

Title: TBA

Date: Aug 22, 2016 09:30 AM

URL: <http://pirsa.org/16080033>

Abstract:

Phonics, v. lines, v. rings, v. atoms ... and phonics

10/ Endlich

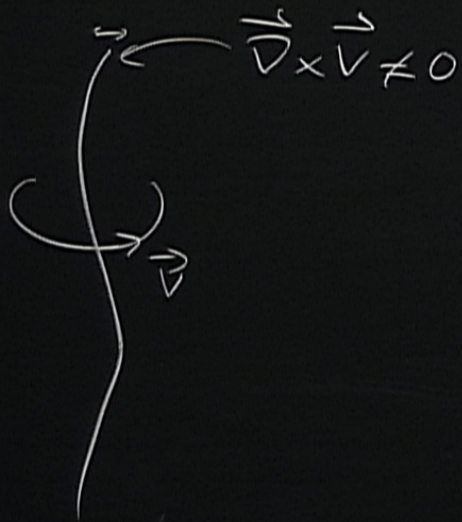
Horn, Penco

Eckert, Garcia-Suenz, Mitsou

Penco

CAUTION
DO NOT TOUCH THE SURFACE
OR THE GLASS OF THE BOARD
AS IT MAY BE DAMAGED BY HEAT
OR OTHER FACTORS.
PLEASE HANDLE CAREFULLY.

• superfluid is fluid



Superfluid = ~~Q~~ + ($\langle Q \rangle \neq 0$)
 SSB
 (BEC)

$\langle J \rangle \propto \delta_0^m$

• Goldstones: (phonons)

$\phi(x) = \mu t + \pi(x)$

$\phi(x) \rightarrow \phi(x) + a$

↑
Lorentz Scalar

fluid

$$\text{Superfluid} = \cancel{\text{SSB}} + (\langle Q \rangle \neq 0)$$

SSB
(BEC)

$$\underline{\Phi}(x) = \rho(x) e^{i\phi}$$

• Goldstones: (phonons)

$$\phi(x) = \mu t + \pi(x)$$

↑
Lorentz Scalar

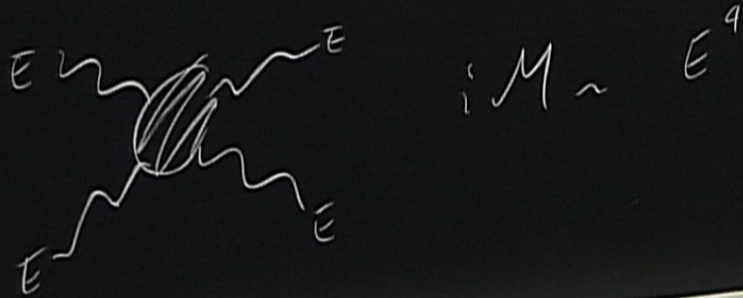
• $\phi(x) \rightarrow \phi(x) + a$

• Poincaré

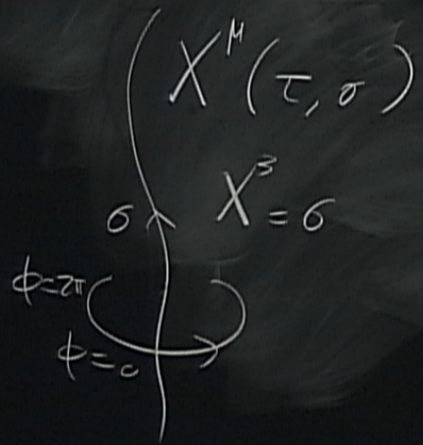
$$\tilde{H} = H - \mu Q$$

$$Z = \sqrt{(Q_\mu \phi)^2} = \mu + \dots$$

$$\mathcal{L} = \mathcal{P}(Z) + \text{h.d.} \rightarrow \dot{\pi}^2 - c_s^2 (\vec{D}\pi)^2 + \# (\partial\pi)^5$$



• vertex lines



$$A_{(2) \mu\nu} \rightarrow A_{(2) \mu\nu} + \partial_\mu \xi_\nu - \partial_\nu \xi_\mu$$

$$\phi \leftrightarrow A_{(2) \mu\nu} \text{ (magnetic dual)}$$

$$\left(\int A_\mu dq^\mu \right)$$

$$S_{KR} = \frac{1}{2} \int A_{\mu\nu}^{(2)} \partial_\tau X^\mu \partial_\sigma X^\nu \left(\cancel{\partial_\alpha X^\alpha \partial_\beta X^\beta} \right) d\tau d\sigma$$

$$f(\partial\phi)^2 \partial_\mu \phi \leftrightarrow \epsilon_{\mu\nu\rho\sigma} \partial^\nu A_{(\rho} \partial^\sigma g((dA_{(2)})^2)$$

$$\phi(x) = \underline{\mu} t + \bar{n}(x) \leftrightarrow$$

$$\mu \leftrightarrow n$$

$$A_{(2)}^{00} = 0$$

$$A_{(2)}^{0i} = n \cdot A^i(x)$$

$$A_{(2)}^{ij} = n \cdot \epsilon^{ijk} (x^k + B^k(x))$$

$$\text{choice of gauge} \left\{ \begin{array}{l} \vec{\nabla} \cdot \vec{A} = 0 \\ \vec{\nabla} \times \vec{B} = 0 \end{array} \right.$$

$$\underline{\vec{\nabla}^2 \vec{A} = \text{sources}}$$

$$\langle A A \rangle = \text{transverse} \times \frac{i}{k^2}$$

$$\langle B B \rangle = \text{longitudinal} \times \frac{i}{\omega^2 - c_s^2 k^2 + i\epsilon}$$

$$\int \mathcal{P}(Z) \longleftrightarrow \int \mathcal{P}(Y)$$

$$Y = \sqrt{(dA_{(2)})^2} = n + \dots$$

$$S_{\text{bulk}} = \int \mathcal{L}(\gamma) d^4x$$

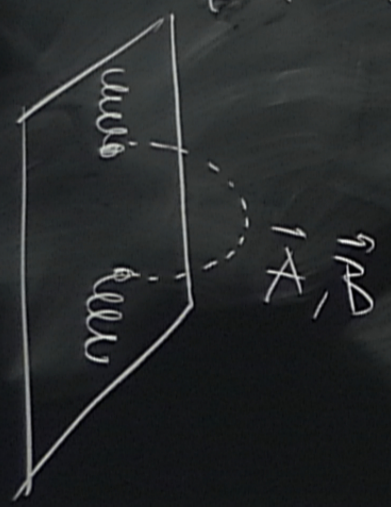
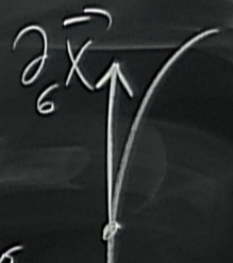
• string eqn ($\tau = X^0 = t$, $A_{(2)} \rightarrow \text{background}$)

$$h_{\alpha\beta} = \partial_\alpha X^\mu \partial_\beta X^\nu \eta_{\mu\nu}$$

$$\partial_\tau \vec{X} \times \partial_\sigma \vec{X} = 0$$

$$u^\mu \sim \partial^\mu \phi$$

$$\mathcal{L} \in \mathcal{E}^{\mu\nu\rho\sigma} \partial_\nu A_{(\rho\sigma)}$$



$$S_{NG'} = \int \sqrt{\det g_{\text{ind}}} \mathcal{L}(\gamma, g_{\alpha\beta}^{\text{ind}}, h_{\alpha\beta})$$

$$S_{KR} = \lambda \int A_{(2)} dX d\sigma$$

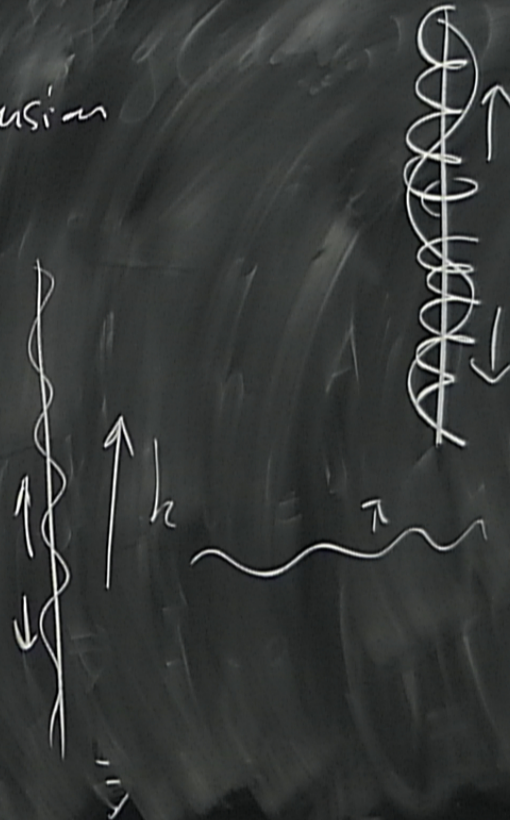
$$T \equiv T(n, l)$$

+ tension

$$\frac{dT}{d \log \mu} = - \frac{n^2 \lambda^2}{(\beta + p)}$$

• Kelvin waves

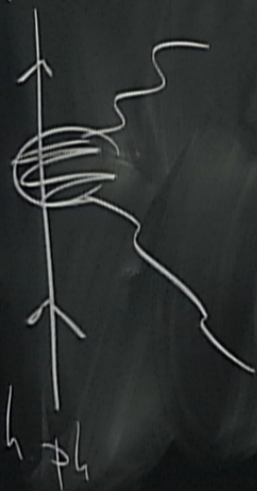
$$\omega = \frac{T(k)}{n \lambda} k^2$$



a point-particle plausibly & rotans

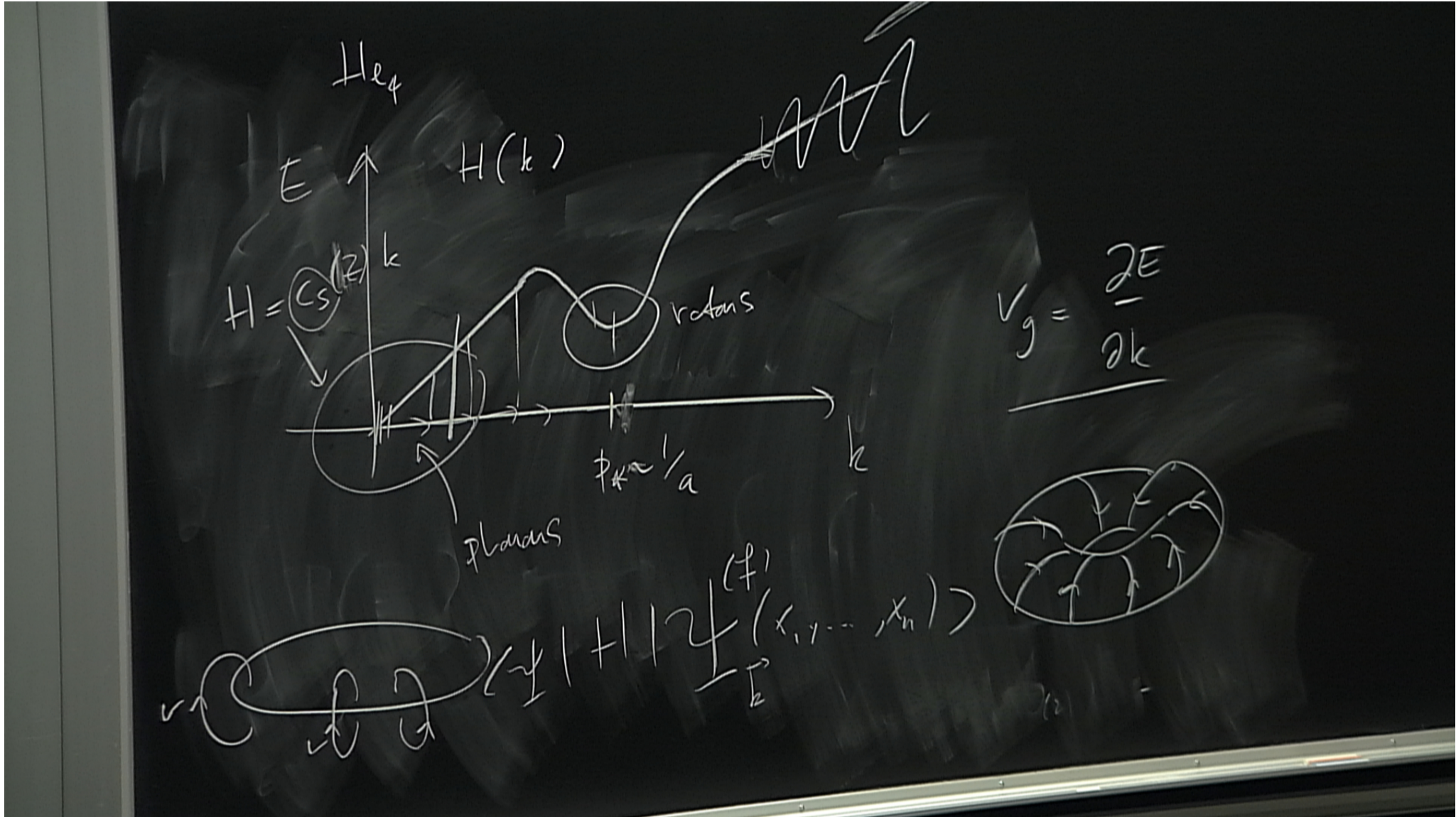
$$S_{pp} = \int dt \, f \left((\dot{\vec{x}} - \vec{u}) \cdot \hat{n}, z \right) \quad (\partial_t)^2$$

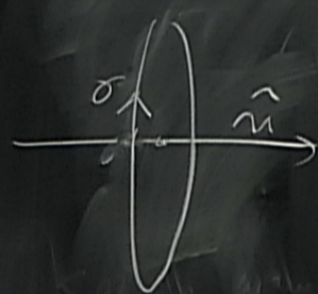
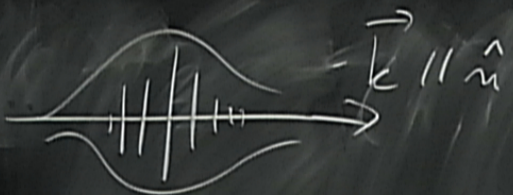
$h \cdot \phi$



iM

same as $\mathcal{P}(z)$





$$\vec{x}(t)$$

$$S[x, p] = p\dot{x} - H(p)$$

$$= p(\dot{x} - c_s)$$

$$\frac{\partial H}{\partial p} = \dot{x} \Rightarrow \dot{x} = c_s$$

$$SO(3) \rightarrow SO(2)$$

$$\theta, \phi \rightarrow \hat{n}(t)$$

$$(SO(3) \times SO(2) \rightarrow SO(2))$$