Lecture Thursday 11. October 2007

Topics:

In lecture: Eigenmodes – Normal Modes
Algebraic Method for quantum Harmonic Oscillator

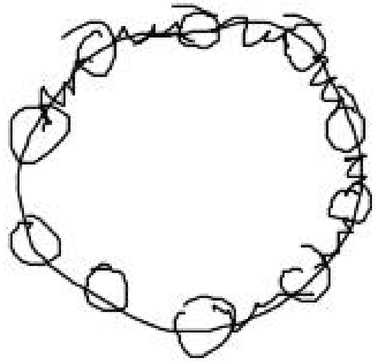
Here: Mainly eigenmodes

Comment:

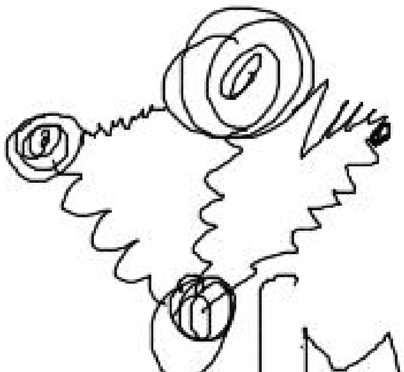
Preliminary version Friday 12.10.2007

α – spring constant

standing waves eigensolutions



travelling eigensolutions



$$(x_i - x_j)^2 \cdot \alpha_{ij}$$

$$M_{ij} \; x_i \; x_j$$

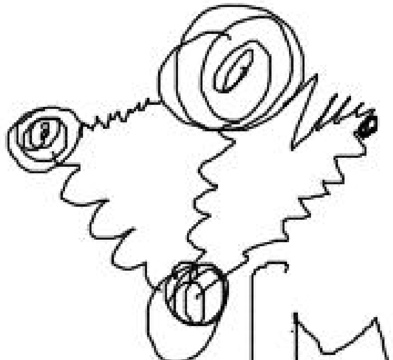
$$\begin{bmatrix} M \end{bmatrix} \begin{bmatrix} x \end{bmatrix}$$

$$\begin{bmatrix} \eta \end{bmatrix} = \begin{bmatrix} S \end{bmatrix} \begin{bmatrix} x \end{bmatrix}$$

$$S^T M S$$

$$1 = S S^T = S^T S$$

$$\begin{bmatrix} x \end{bmatrix} = \begin{bmatrix} S^T \end{bmatrix} \begin{bmatrix} \eta \end{bmatrix}$$



$(x_i - x_j)^2 \cdot \alpha_{ij}$

$M_{ij} \; x_i \; x_j$

$[M]\,[x]$ $\qquad\qquad$ $[\eta] = [S]\,[x]$

$S^T M S$

$1 = S S^T = S^T S$ $\qquad\qquad$ $[x] = [S^T]\,[\eta]$

$$\sum_i \left(\frac{1}{2} x_i^2 + \Omega_i^2 x_i^2 \right)$$

independent H.O.

$m = 1 \longrightarrow$ diagonalize the $V \longrightarrow \Omega_i^2$ are eigenvalues

the "normal coordinates" are the eigenvectors

Einstein – ether

Vacuum (already before Einsteins death) is a very complex object

Casimir effect

Einstein .... ether back in a very different and very complex form
(Gerald Holton)

Electric and Magnetic fields

E and B in every point

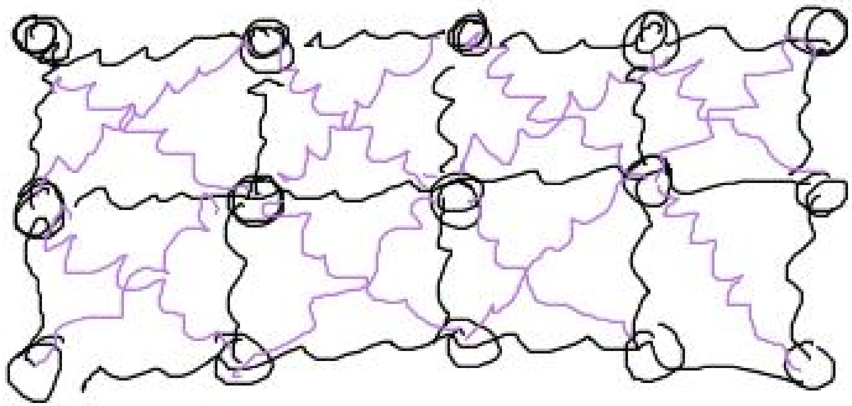
potentials ϕ and $\mathbf{A}$ (our constructions)

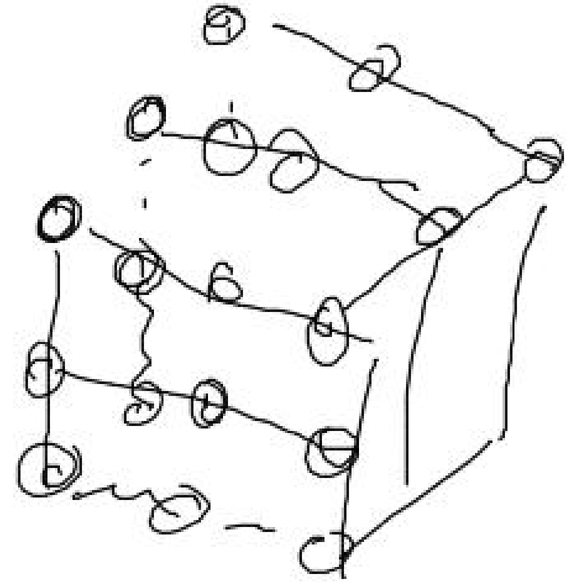
Wave properties common with One dimension scalar field

elementary wave equation - cos (k x)

$$d^2/dx^2\ u + k^2 u = 0$$

Golstein, Classical Mechanics





$$\sum_i \left(\frac{1}{2} \dot{x}_i^2 + \Omega_i^2 x_i^2 \right)$$

independent H.O.

$m=1 \longrightarrow$ diagonalize the $V \longrightarrow \Omega_i^2$

$\sin(\omega t - k \cdot x_i)$

δ_i phase shift of the football match neighbours

ϕ_0 shift of phase

$\sin(\omega t - kx)$

$\sin\left(-k\left(x - \frac{\omega}{k}t\right)\right)$

$\sin(-ky)$

where

$y = x - vt$

$v = \frac{\omega}{k}$ phase velocity

velocity drag

Any system of harmonically coupled units will have independent oscillation, behaving just like HO

Strings and memebranes and "objects" can be divided into small elements -> limitting behaviour

discretization
relation between frequency and "wave number" is called dispersion relation
the velocity is the same -> non-dispersive
$\omega = \omega(k)$ -> dispersive

Complex numbers are gone in ALG. NOTATION

$e^{i\alpha}$ is an eigenvalue ... $\alpha\beta\gamma\delta$