

Title: Quantum Optics meets Manybody Physics

Date: Jun 27, 2007 09:00 AM

URL: <http://pirsa.org/07060073>

Abstract:

Ingredients:

light + atoms



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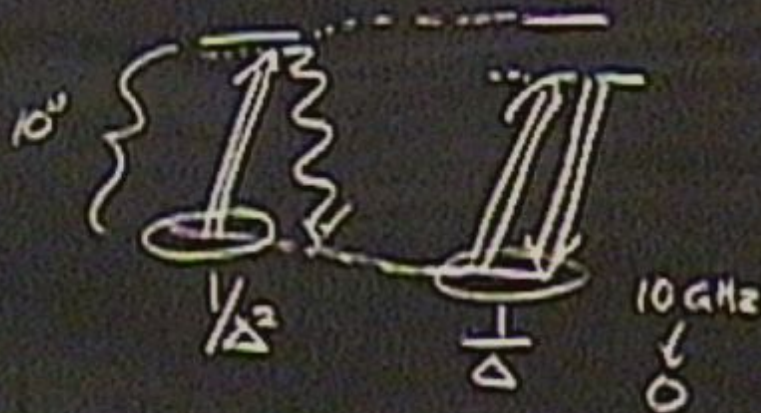
light + atoms



Ingredients:

light + atoms

Scalar potential  
 $\propto I$



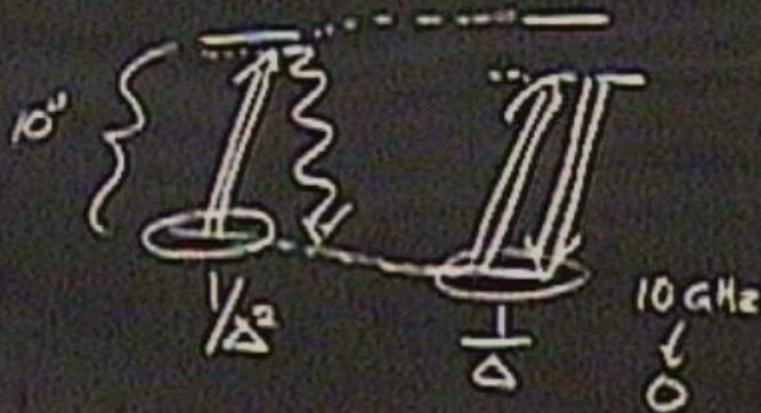
# Ingredients:

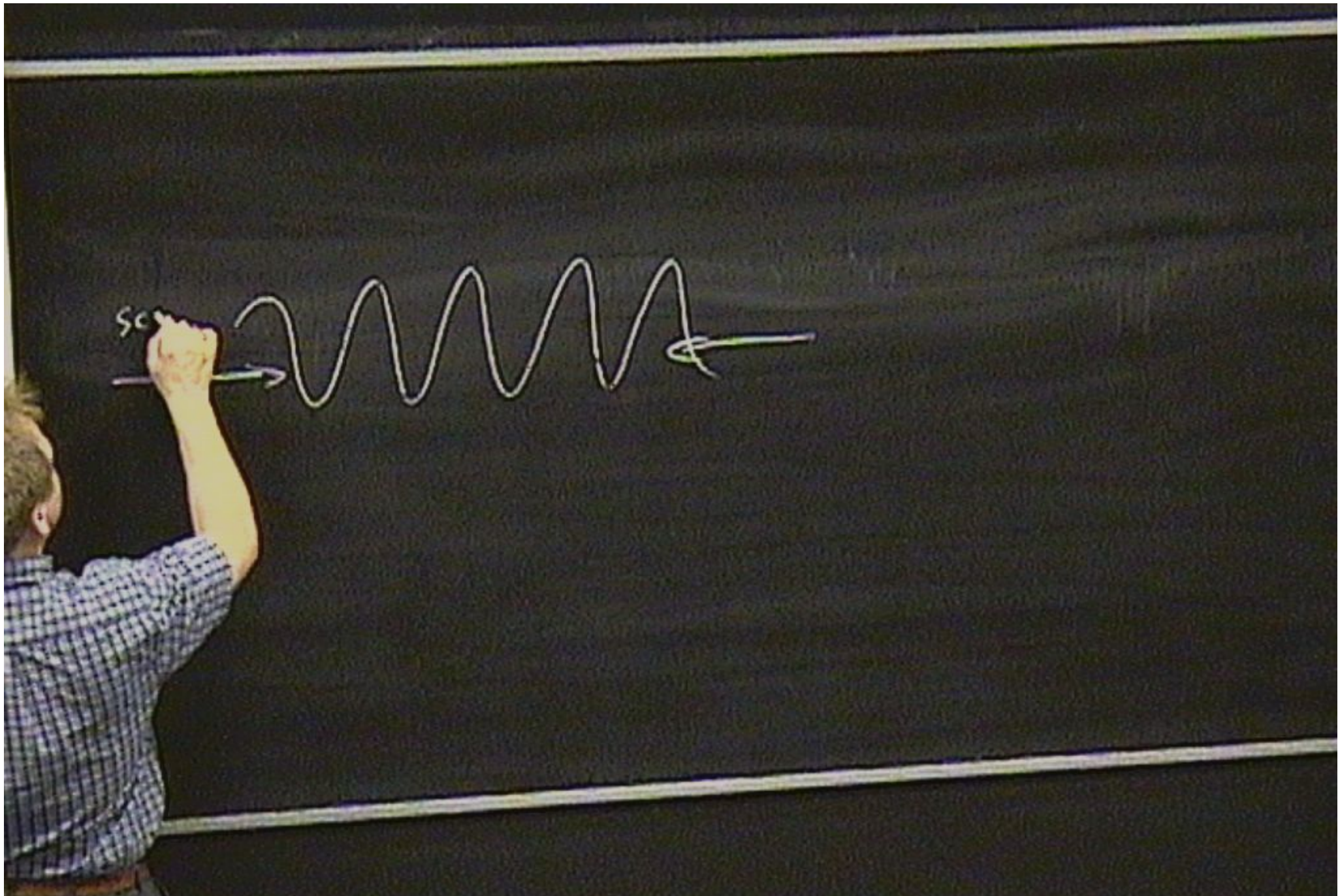
light + atoms

Scalar potential  
 $\propto I$

Vector  $\propto I(\vec{E} \times \vec{E}) \propto m$

Tensor  $\propto m^2$

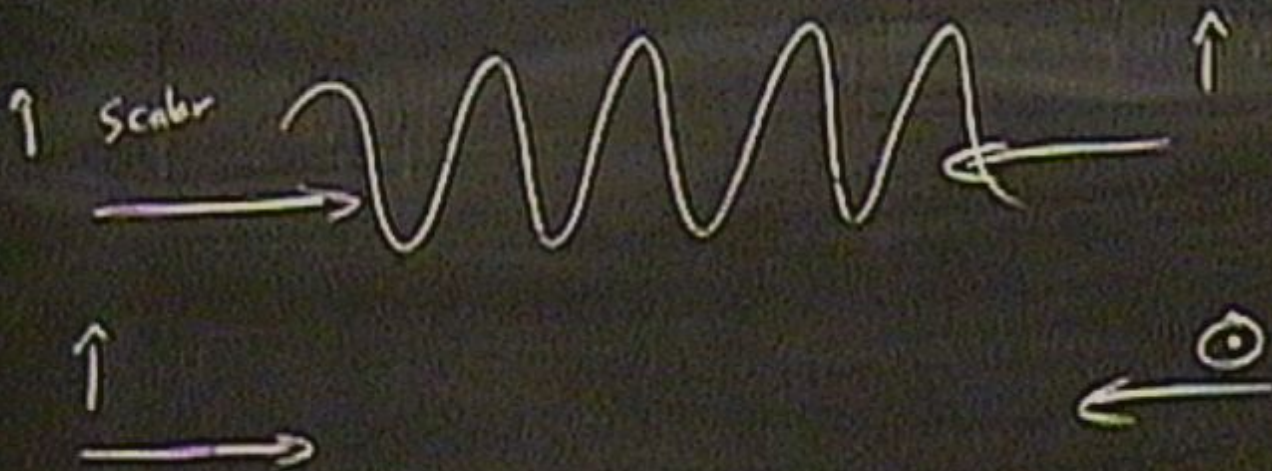


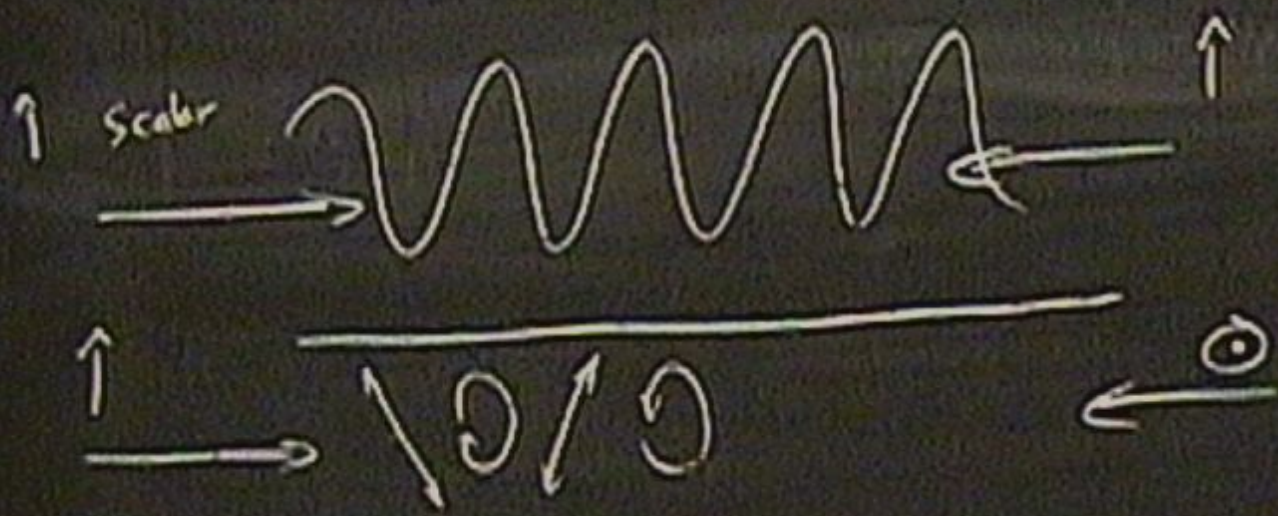


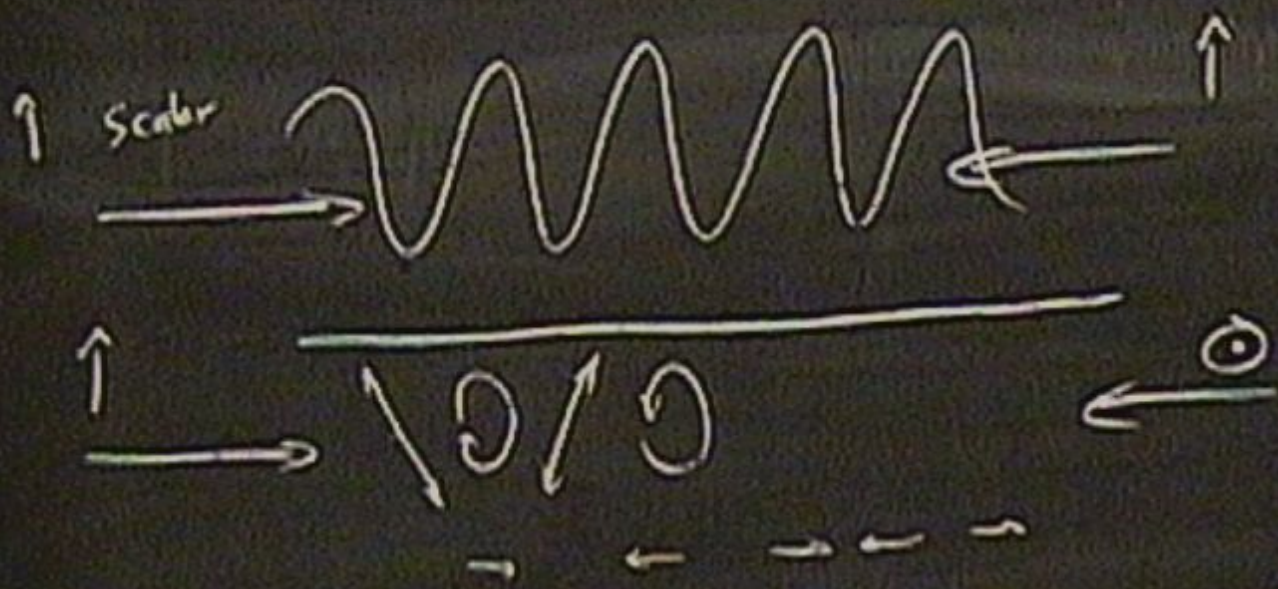
sc

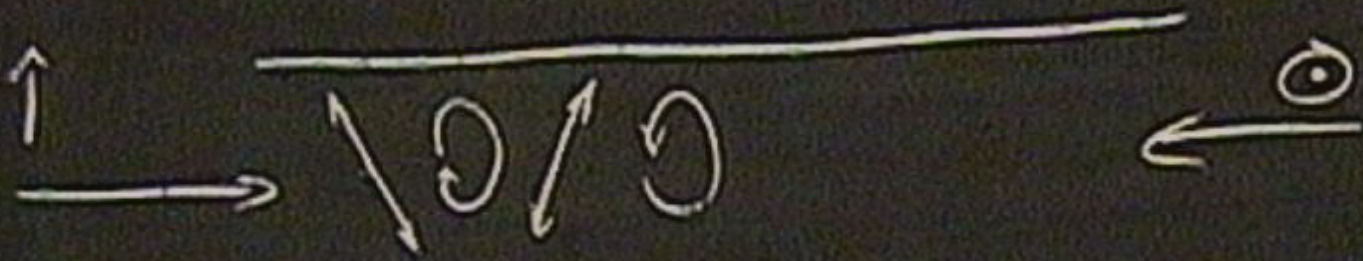












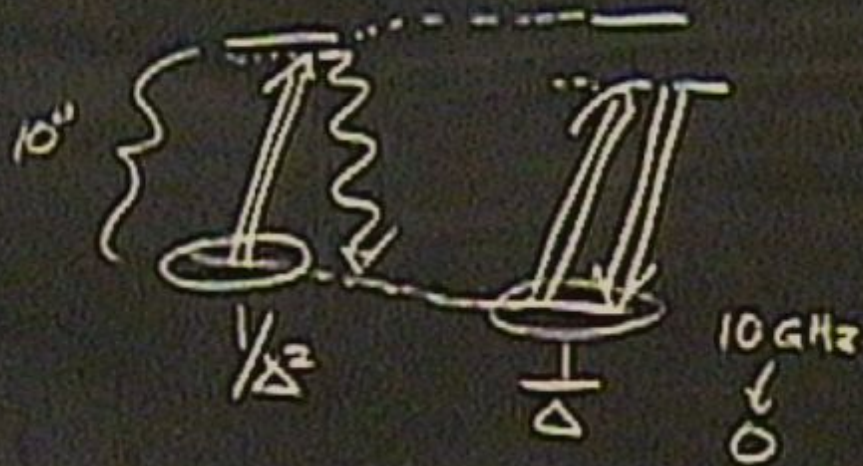
# Ingredients:

light + atoms

Scalar potential  
 $\propto I$

Vector  $\propto I(\vec{E} \times \vec{E}) \propto m$

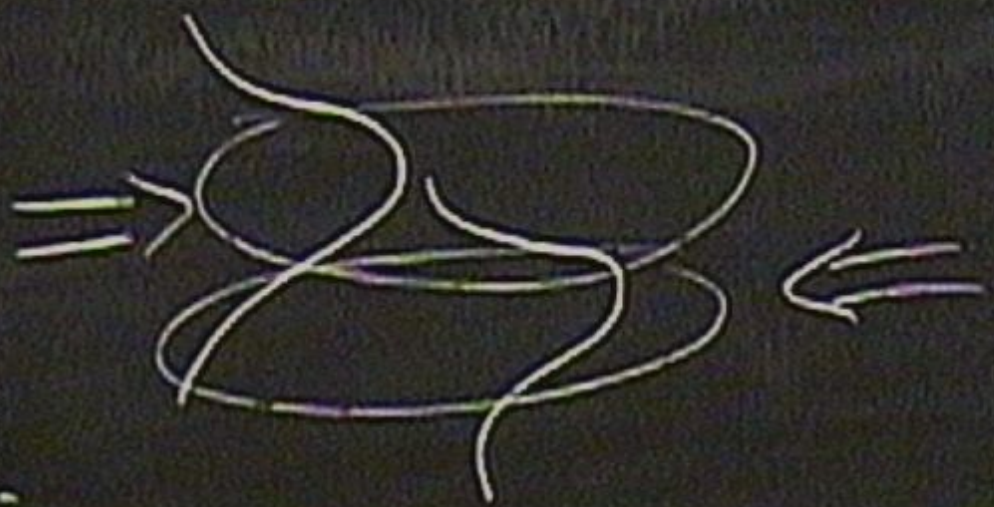
Tensor  $\propto m^2$

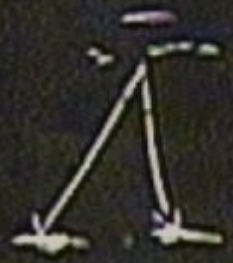
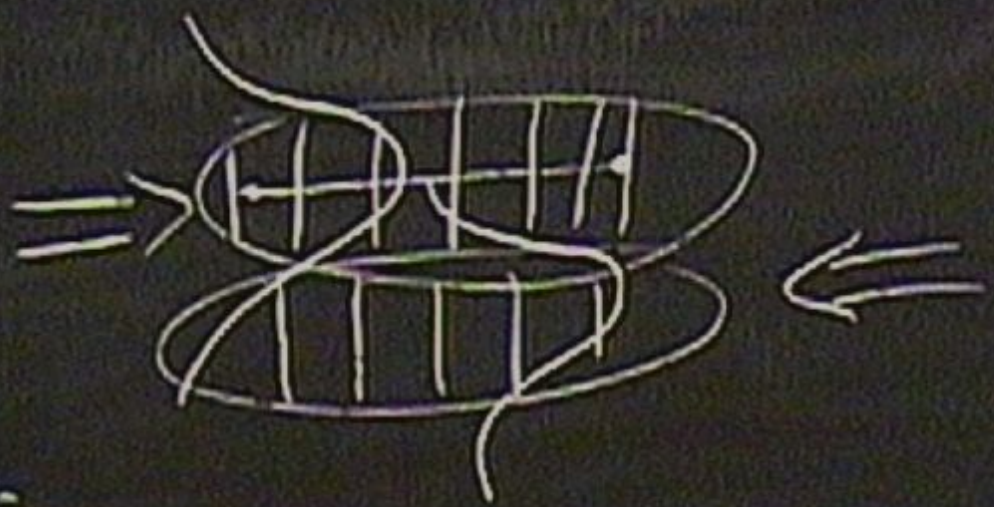


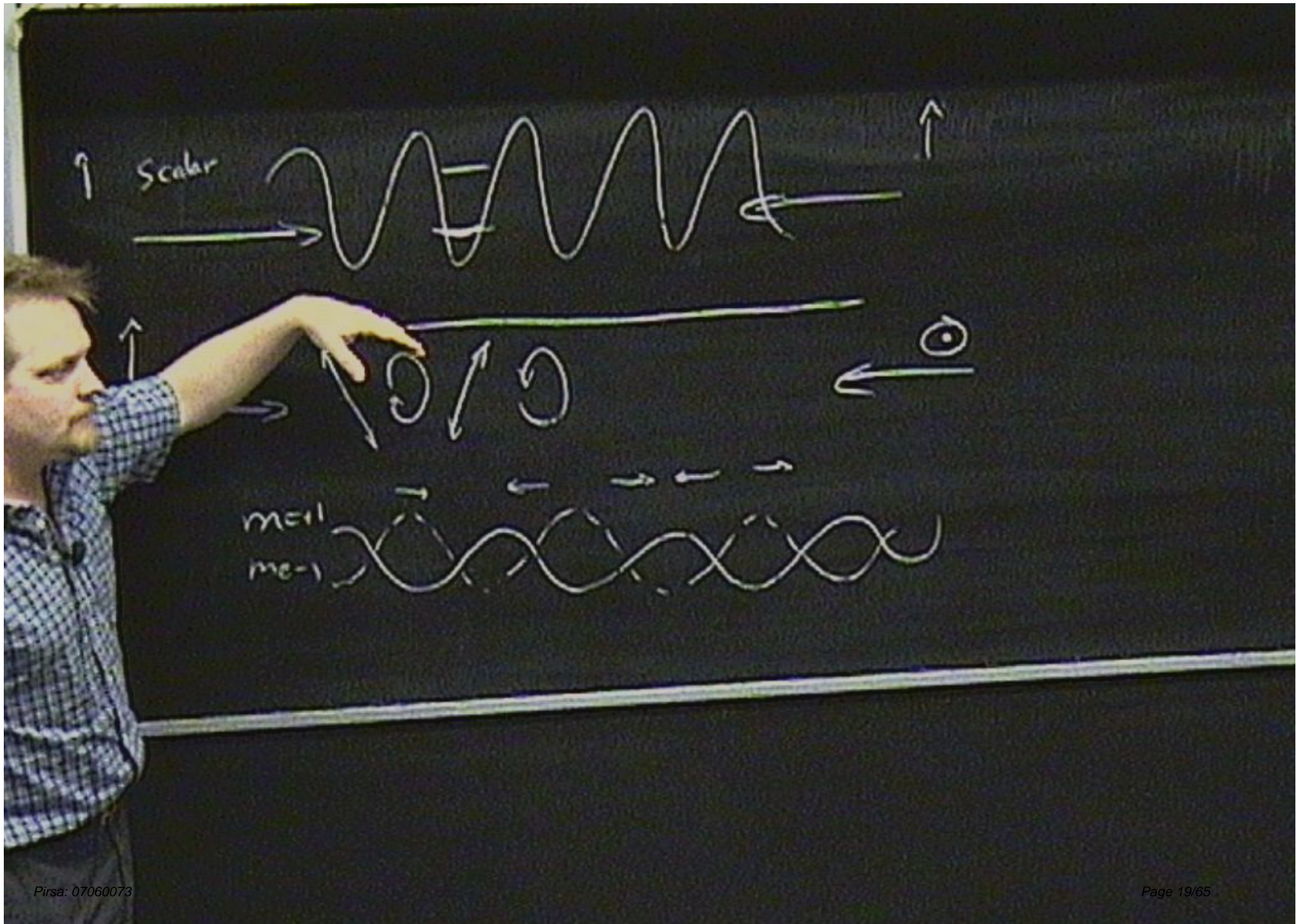






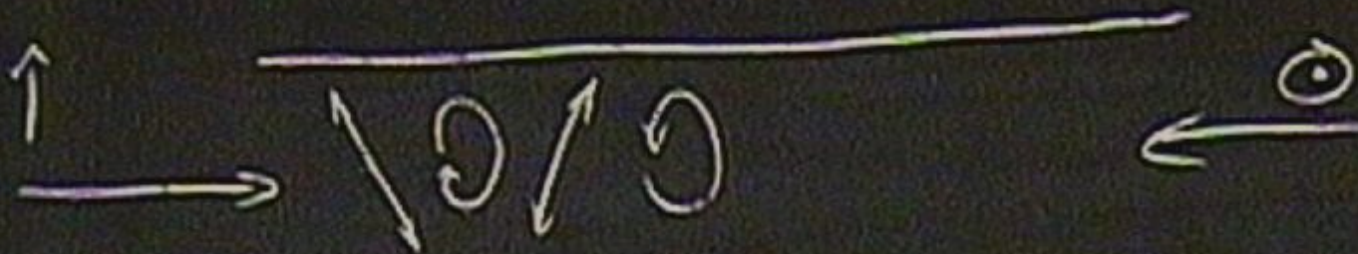
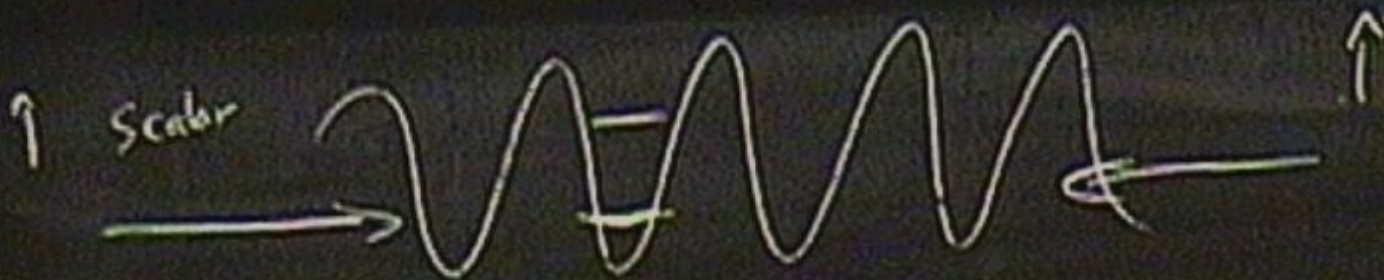






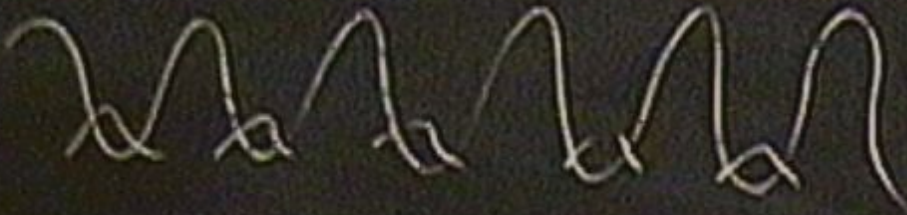
↑ Scalar

$m_e + 1$   
 $m_e - 1$



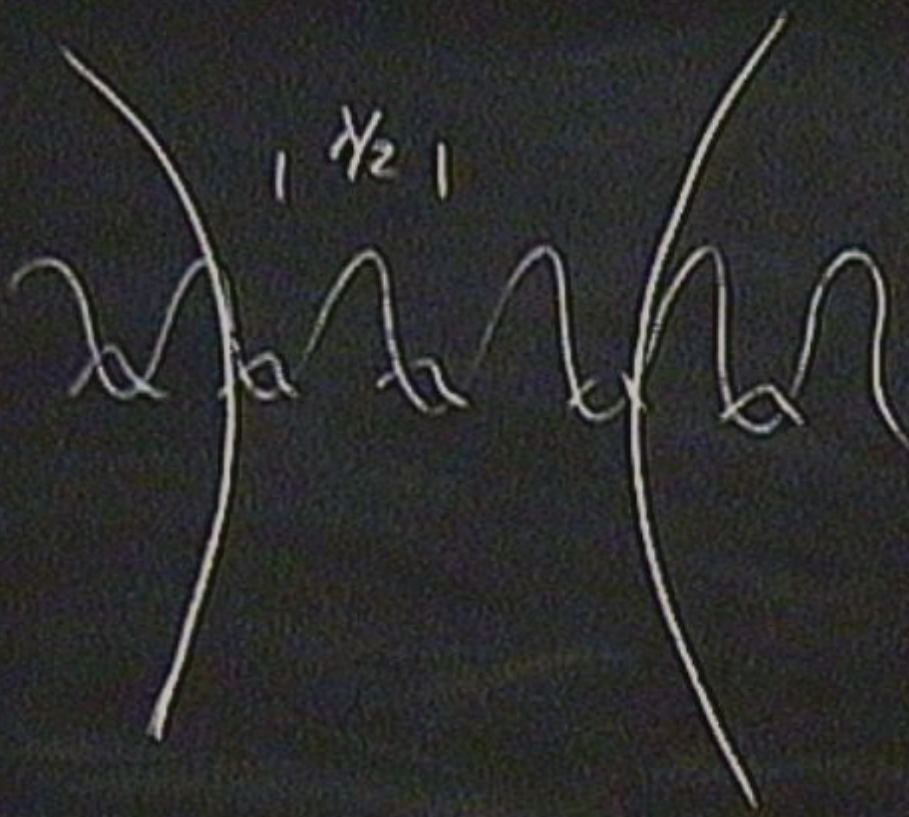
Handwritten scribbles or symbols on a dark background.

$\left| \frac{1}{2} \right|$

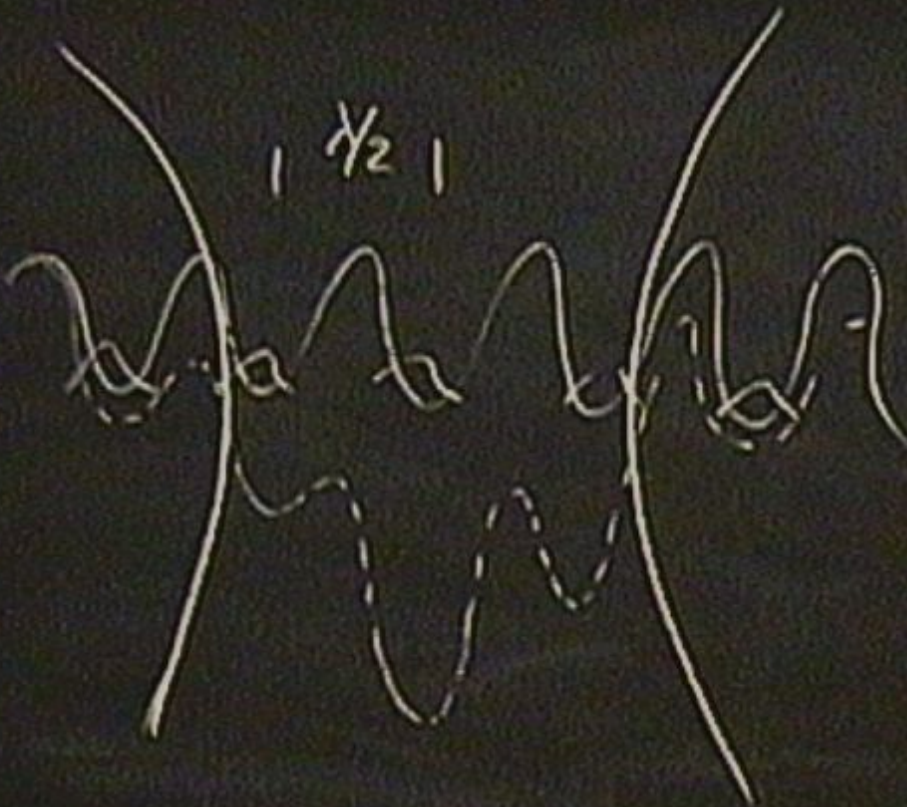


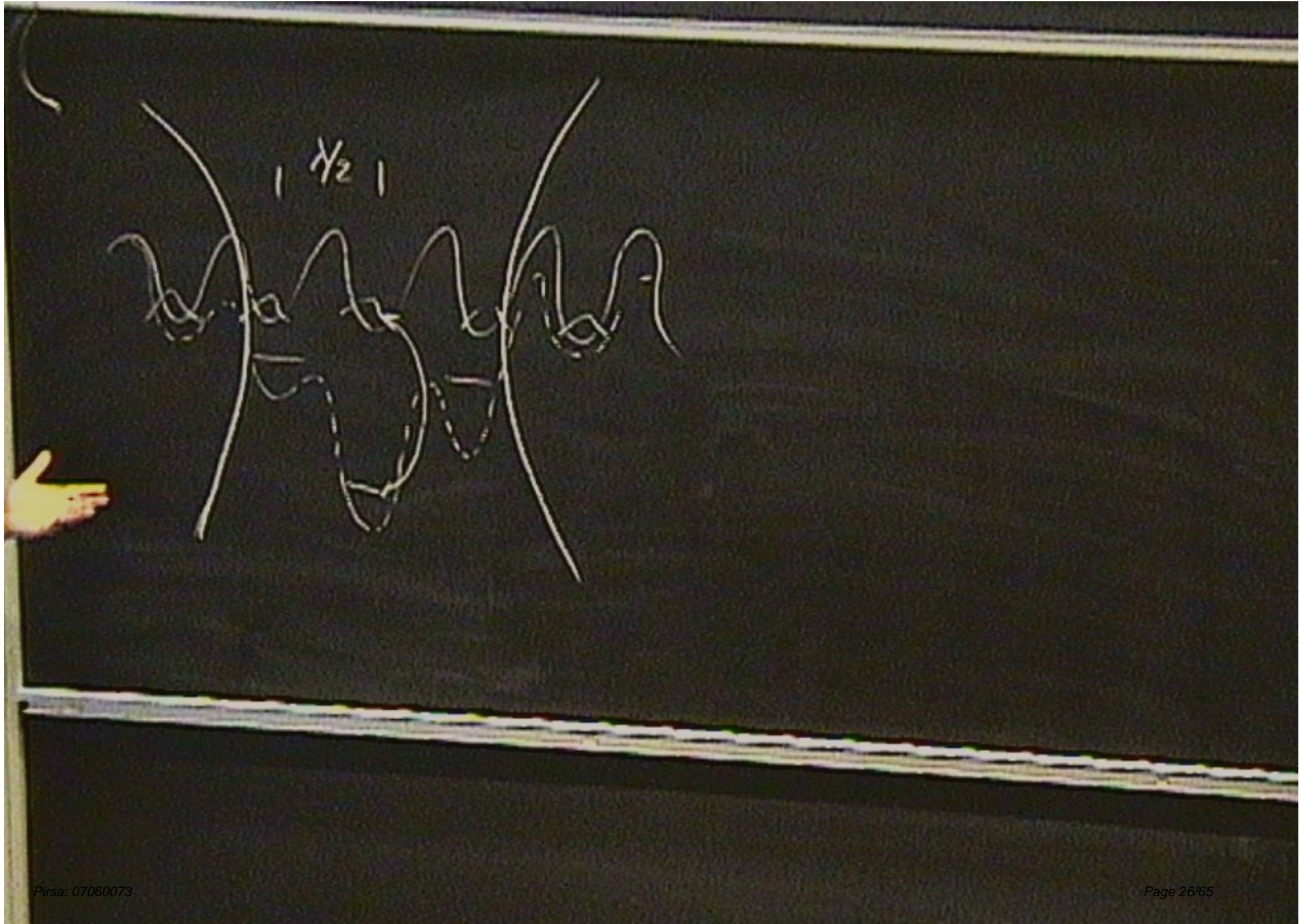
$1, \frac{1}{2}, 1$

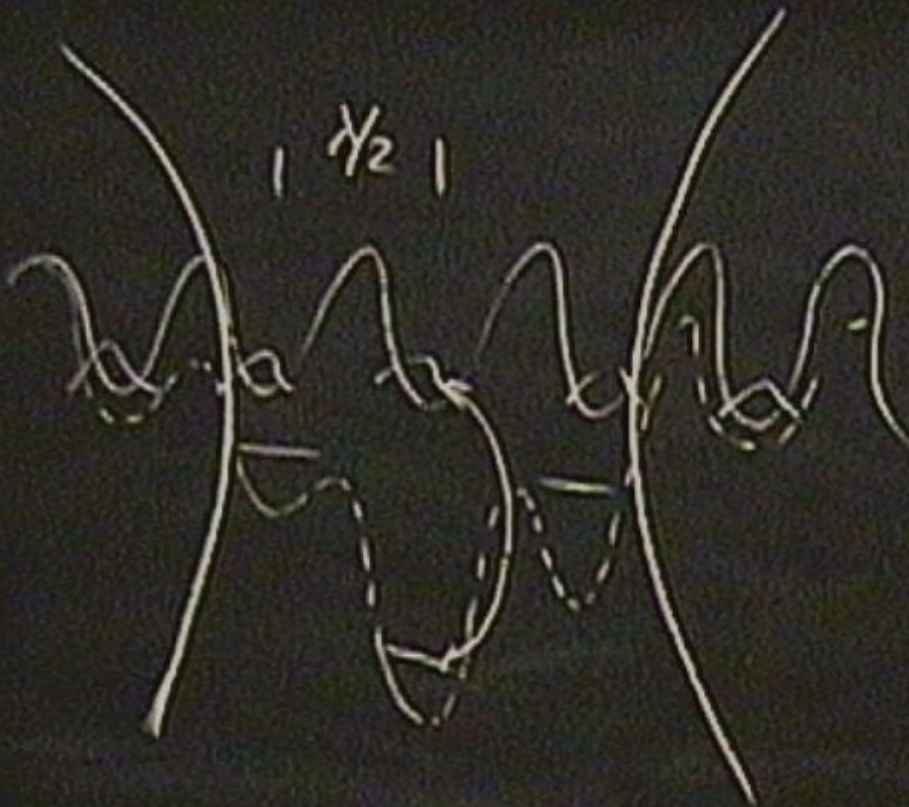












- point contact -

- point contact - S-function  
S-wave

— point contact —  $\delta$ -function  
S-wave

— point contact —  $\delta$ -function  
S-wave

$$\int \psi(\vec{r}_1) \delta(\vec{r}_1 - \vec{r}_2) \psi(\vec{r}_2) d^3r$$
$$\int |\psi|^2 |\psi|^2 d^3r$$

- point contact -  $\delta$ -function  
S-wave

$$\int \psi(\vec{r}_1) \delta(\vec{r}_1 - \vec{r}_2) \psi(\vec{r}_2) d^3r$$
$$\int |\psi|^2 |\psi|^2 d^3r$$

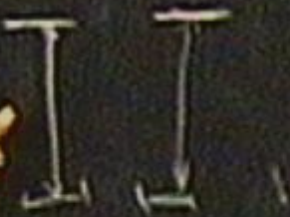


- point contact - S-function  
S-wave

$$\left\{ \begin{array}{l} \Psi(\vec{r}_1) \delta(\vec{r}_1 - \vec{r}_2) \Psi(\vec{r}_2) d \\ \int |\Psi|^2 |\Psi|^2 d^3r \end{array} \right.$$

- point contact -  $\delta$ -function  
S-wave

- induced dipole interaction



$$\int \psi(\vec{r}_1) \delta(\vec{r}_1 - \vec{r}_2) \psi(\vec{r}_2) d^3r$$
$$\int |\psi|^2 |\psi|^2 d^3r$$

- point contact - S-function  
S-wave

- induced dipole interaction



$$\int \psi(r_1) \delta(r_1 - r_2) \psi(r_2) d$$
$$\int |\psi|^2 |\psi|^2 d^3r$$

— point contact - S-function  
S-wave

— induced dipole interaction



— ground state dipole polariz.

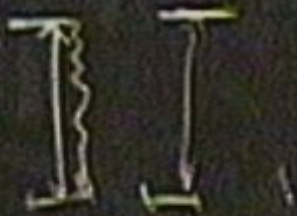
$$\int \psi(\vec{r}_1) \delta(\vec{r}_1 - \vec{r}_2) \psi(\vec{r}_2) d^3r$$
$$\int |\psi|^2 |\gamma|^2 d^3r$$

- point contact -  $\delta$ -function  
 S-wave

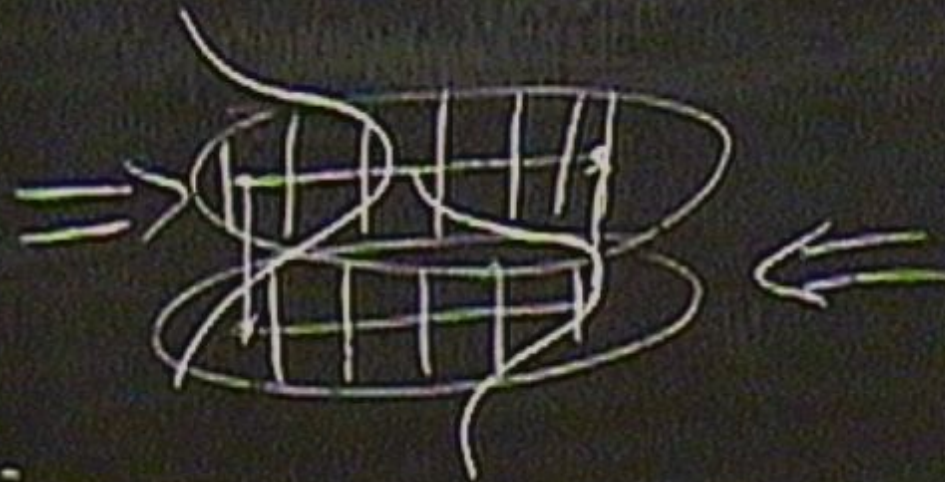
$$\int \psi(\vec{r}_1) \delta(\vec{r}_1 - \vec{r}_2) \psi(\vec{r}_2) d^3r$$

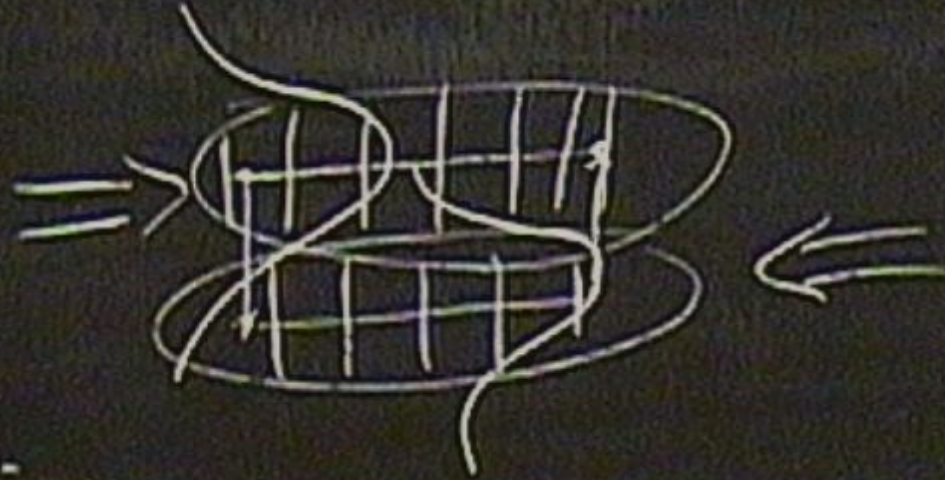
$$\int |\psi|^2 |\psi|^2 d^3r$$

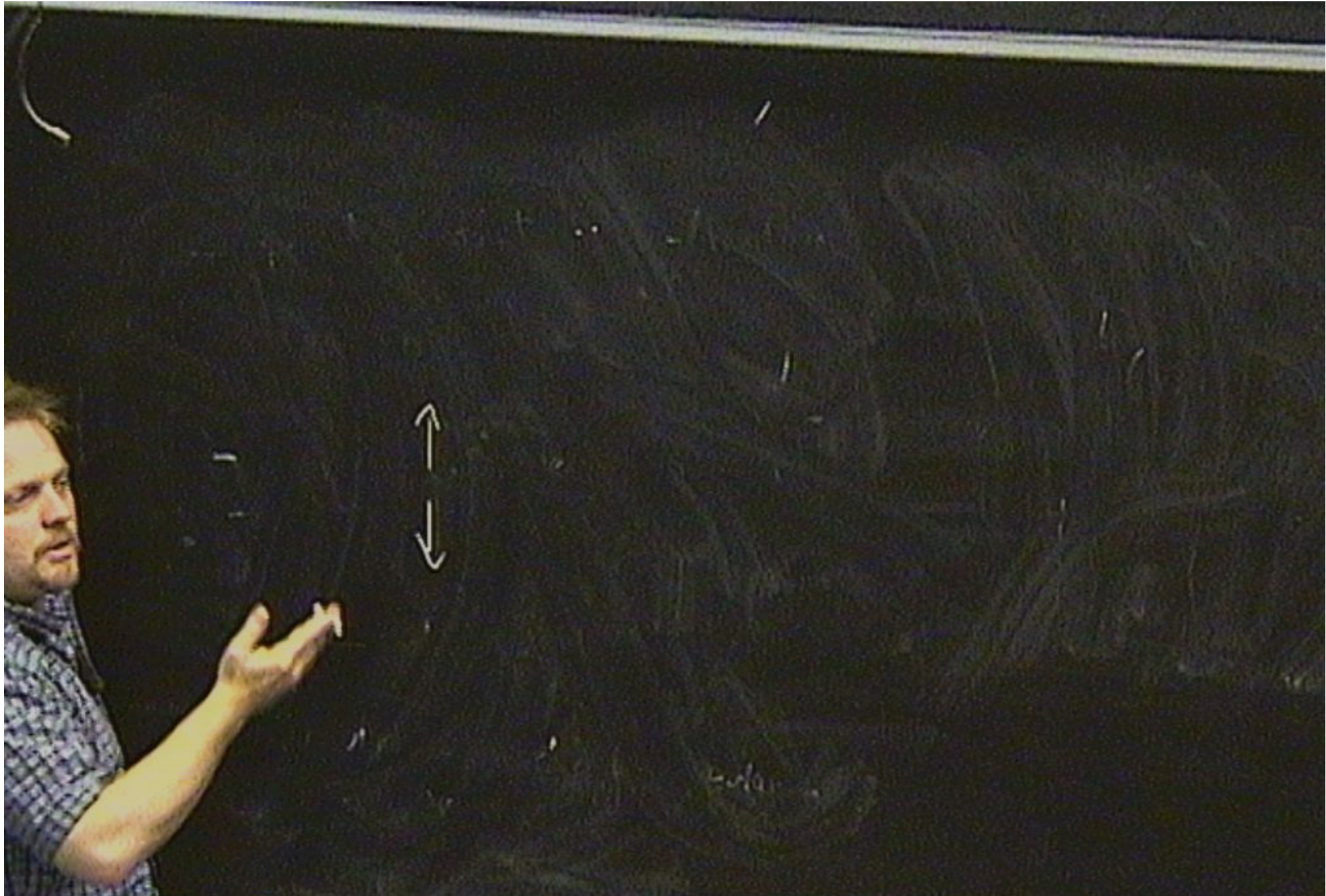
- induced dipole interaction



- Ground state dipole      polar mol.  
    induced dipole

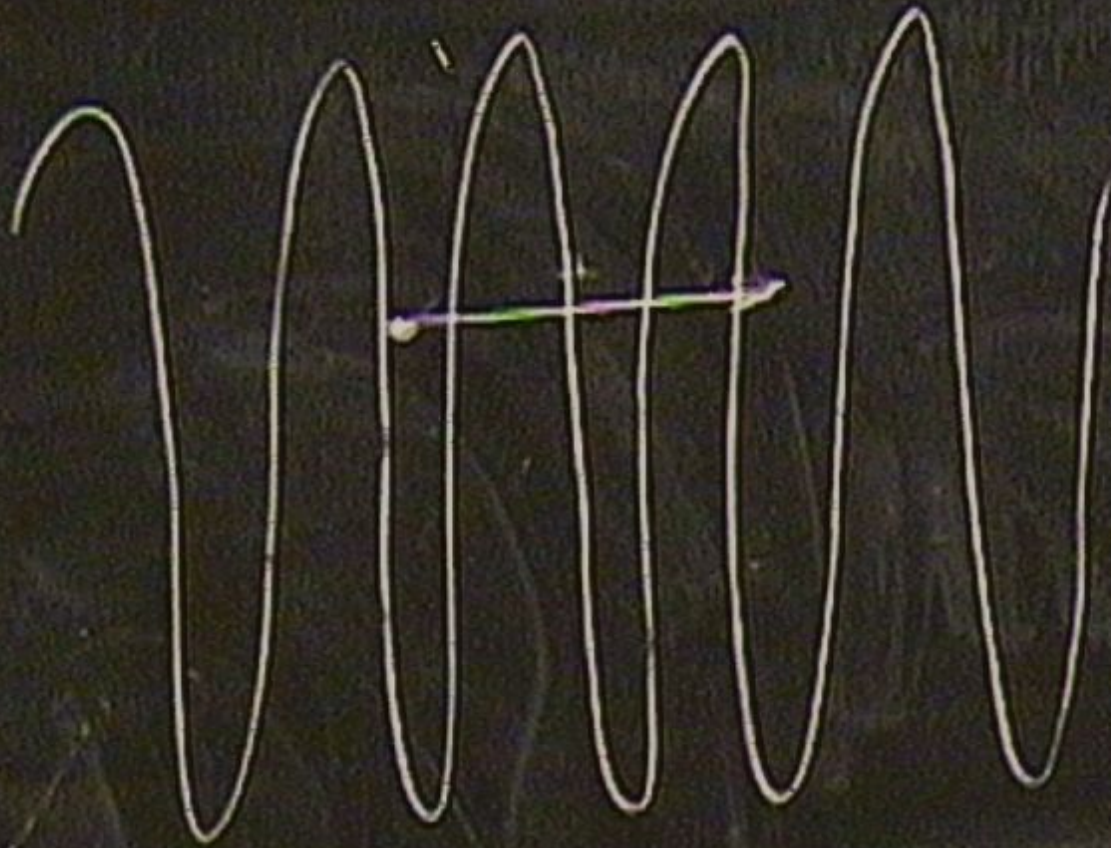






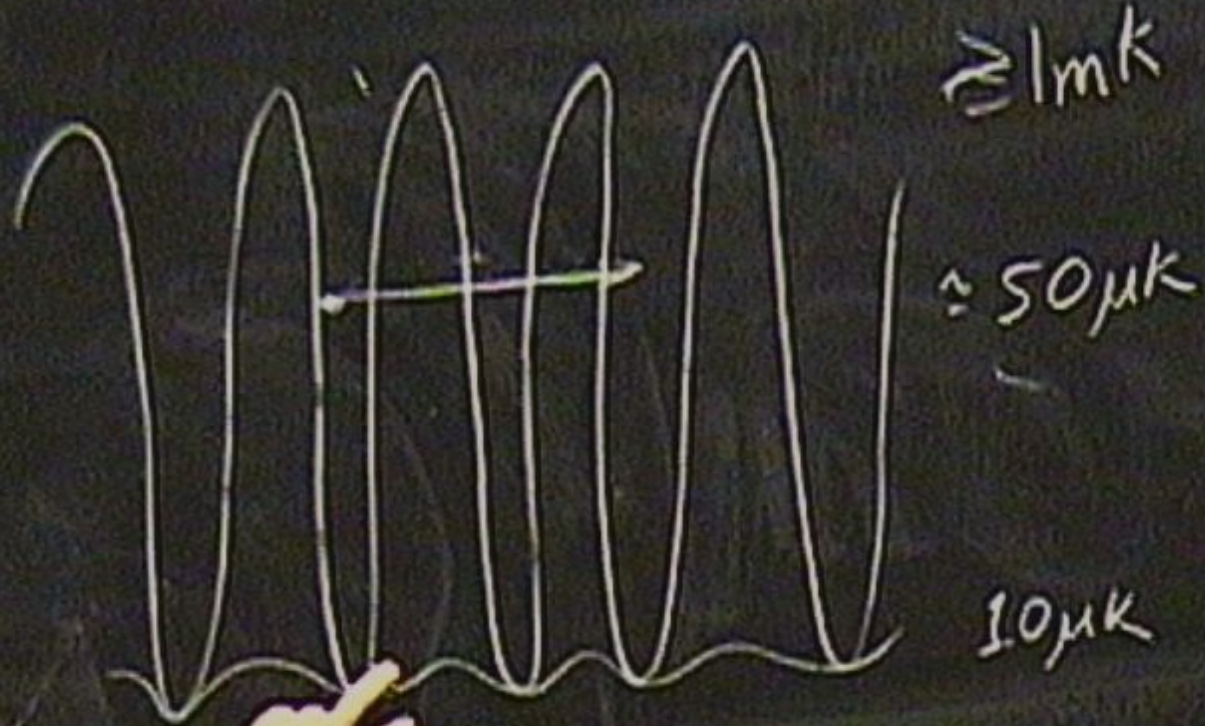


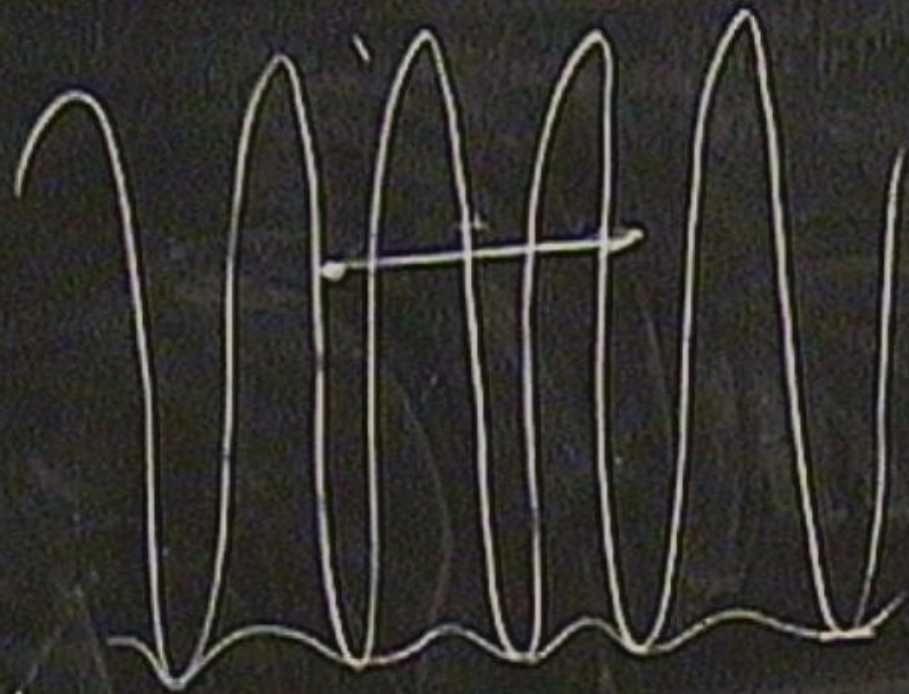




$\approx 1\text{mk}$

$\approx 50\mu\text{k}$



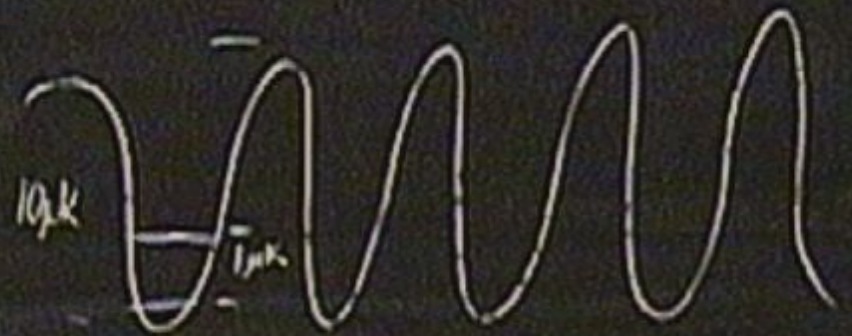
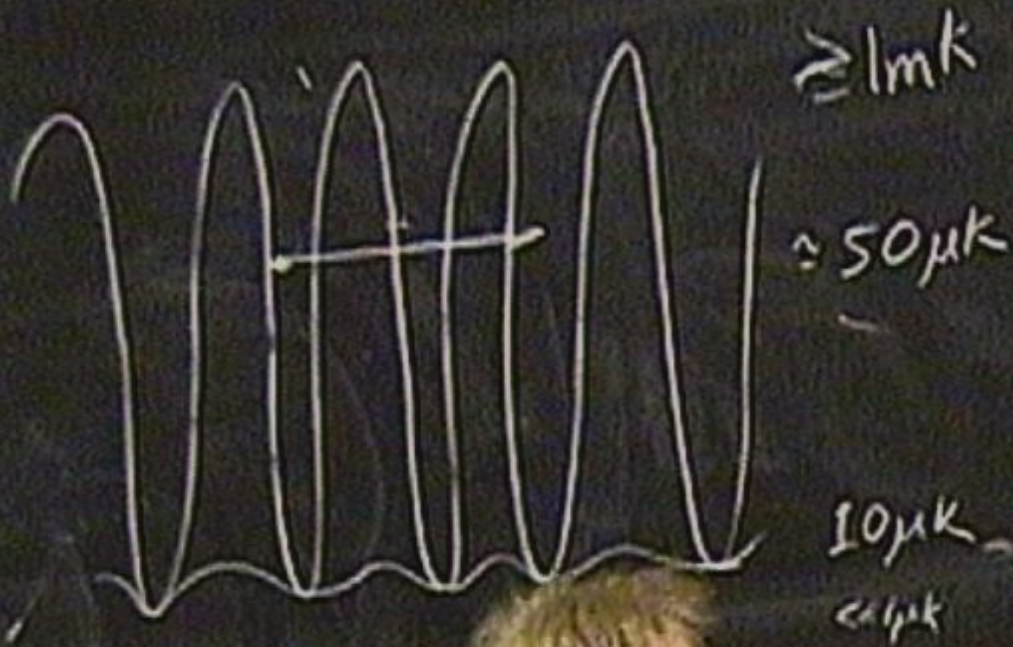


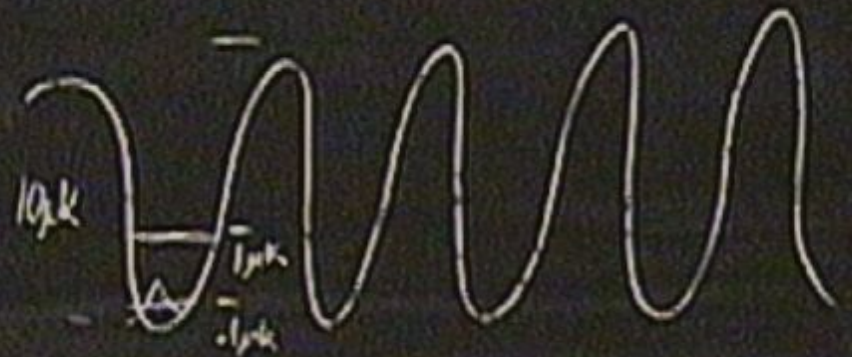
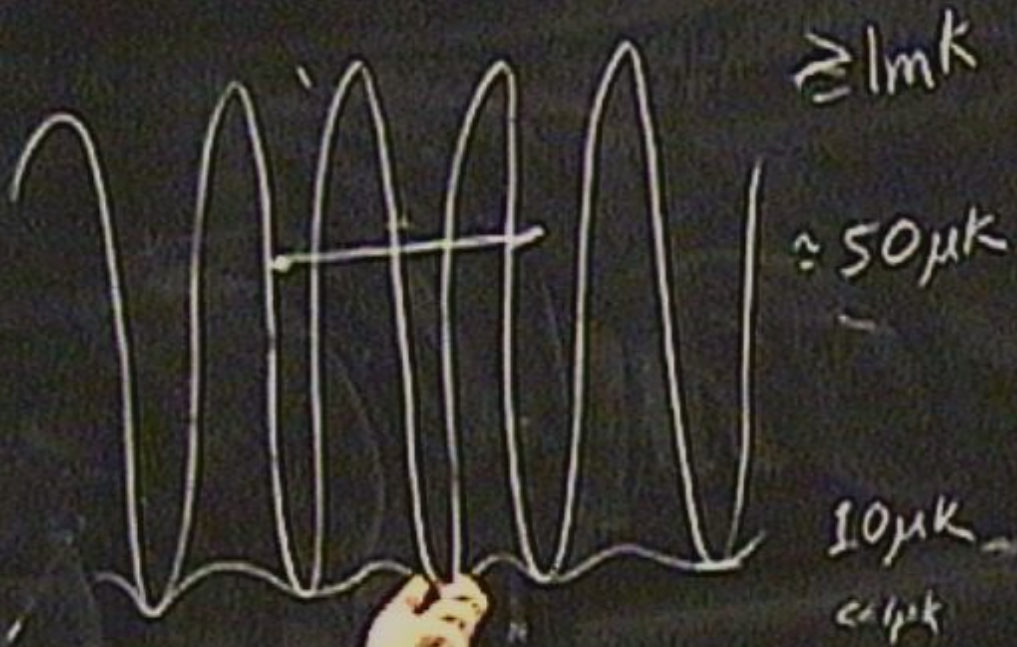
$\approx 1\text{mV}$

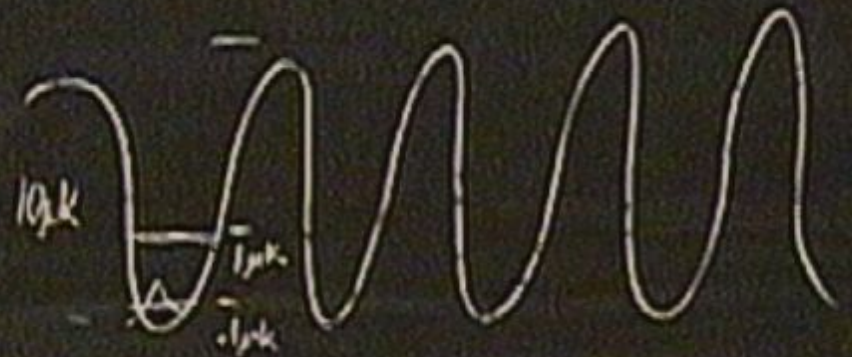
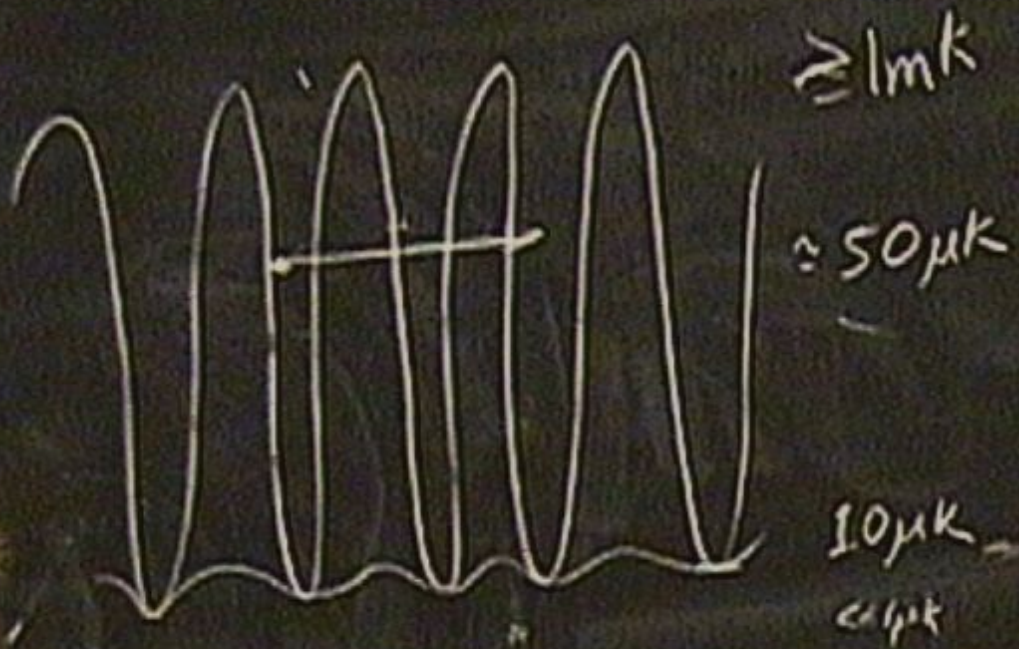
$\approx 50\mu\text{s}$

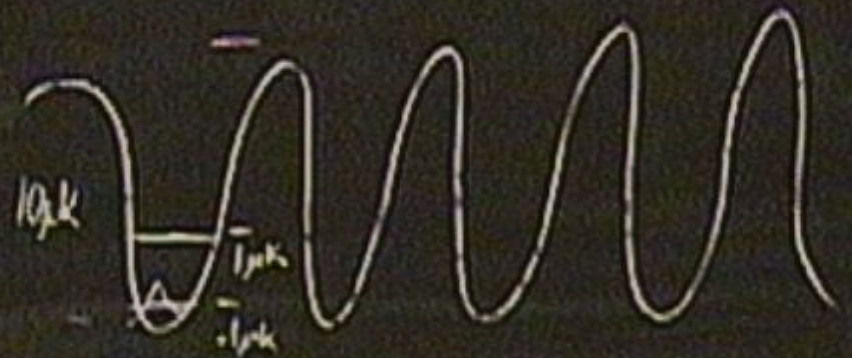
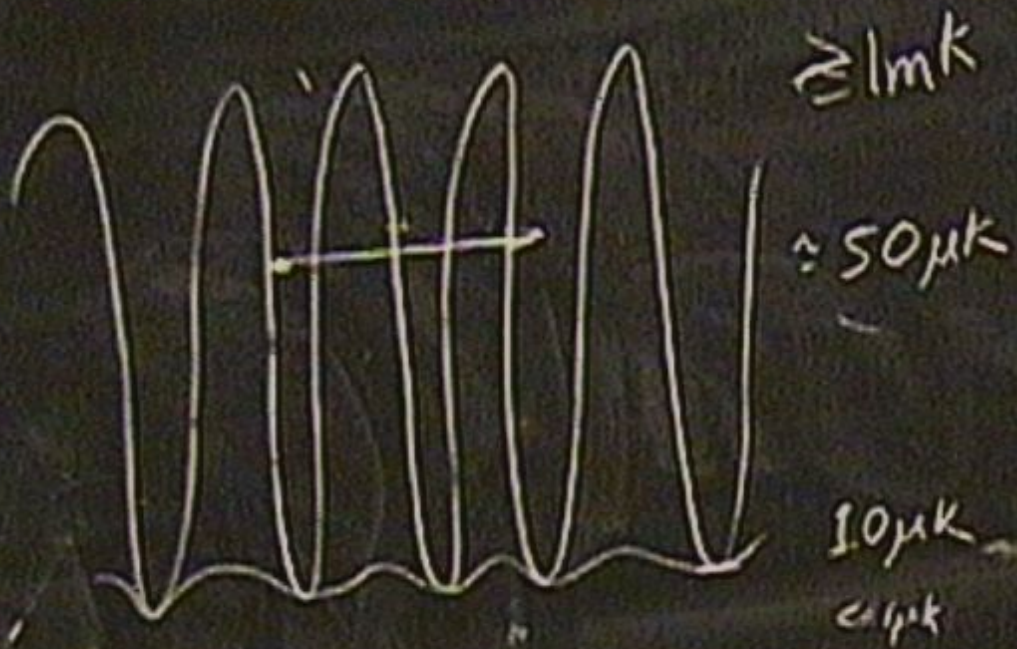
$10\mu\text{s}$

$\ll 1\mu\text{s}$

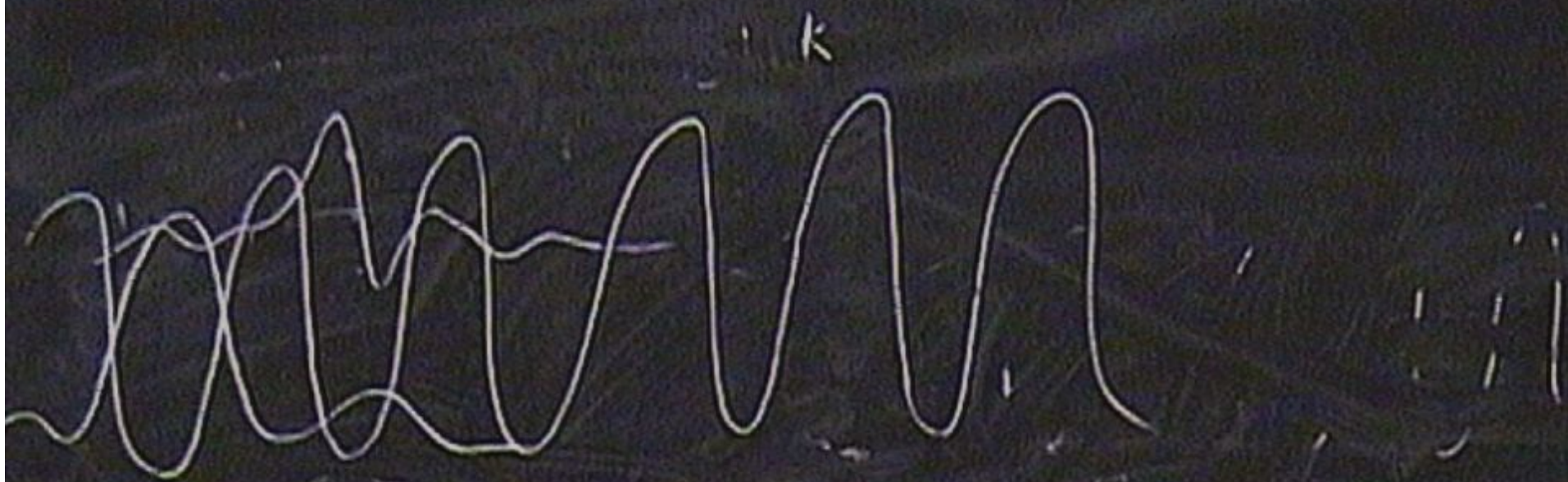




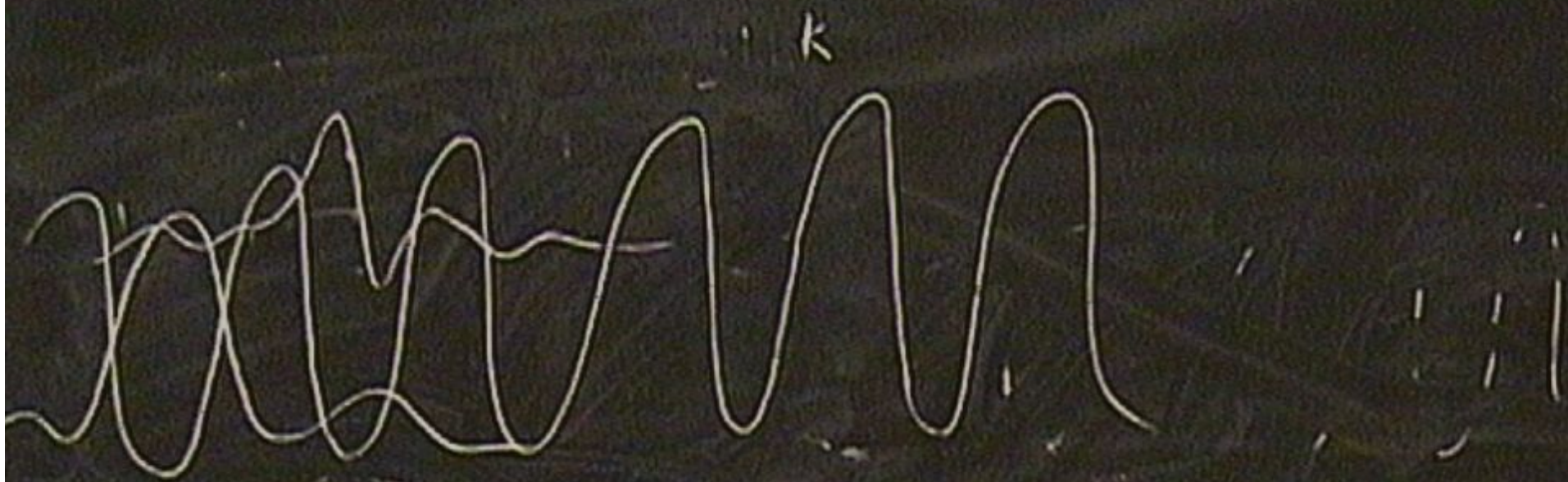






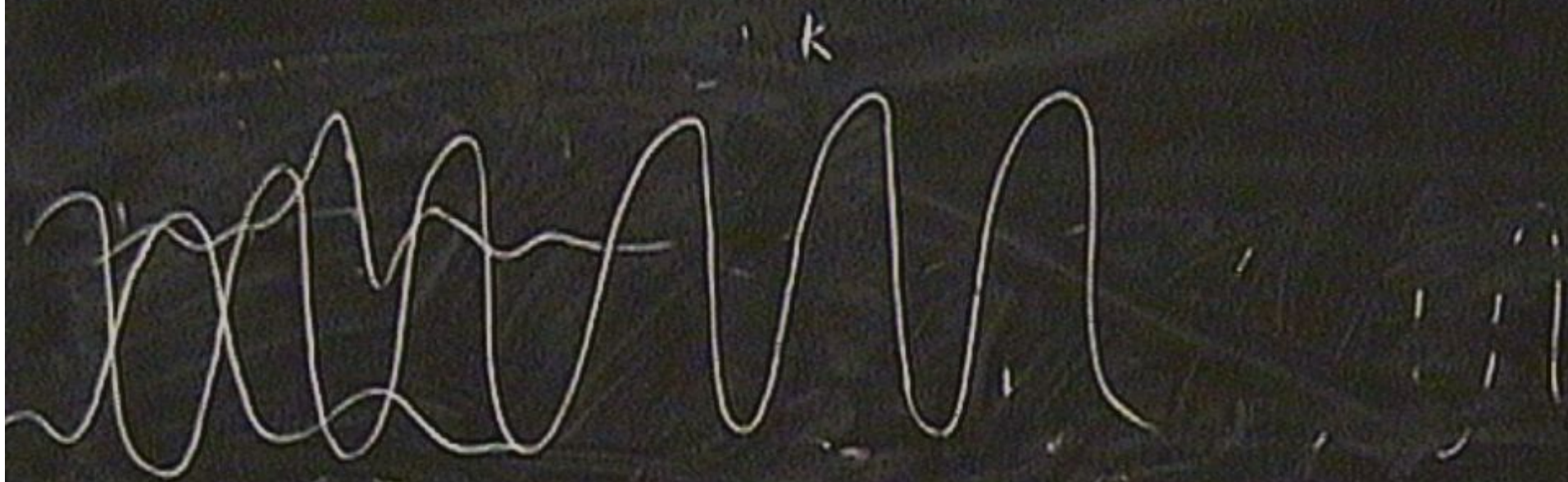


$$U \approx 0.1 \mu k$$



$$L \approx 0.1 \mu\text{K}$$

$$t \ll 0.1 \mu\text{K}$$



$$U \approx 0.1 \mu\text{K}$$

$$t \lesssim 0.1 \mu\text{K}$$

$$\ll$$

$$\frac{t^2}{U} \lesssim 40^{-3} \mu\text{K}$$



$$H = -t \sum \hat{a}_j^\dagger \hat{a}_{j+1} + \frac{U}{2} \sum \hat{n}_j (\hat{n}_j - 1)$$

+

$$H = -t \sum \hat{a}_j^\dagger \hat{a}_{j+1} + \frac{U}{2} \sum \hat{n}_j (\hat{n}_j - 1)$$

$$+ V \sum \hat{n}_j \hat{n}_{j+1}$$



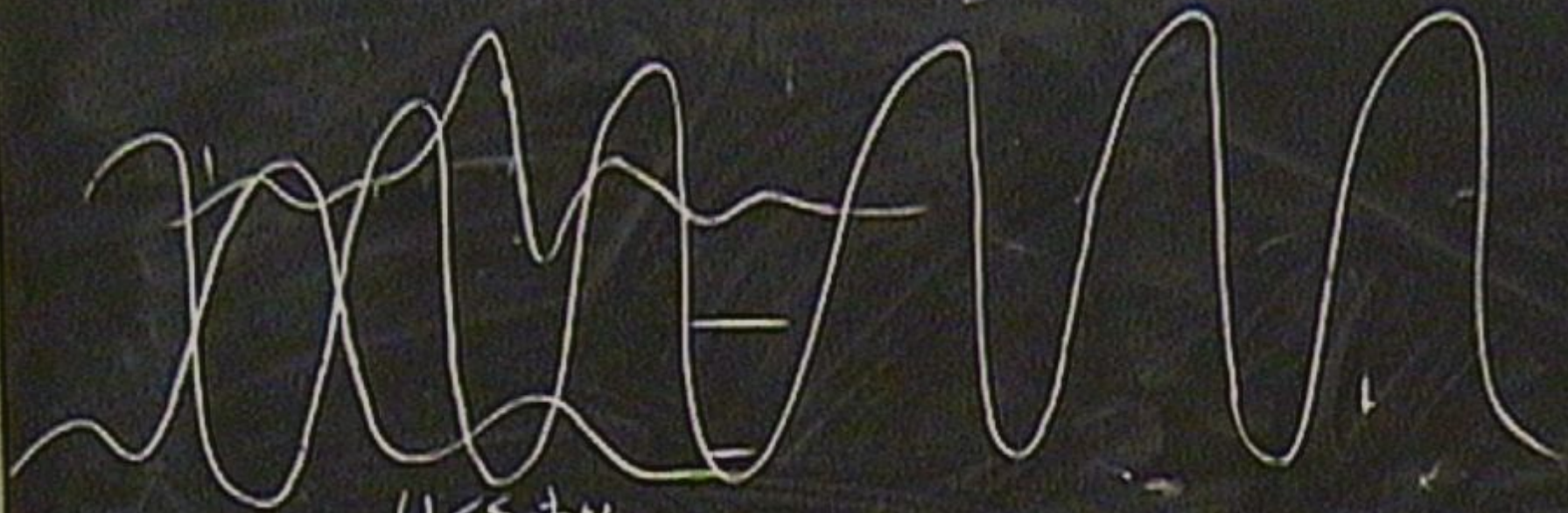


$$H = -t \sum \hat{a}_j^\dagger \hat{a}_{j+1} + \frac{U}{2} \sum \hat{n}_j (\hat{n}_j - 1)$$

$$+ V \sum \hat{n}_j \hat{n}_{j+1}$$

+ upper band

lower



$$u \ll \frac{h\nu}{\Delta_{\text{broad}}}$$

$$u \approx 0.1 \mu\text{K}$$

$$t \lesssim 0.1 \mu\text{K}$$

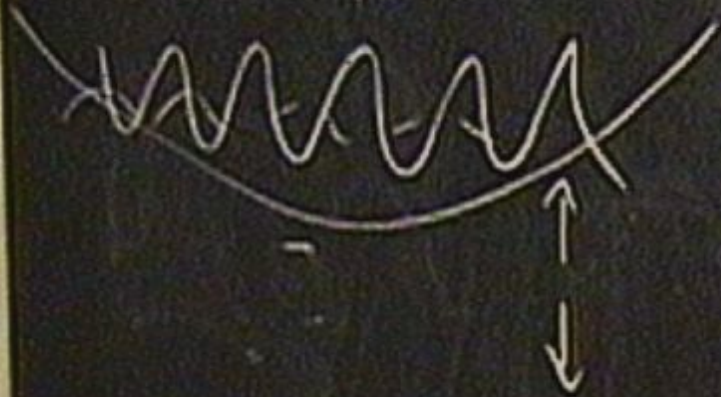
$$\ll 0.01 \mu\text{K}$$

$$\frac{t^2}{u} \lesssim 40^{-3} \mu\text{K}$$

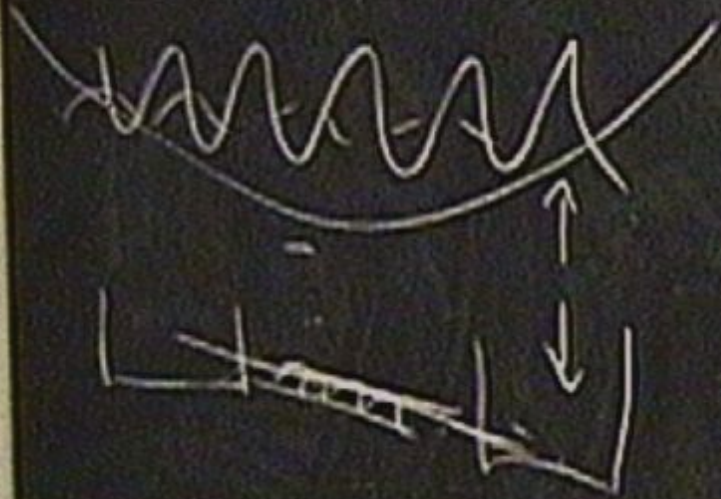
↑  
↓

$$H = -t \sum \hat{a}_j^\dagger \hat{a}_{j+1} + \frac{U}{2} \sum \hat{n}_j (\hat{n}_j - 1) + \sum \epsilon_i \hat{n}_i + V \sum \hat{n}_j \hat{n}_{j+1} + \text{upper bands}$$

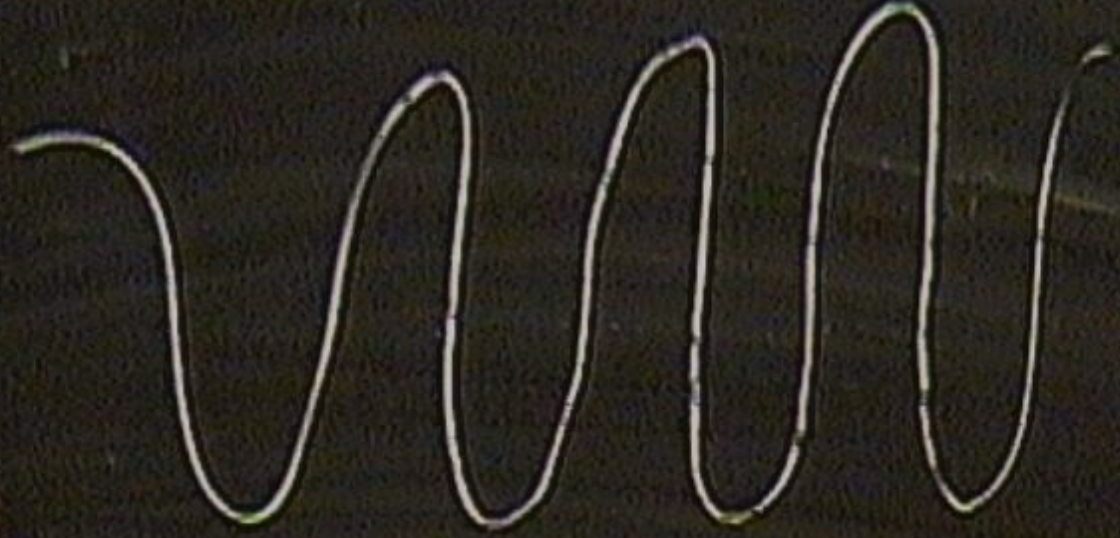




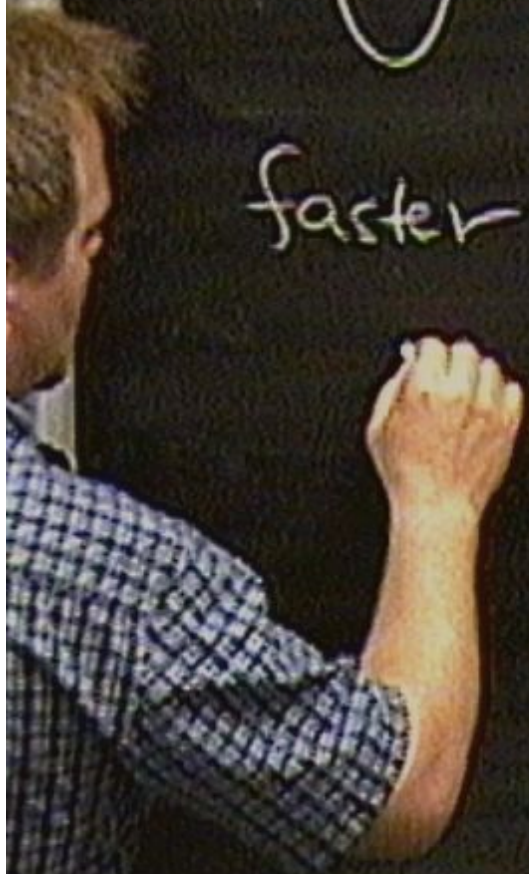
$$\begin{aligned}
 H = & -\epsilon \sum \hat{a}_j^\dagger \hat{a}_{j+1} + \frac{u}{2} \sum \hat{n}_j (\hat{n}_j - 1) \\
 & + V \sum \hat{n}_j \hat{n}_{j+1} + \sum \epsilon_i \hat{n}_i \\
 & + \text{upper layer}
 \end{aligned}$$

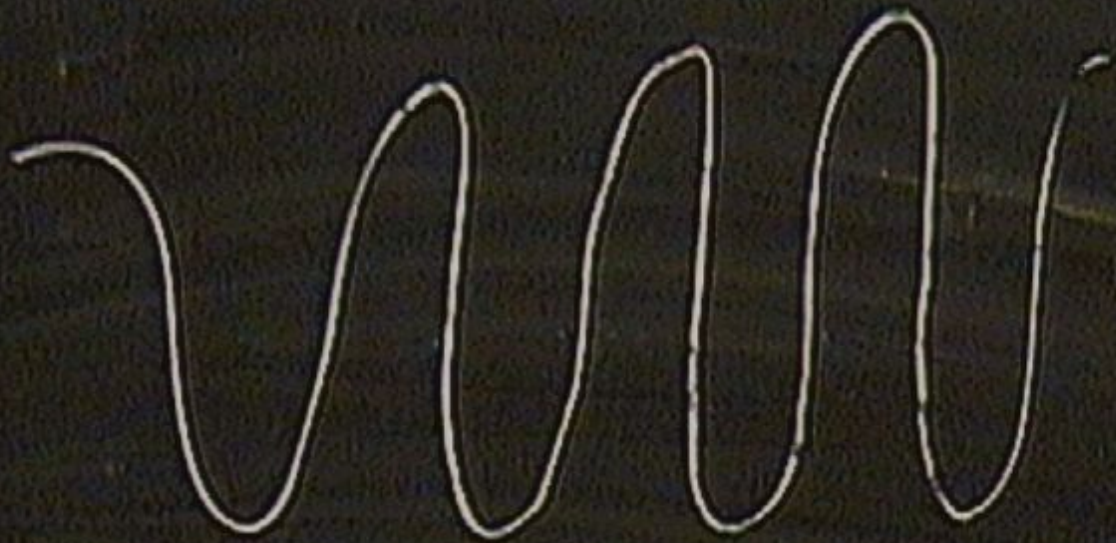


$$\begin{aligned}
 H = & -\epsilon \sum \hat{a}_j^\dagger \hat{a}_{j+1} + \frac{u}{2} \sum \hat{n}_j (\hat{n}_j - 1) \\
 & + V \sum \hat{n}_j \hat{n}_{j+1} + \sum \epsilon_j \hat{n}_j \\
 & + \text{upper bands}
 \end{aligned}$$



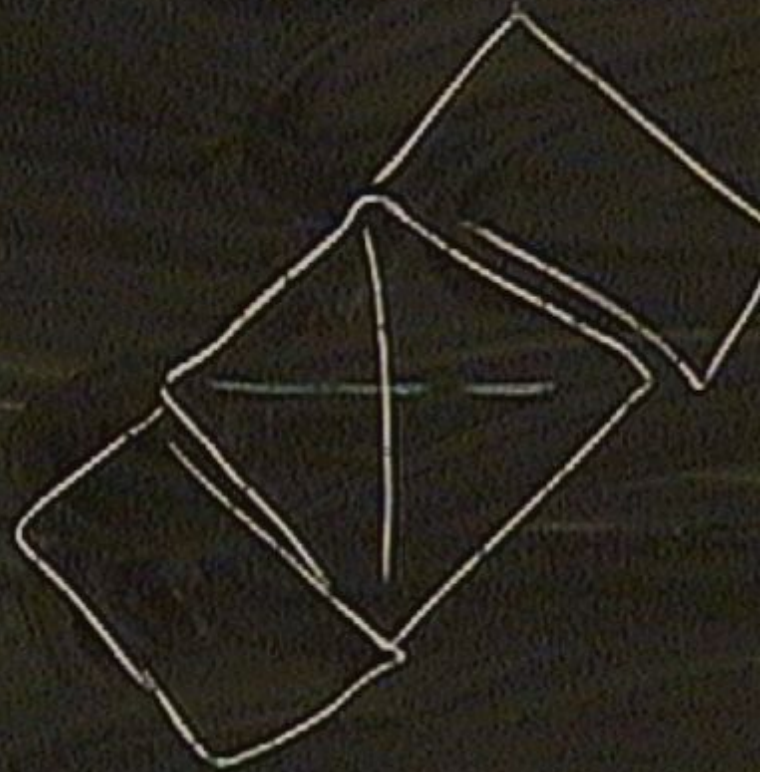
faster

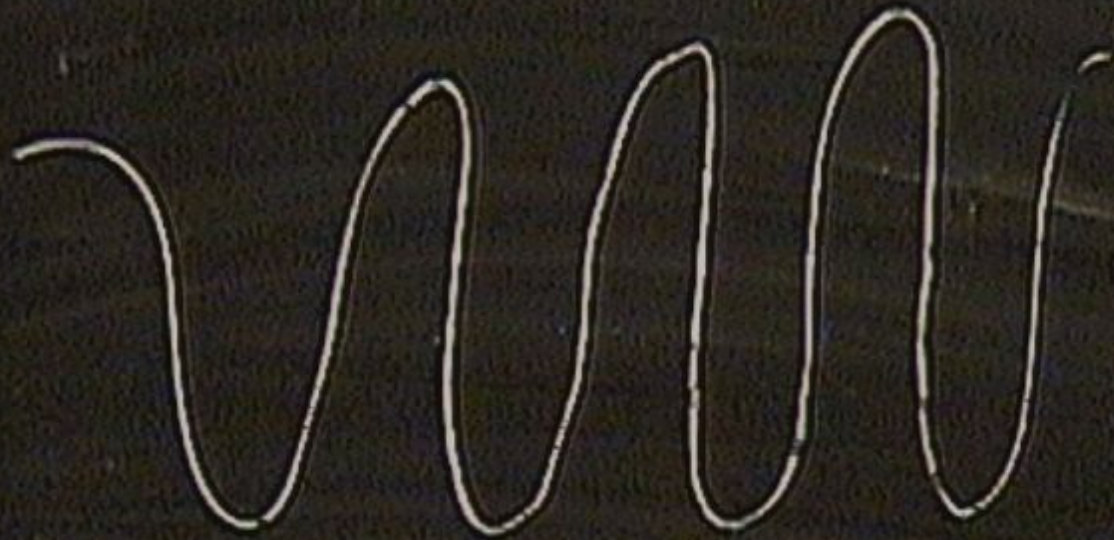




faster

$u \ll \frac{1}{2} \ll \hbar \omega$

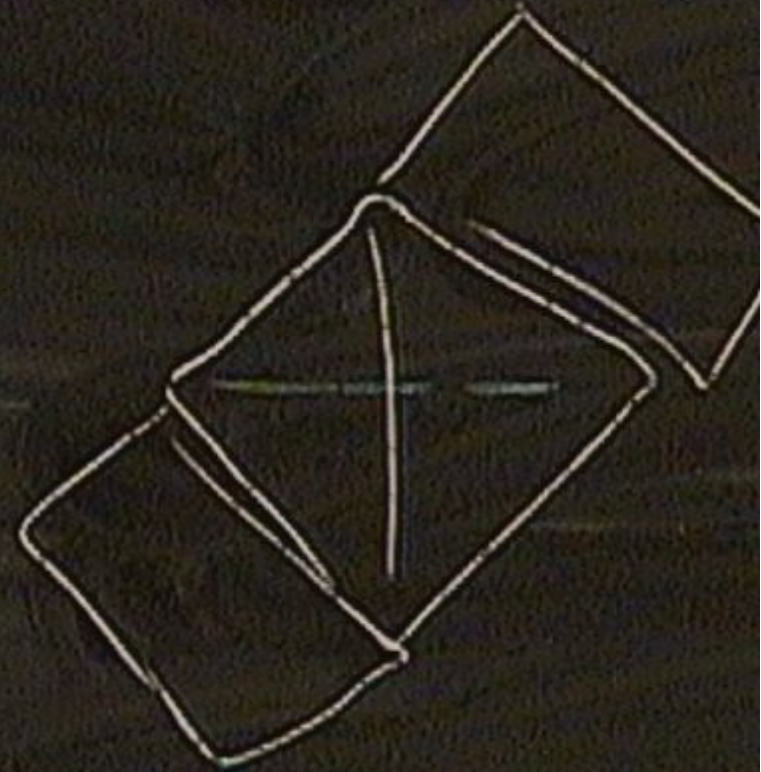


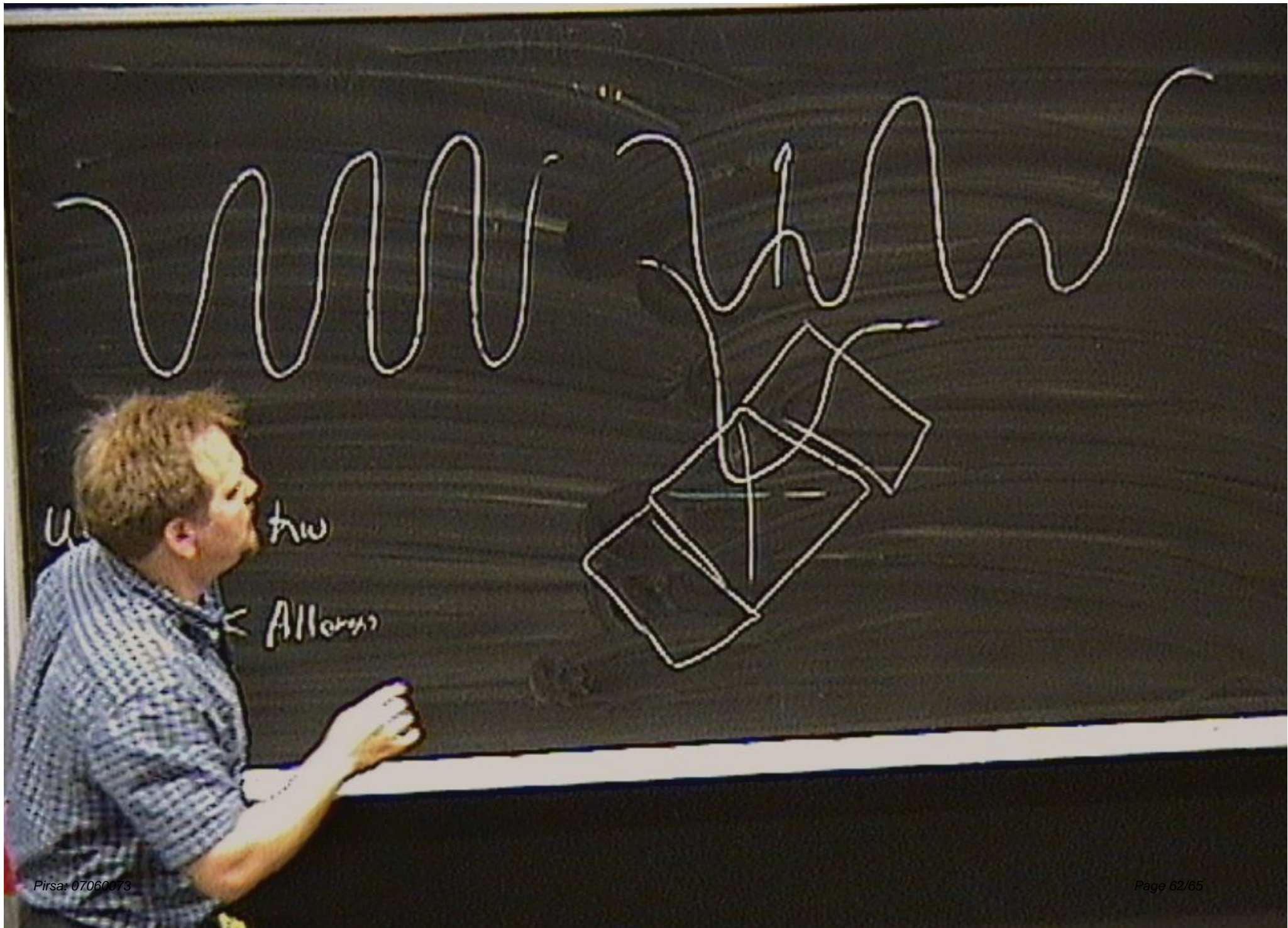


faster

$$u \ll \frac{1}{T} \ll \omega$$

$$\frac{1}{T} \ll \text{All other } \omega$$





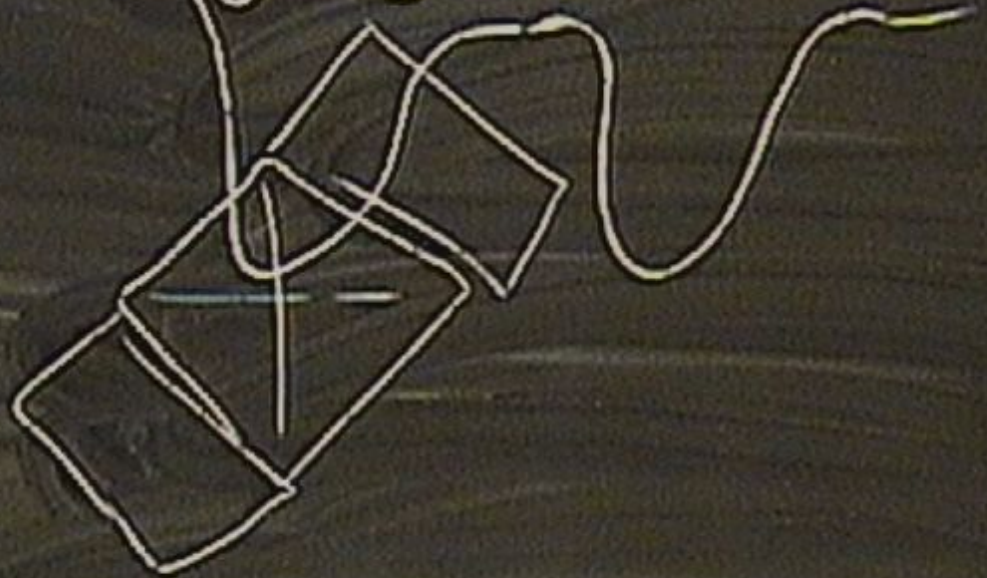
u hw  
← All cases

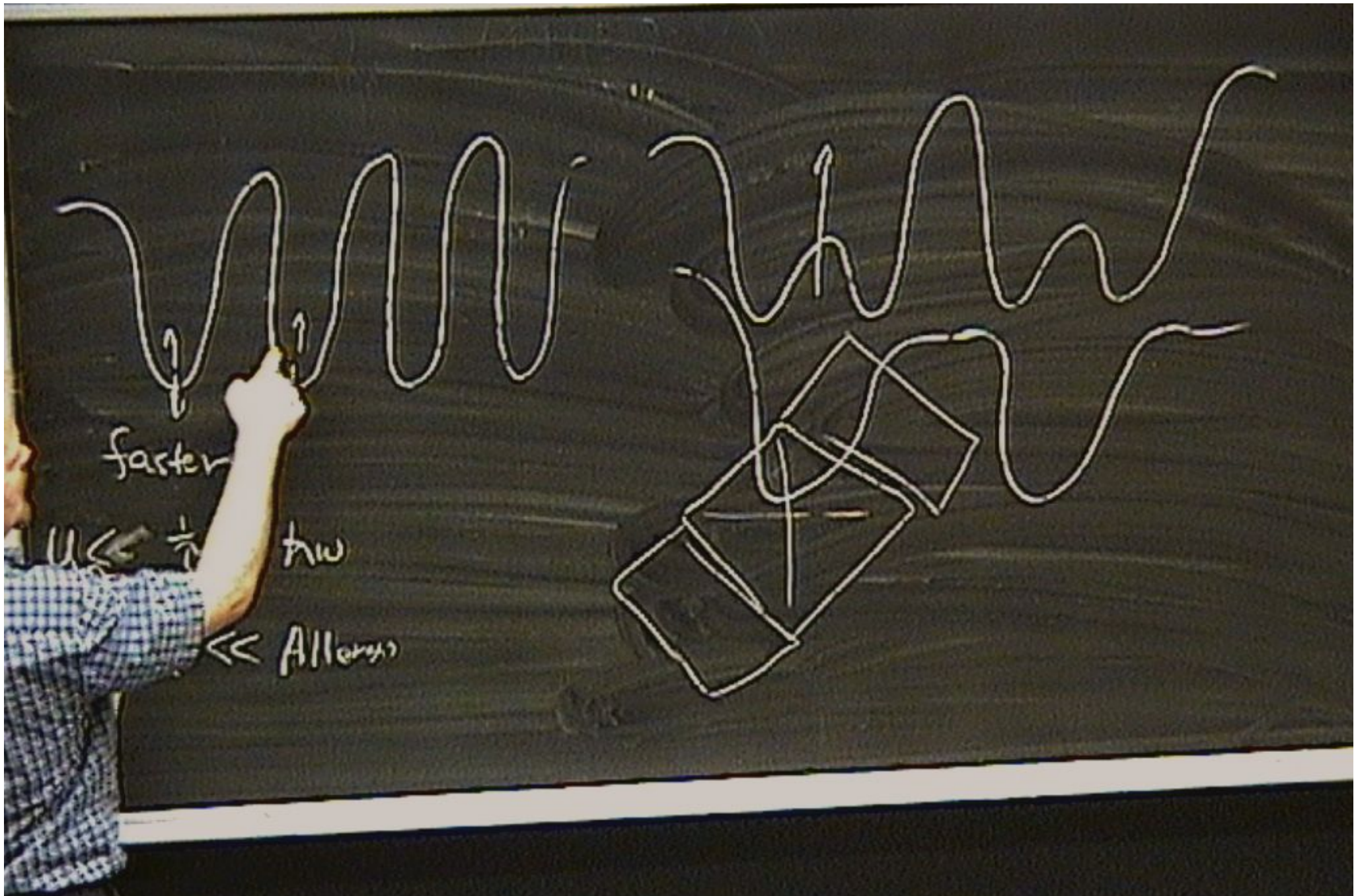


faster

$$u \ll \frac{1}{2} \ll \hbar \omega$$

$$\frac{1}{2} \ll \text{All other } \omega$$





faster

$u \leq \frac{1}{2} h w$

<< Allergis







faster

$$u \ll \frac{1}{2} \ll \lambda u$$

$$\frac{1}{2} \ll \text{All other}$$

