End Semester Examination

PH-4107 & PH-5102

Answer all questions

27-11-2018, Marks = 100

Q.1 For the Maxwell Lagrangian density

$\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu}$,

(a) Identify the true degrees of freedom interms of A_μ [5]

(b) Identify the constraints and interpret, [5]

(c) Find out the energy and momentum expressions after quantization: [15]

$[a^i_\mu, a^{\dagger j}_{\mu'}] = \delta_{\mu\mu'} \delta_{ij}$, where i and j represent polarization

Q.2 Find the coherent state $(a|\alpha\rangle = \alpha|\alpha\rangle)$ for the single mode case and find the photon statistics with its physical interpretation. [10]

Write the Wigner function [15] for the photon added coherent state.

Hint: you may use $a = \frac{1}{\sqrt{2}}(\hat{x} + i\hat{p})$ for explicitness. $= \frac{1}{\sqrt{2}}\left(\frac{\partial}{\partial x} + x\right)$

Q.3 For the non-linear Schrödinger equation,

$$i\hbar \frac{\partial \psi}{\partial t} = -\frac{\hbar^2}{2m}\frac{\partial^2 \psi}{\partial x^2} + g|\psi|^2\psi - \mu\psi$$

find the Lagrangian density.

For the grey soliton

$$\psi = \sqrt{\rho_0}\,[i\sin\theta + \cos\theta \tanh(\alpha x/\xi)]$$

find ξ and the soliton energy, $\epsilon = \int dx\, \mathcal{H}$, where $\mathcal{H}$ is the Hamiltonian density.

Marks = 12½ + 12½ = 25

Q.4 Define the Stokes vector terms of Jones matrix and write down the physical requirements of a Mueller matrix. [15]

Use a 'classically' entangled electric field to illustrate the above point. [10]