SEMINAR 5

WHAT IS THE BLACK BOX TELLING US WHERE THE FREQUENCIES OF WAVES/SIGNAL LIVE?

\[ F : \mathbf{f} \rightarrow \mathbf{\hat{f}} \]

\[ \mathbf{f} = \begin{pmatrix} f_1 \\ \vdots \\ f_N \end{pmatrix} \quad \mathbf{\hat{f}} = \begin{pmatrix} \hat{f}_1 \\ \vdots \\ \hat{f}_N \end{pmatrix} \]
\[ x \mapsto W(x) \]

\[ x_j = \frac{2\pi j}{N} \]

\[ f_j = W(x_j) \]

Low freq

High freq
\[ \omega = e^{-\frac{2\pi i}{N}} \]

\[ F = \frac{1}{\sqrt{N}} \begin{pmatrix} \omega^0 & \cdots & \omega^{(N-1)} \\ \vdots & \ddots & \vdots \\ \omega^{(N-1)} & \cdots & \omega \\ \end{pmatrix} \]

\[ \omega^0 = 1 \quad \text{etc. powers of } \omega \]

**TABLE OF NUMBERS:**

*e.g. N = 2*

\[ F = \frac{1}{\sqrt{2}} \begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix} \]
\[
F \left( \begin{array}{c} f_1 \\ f_2 \end{array} \right) = \left( \begin{array}{c} \hat{f}_1 \\ \hat{f}_2 \end{array} \right)
\]

\[
\hat{f}_1 = \frac{1}{\sqrt{2}} \left( f_1 + f_2 \right)
\]

\[
\hat{f}_2 = \frac{1}{\sqrt{2}} \left( f_1 - f_2 \right)
\]

**NOTE**

\[
f_1 = \frac{1}{\sqrt{2}} \left( \hat{f}_1 + \hat{f}_2 \right)
\]

\[
f_2 = \frac{1}{\sqrt{2}} \left( \hat{f}_1 - \hat{f}_2 \right)
\]
MORE ON THAT LATER...

LIGHT CARRIED BY PARTICLES

PHOTOELECTRIC EFFECT

Energy of emitted photon depends on frequency NOT intensity.
Einstein 1905

Photons are quanta of light with energy

\[ E = hf \]

- Planck constant
- Frequency

Need sufficiently high \( f \) to get \( E \) large enough to kick out an electron...
"MATTER IS WAVE"

\[ E = mc^2 \]

\[ c = \frac{\lambda}{f} \]

\[ \lambda = \frac{h}{p} \]

So...

A particle with momentum \( p \) is a wave with wavelength \( \lambda \)
BUT...

BEWARE OF SUCH MANIPULATIONS...

TIME = MONEY

KNOWLEDGE = POWER

WORK = POWER \times TIME

\downarrow

MONEY = \frac{WORK}{KNOWLEDGE}

i.e. AS KNOWLEDGE \rightarrow 0

YOU NEED LITTLE WORK

TO MAKE A LOT OF MONEY

???

???