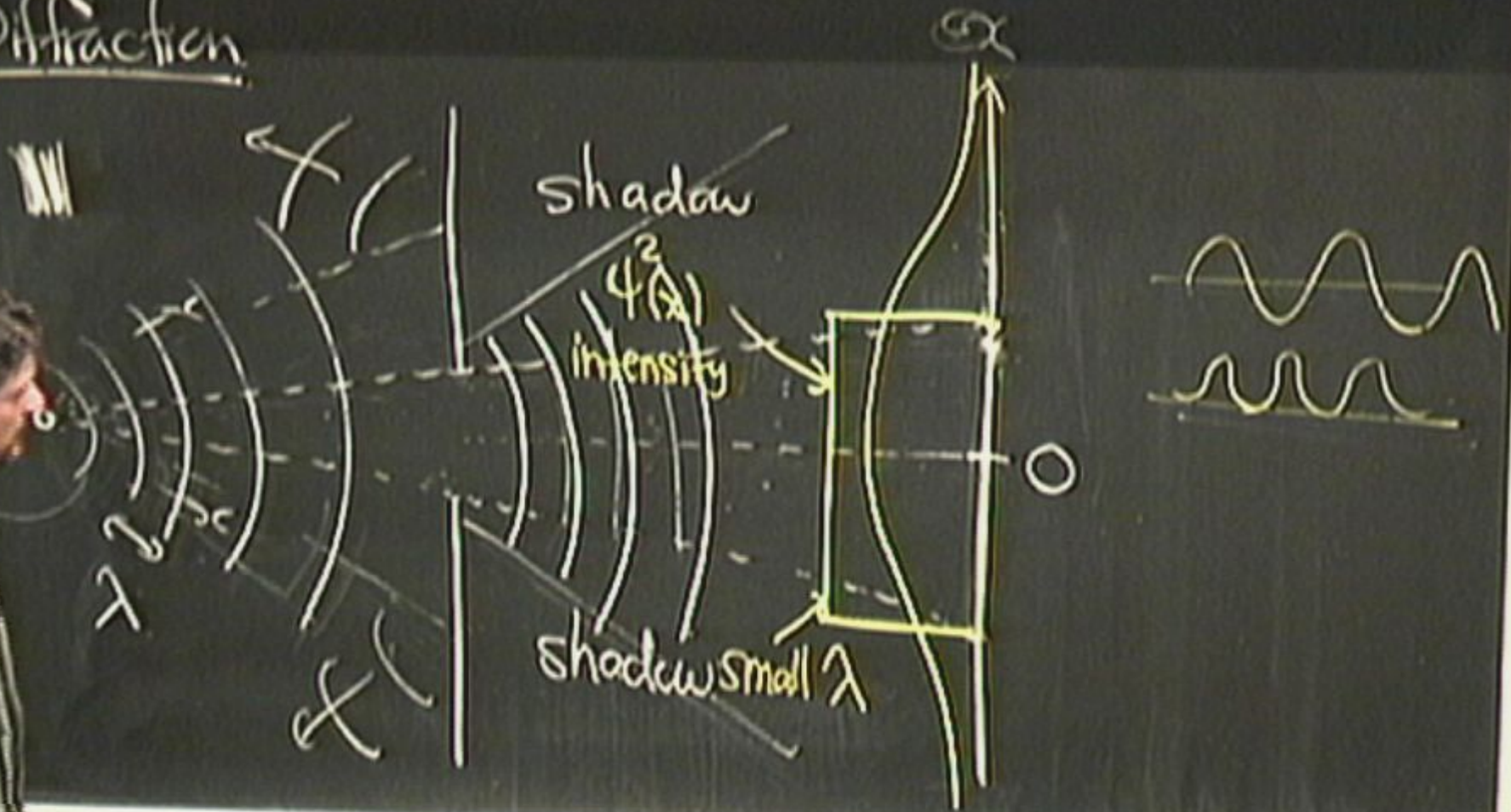
$\psi(x,t)$

* Huygens.



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Diffraction



(1) I identify $\psi^2(x)$ with $P(x)$



wave intensity



particle probability

(1) I identify $\psi^2(x)$ with $P(x)$

↑
wave intensity

↑
particle probability

(2) Small λ \leftrightarrow large p

(1) I identify $\psi^2(x)$ with $P(x)$



wave intensity



particle probability

(2) small λ \leftrightarrow large p

large λ \leftrightarrow small p

(1) I identify $\psi^2(x)$ with $P(x)$

↑ wave intensity ↑ particle probability

(2) small λ \leftrightarrow large p

large λ \leftrightarrow small p

Guess: $\lambda \propto \frac{1}{p}$

(1) I identify $\psi^2(x)$ with $P(x)$

↑ wave intensity ↑ particle probability

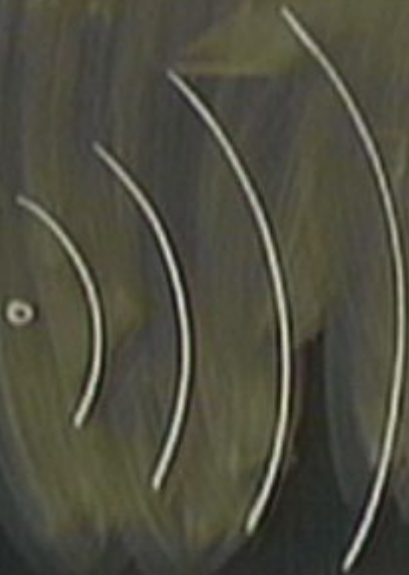
(2) Small λ \leftrightarrow large p

large λ \leftrightarrow small p

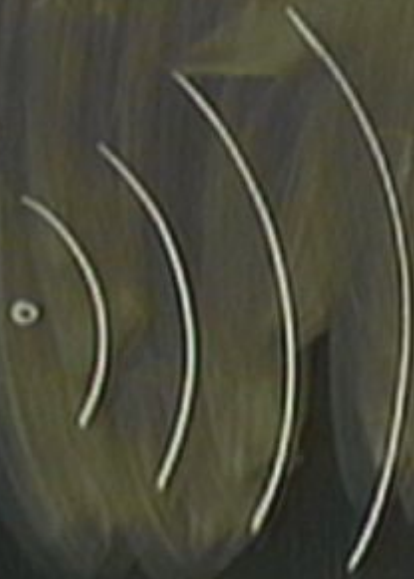
GUESS

$$\lambda \propto \frac{1}{p}$$

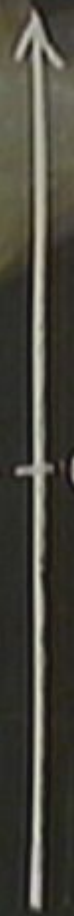
Interference



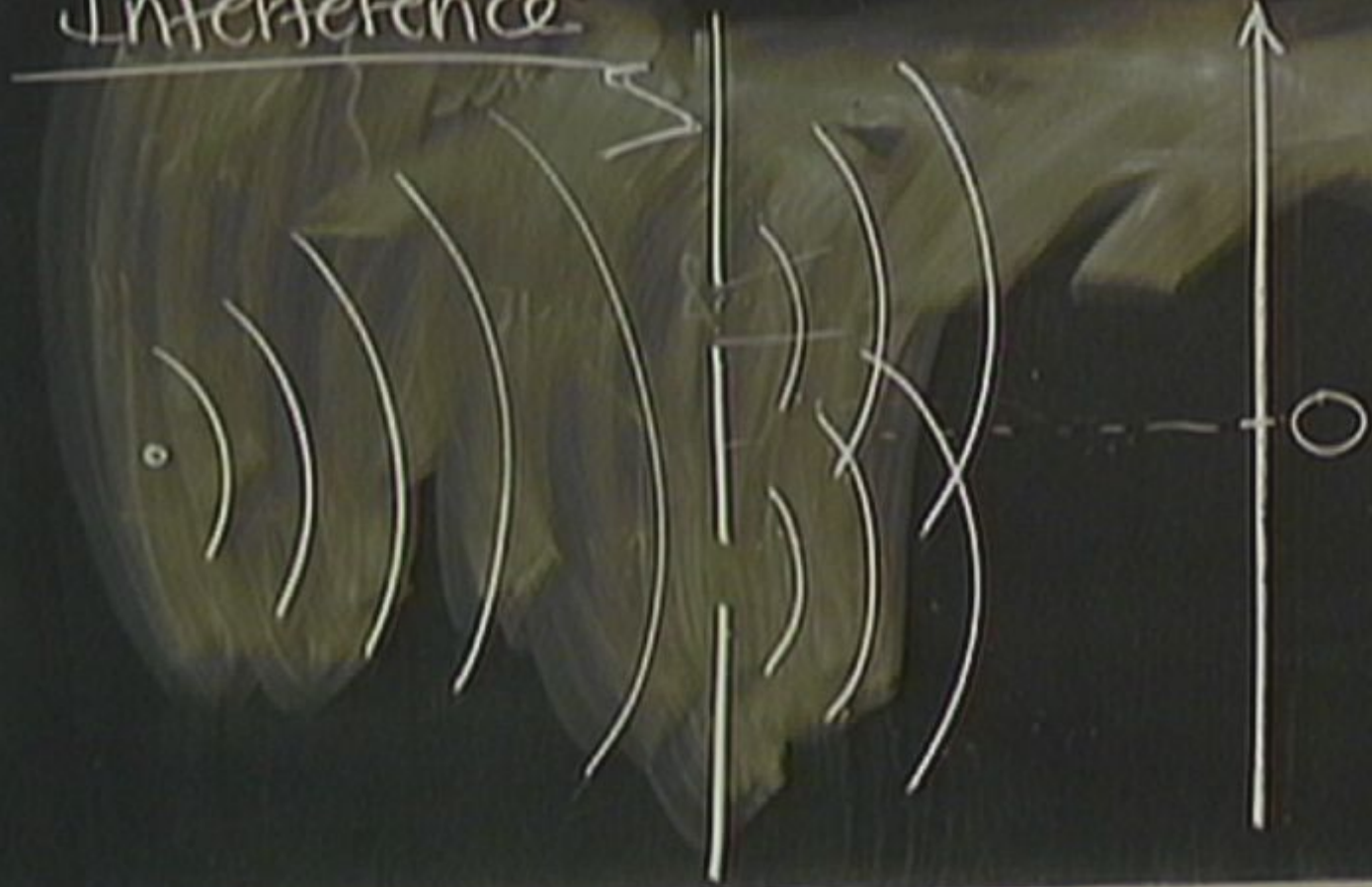
Interference



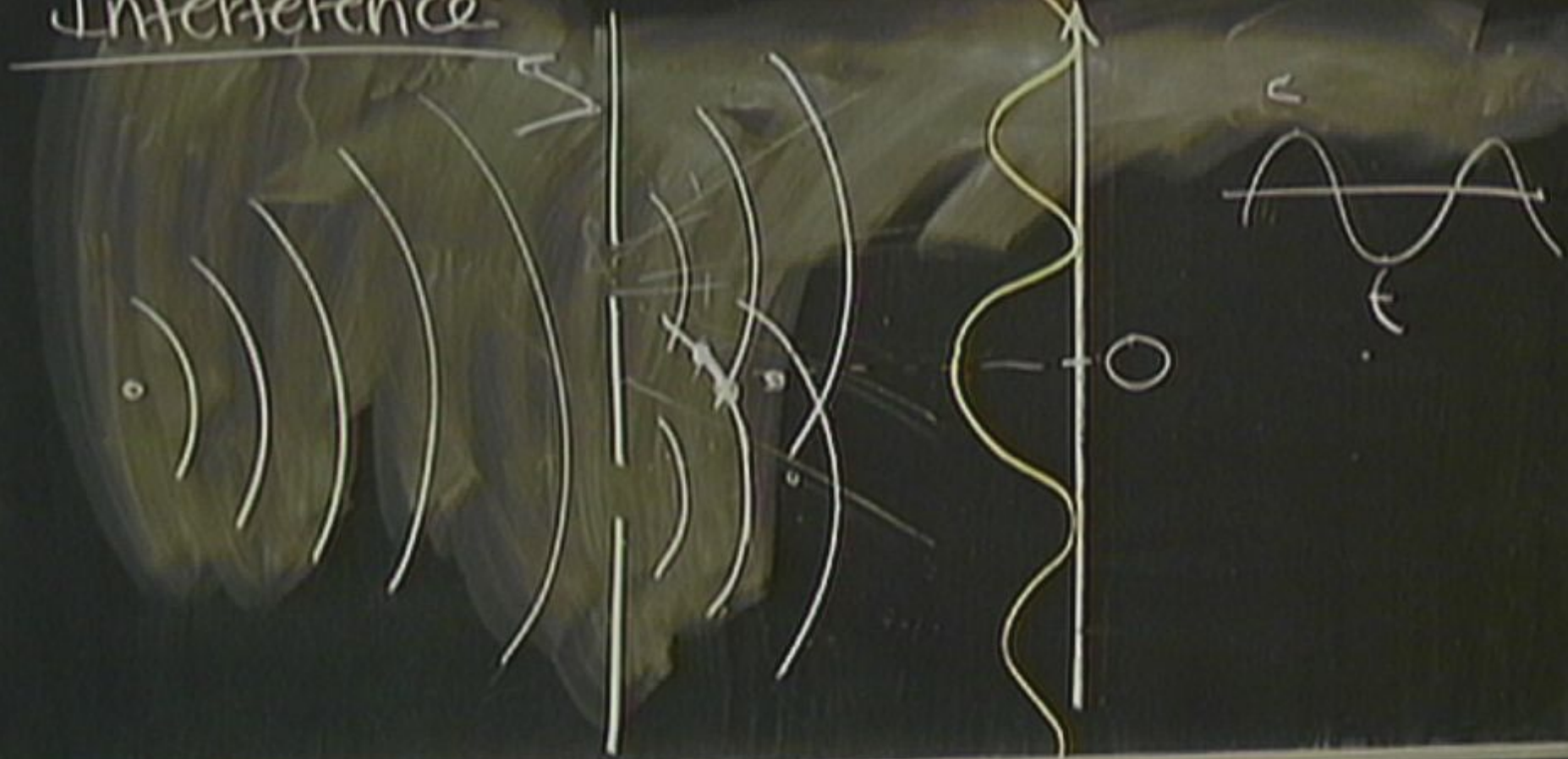
x



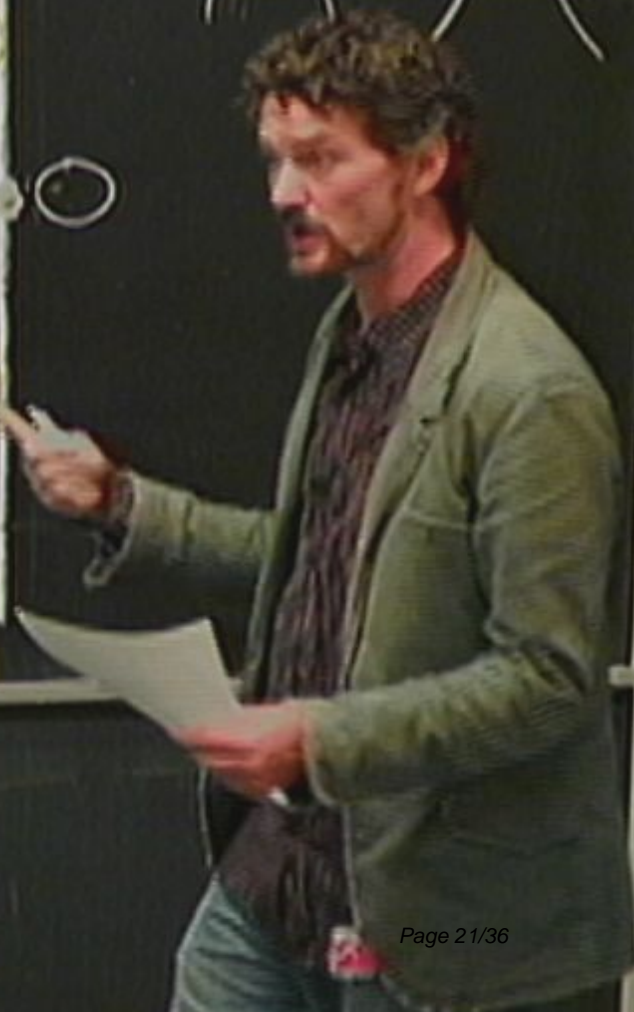
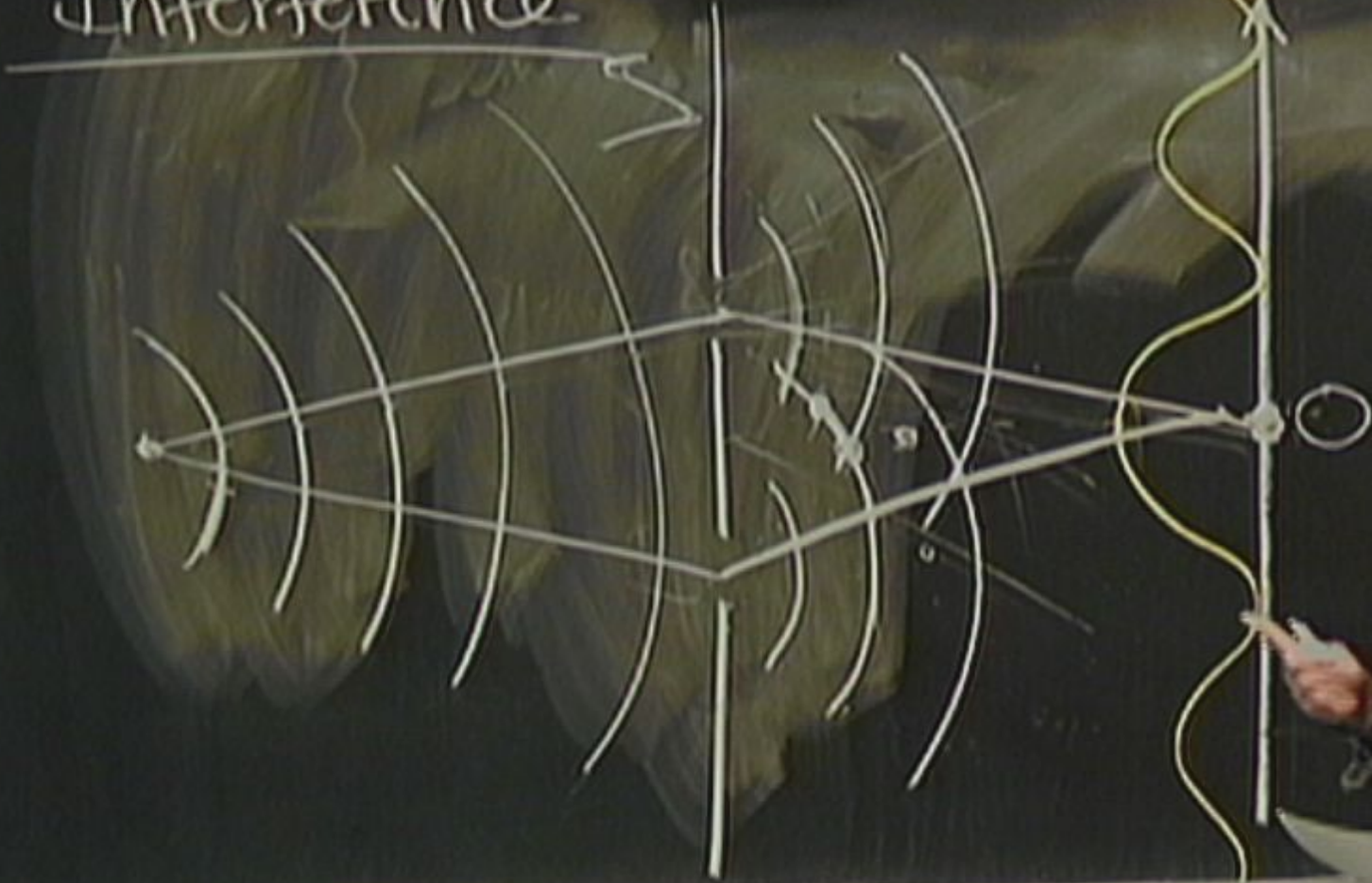
Interference



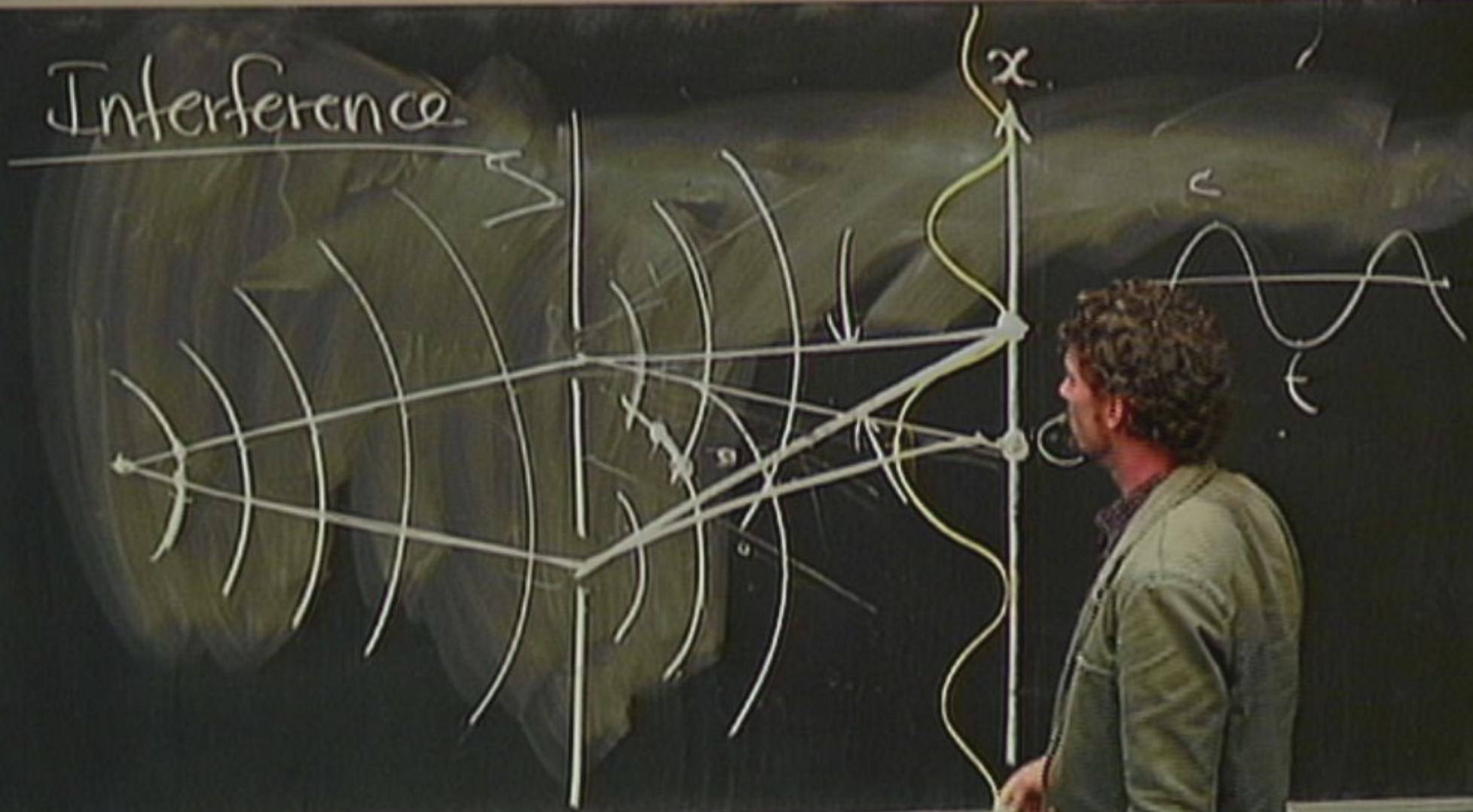
Interference



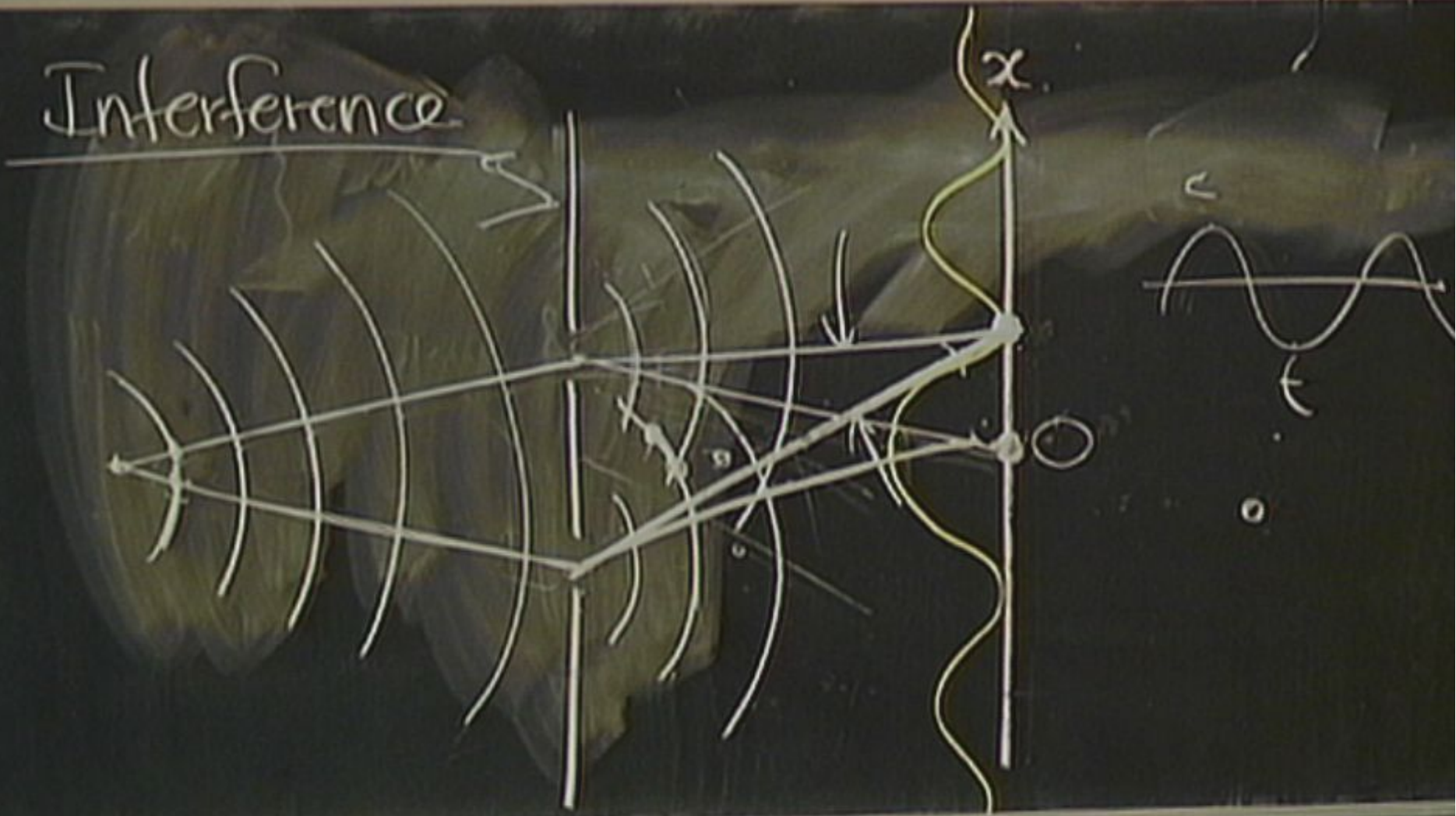
Interference



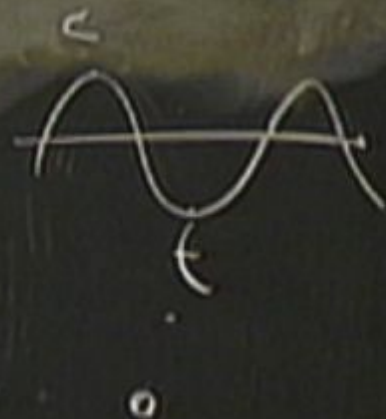
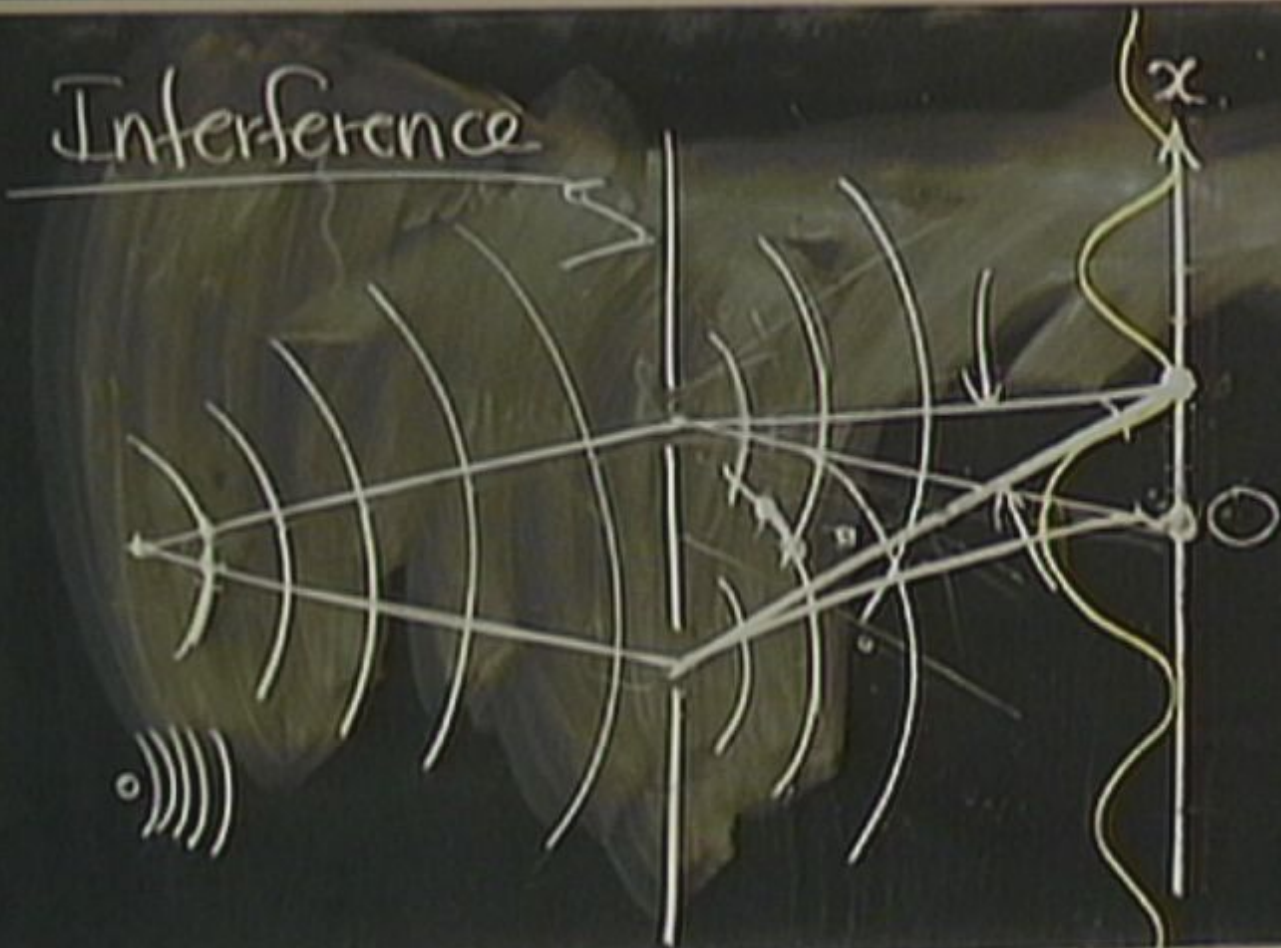
Interference



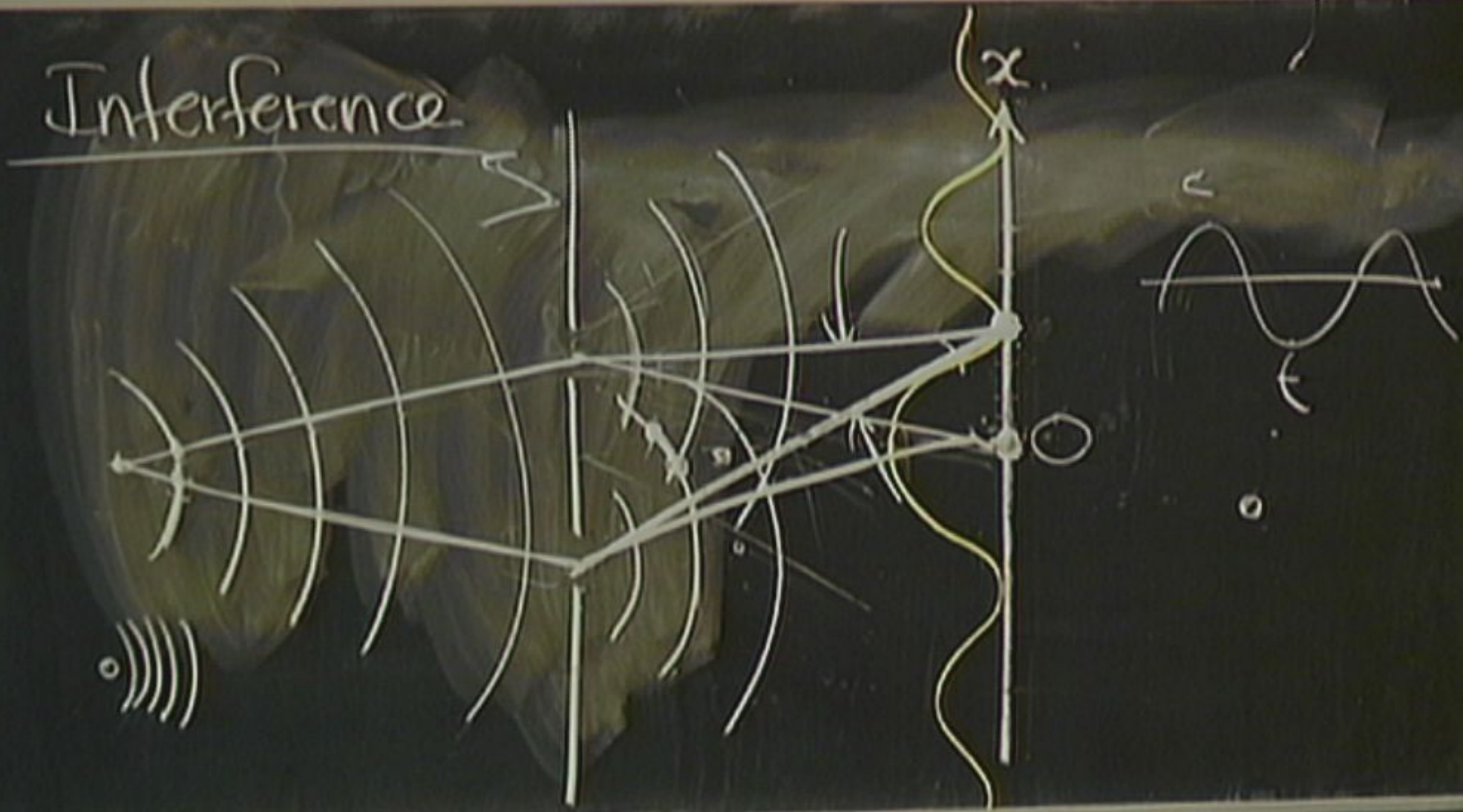
Interference



Interference



Interference






Small λ



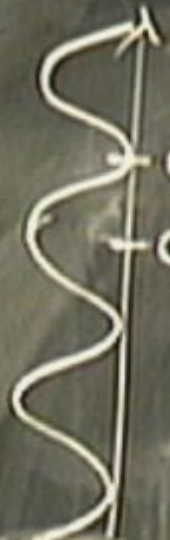
Large λ



Small λ



large λ



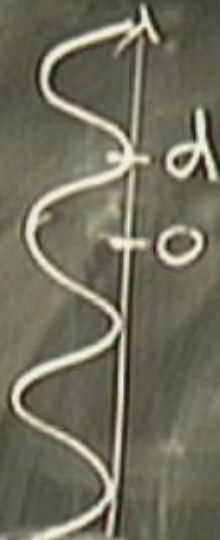
λ just right.



Small λ



large λ



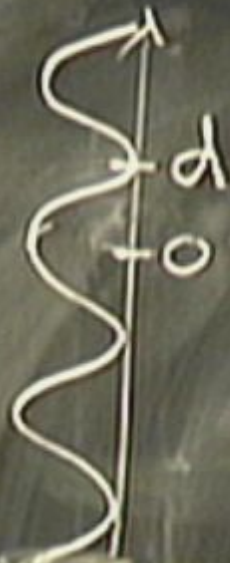
λ just right.



Small λ

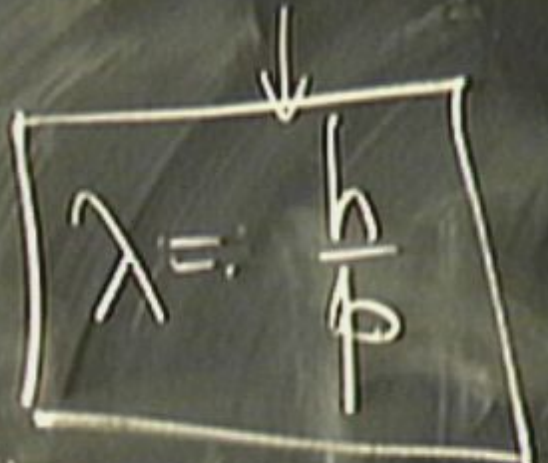


large λ



λ just right

$$\Psi^2(x) = P(x)$$



$$h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$$



Small λ



large λ



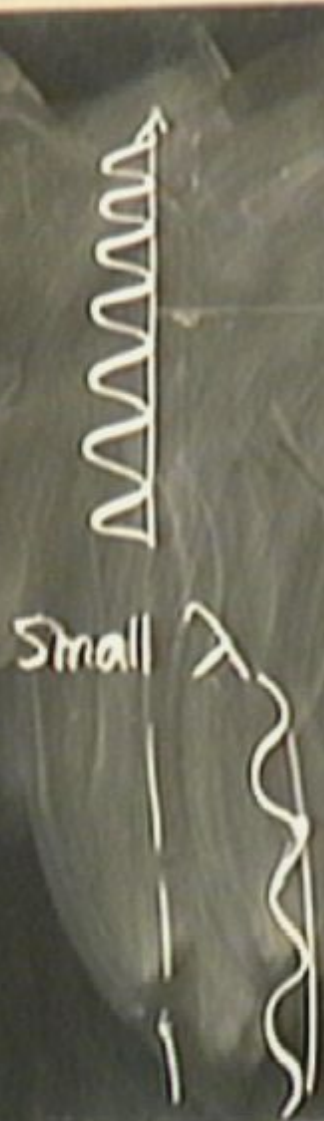
de Broglie

λ just right.

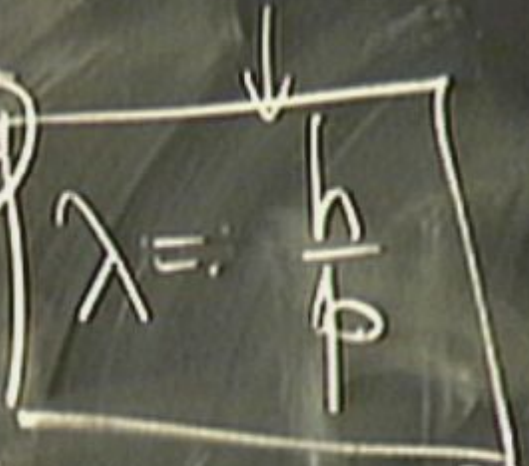
$$\psi^2(x) = P(x)$$

$$\lambda = \frac{h}{p}$$

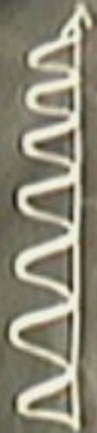
$h = 6.626 \times 10^{-34}$ J's
Planck.



$$\psi^2(x) = P(x)$$



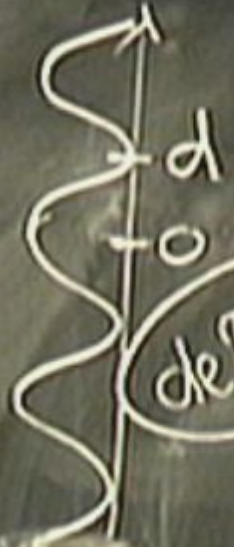
$h = 6.626 \times 10^{-34}$ J's
Planck.



Small λ



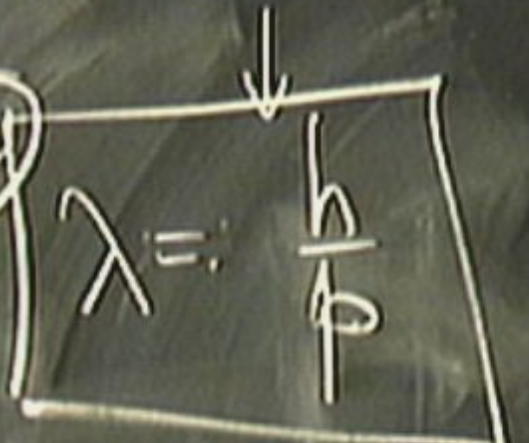
large λ



λ just right.

de Broglie

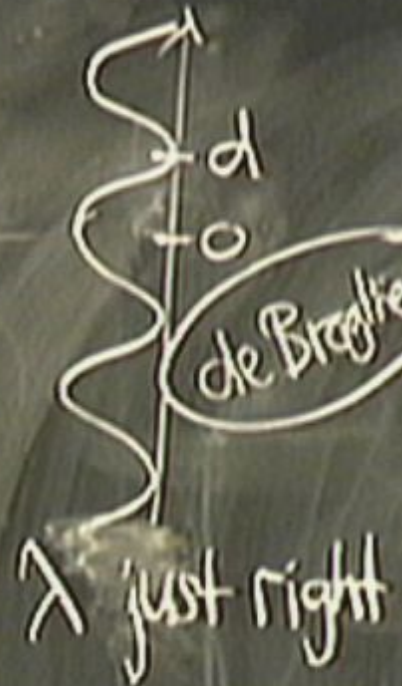
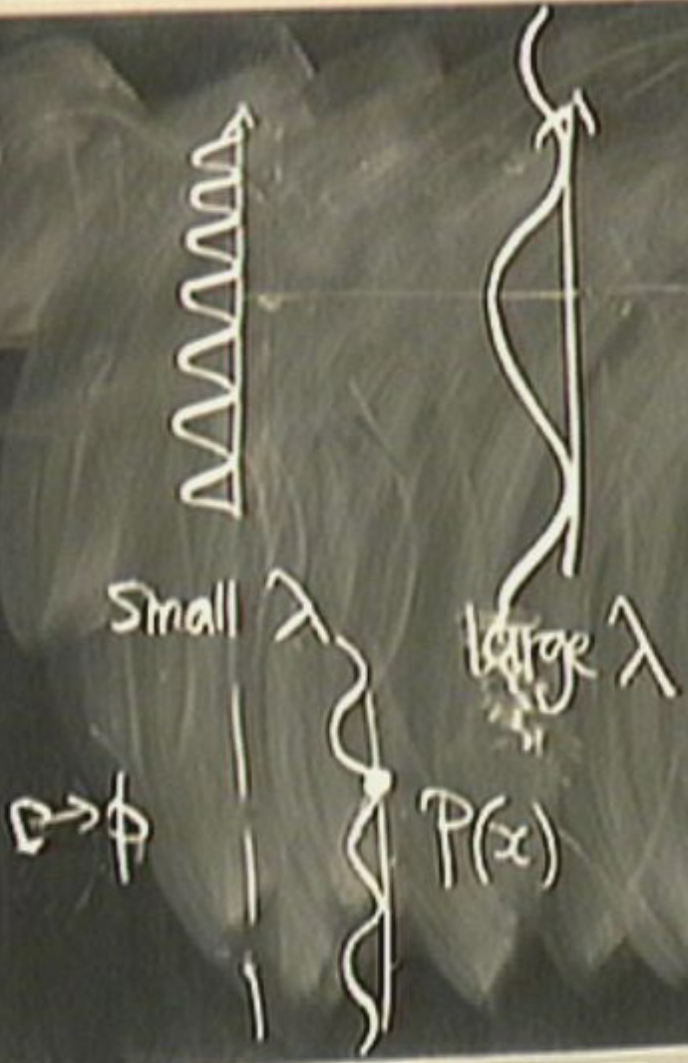
$$\Psi^2(x) = P(x)$$



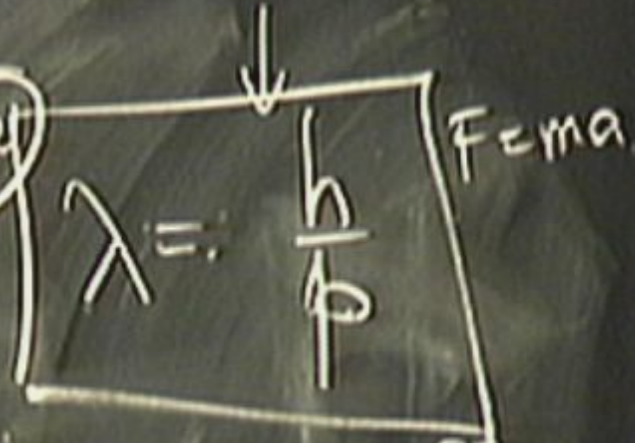
$$h = 6.626 \times 10^{-34} \text{ J's}$$

Planck.

n

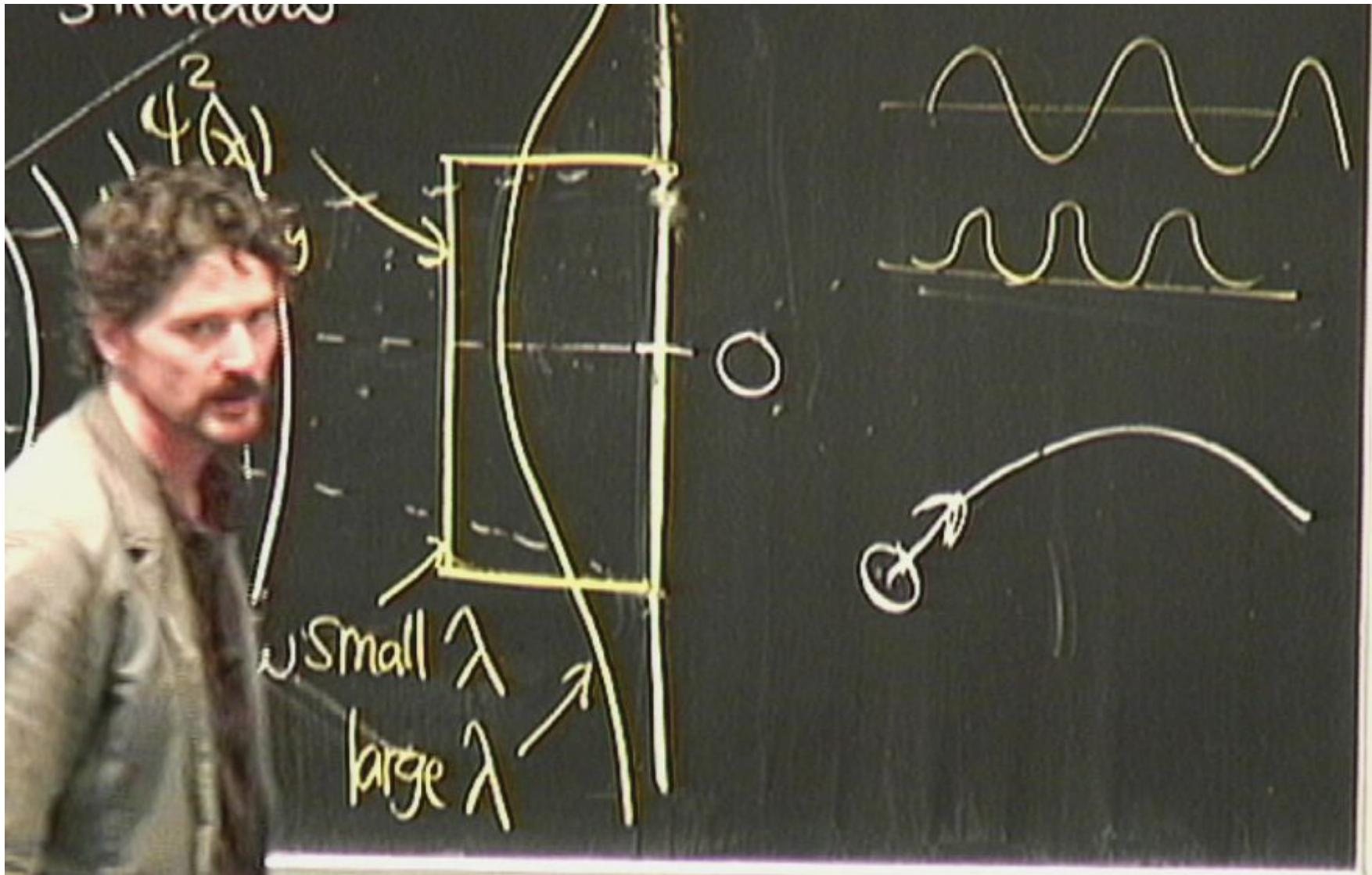


$$\psi^2(x) = P(x)$$



$h = 6.626 \times 10^{-34}$ J's

Planck.



CAUTION
 Do not touch the metal door
 when using the microscope.
 Do not touch the lens.
 Do not touch the base.

$$\psi^2(x) = P(x)$$

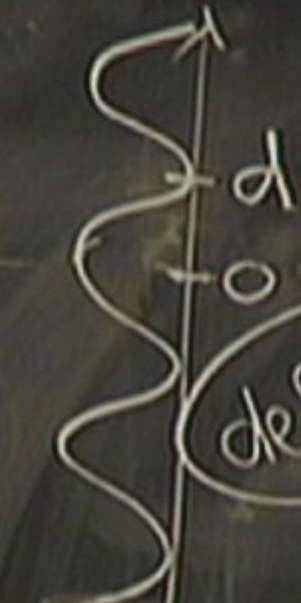
de Broglie

$F = ma$

$$\lambda = \frac{h}{p}$$

$$h = 6.626 \times 10^{-34} \text{ J's}$$

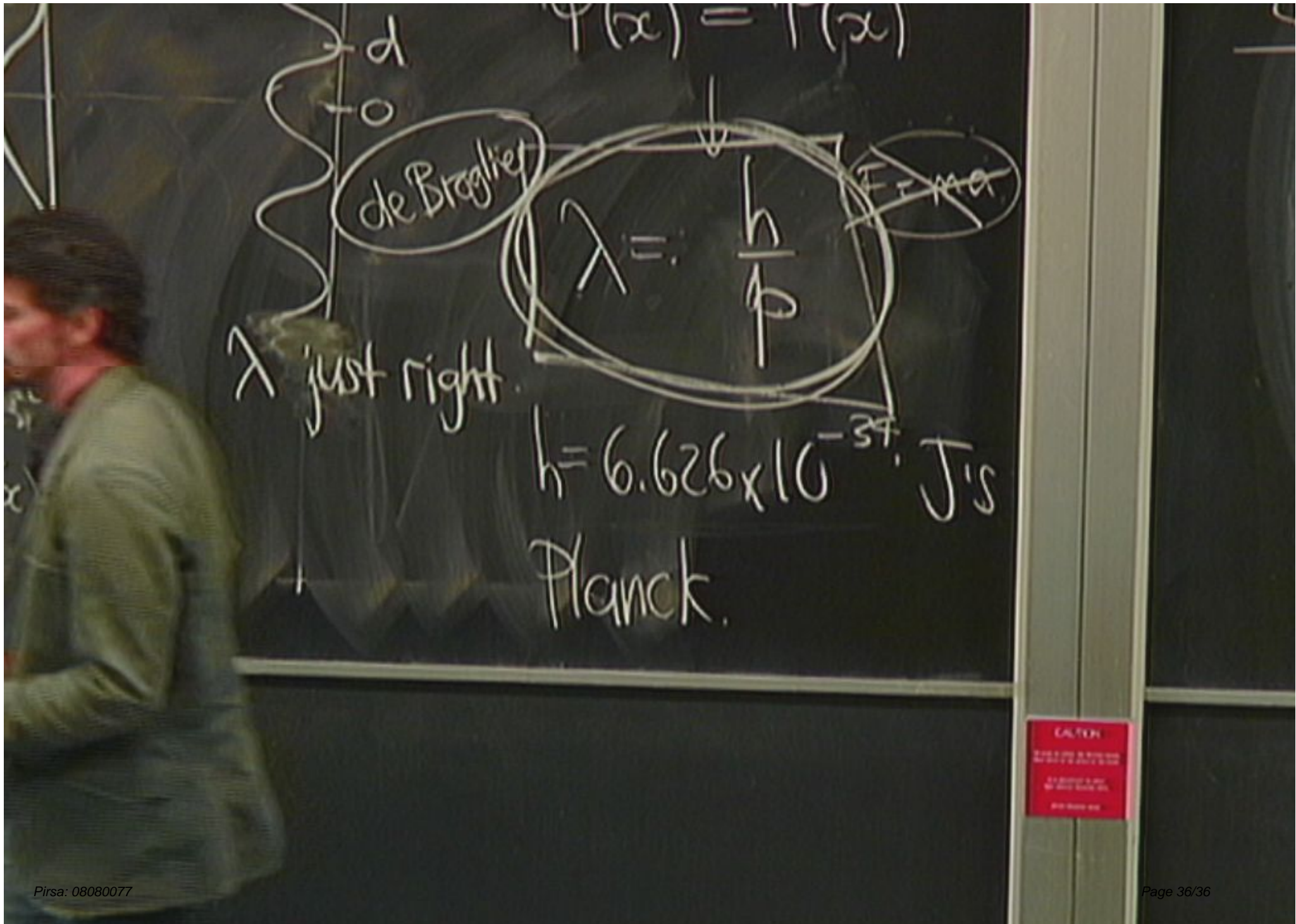
Planck



large λ

λ just right

$P(x)$



$$\psi(x) = \psi(x)$$

de Broglie

$$\lambda = \frac{h}{p}$$

~~$E = mc^2$~~

λ just right.

$$h = 6.626 \times 10^{-34} \text{ J's}$$

Planck.

CAUTION
DO NOT TOUCH THE BOARD
OR THE CHALK