

Title: Photon phase diffusion and number squeezed state

Abstract:

Recently, strong coupling regimes of BEC atoms inside an optical cavity and superconducting qubits inside micro-wave circuit cavity were achieved experimentally. The strong coupling regimes in both systems were described by the Dicke model. In this talk, we study the Dicke model by  $1/N$  expansion. In the normal state, we find a  $\sqrt{N}$  behavior of the collective Rabi Splitting consistent with the experimental data. Inside the super-radiant phase, we identify an emergent quantum phase diffusion mode at a finite  $N$  and also work out many remarkable experimental consequences of this mode such as its low frequency, photon number squeezing properties and photon statistics. The photons in this quantum phase diffusion mode are in a number squeezed state with much enhanced signal/noise ratio which may have wide applications in the field of high resolution, high sensitive measurement and also in quantum information processing.