Coleman Lecture 3: From Fock spaces to the Klein-Gordon Equation

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http://media.physics.harvard.edu/video/?id=Sidney_Coleman_lecture_03

The construction of a quantum field within Fock space.

$$\alpha = \sqrt{(2\pi)^3 2\omega_p} \cdot a$$

$$\phi(x) = f\phi_- + f_+\phi_+$$

$$\phi_-(x) = \int \frac{d^3p}{(2\pi)^{3/2}\sqrt{2\omega_p}} a_p e^{-ipx}$$

$$\phi_-^* = \phi_+$$

$$\phi_+(x) = \int \frac{d^3p}{(2\pi)^{3/2}\sqrt{2\omega_p}} a_p^* e^{+ipx}$$

$$[\phi_+(x), \phi_-(y)] = \Delta_+(x-y) = \int \frac{d^3p}{(2\pi)^3 2\omega_p} e^{-ip(x-y)}$$

$\Delta_+(x) \stackrel{?}{=} 0$ when $x^2 < 0$? No!

Take $\phi = \phi_+ + \phi_-$; is ϕ a quantum field?

$$[\phi(x), \phi(y)] = \Delta_+(x-y) - \Delta_+(y-x)$$
$$=: i\Delta(x-y)$$

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(1) $(\Box^2 + \mu^2)\,\phi(x) = 0$ — The "Klein-Gordon Eqn" first written by Schrödinger.

(2) $[\phi(x), \phi(y)] = i\Delta(x-y, \mu^2)$

(3) ϕ is hermitian.

From these equations we can recover

a_p & $a_p^\dagger$ & all of Fock space.

(2) can be replaced with

(2'a) $[\phi(t,\vec{x}), \phi(t,\vec{y})] = 0$

(2'b) $[\phi(t,\vec{x}), \dot{\phi}(t,\vec{y})] = i\delta^3(\vec{x}-\vec{y})$