Abstract

In this thesis, various aspects of nonclassicality are studied in different systems, bringing out an interplay of nonclassicality with the underlying dynamics. Various witnesses and measures of nonclassicality, both spatial as well as temporal, are analyzed using the lexicon of open and closed quantum systems, ranging from subatomic to quantum optical systems. This leads one to address the problem of quantification of the degree of quantumness of channels, the completely positive and trace preserving maps. Part of this thesis is devoted to the analysis of nonclassical properties of light in the context of Parity-Time ($\mathcal{PT}$) symmetric systems, i.e., the systems whose time evolution is governed by non-Hermitian Hamiltonian bearing $\mathcal{PT}$ symmetry.

Comprising of seven chapters, the thesis starts with a broad literature survey of various concepts in chapter 1. In chapter 2, an introduction to the tools used in this thesis is made. This includes a description of open quantum systems, dynamical maps and various spatial and temporal quantum correlations. Further, a summary of various facets of nonclassicality of light is given. Chapter 3 provides a detailed analysis of various spatial and temporal quantum correlations in subatomic systems like neutrinos and neutral mesons. In chapter 4, a detailed account of the effect of non-Markovian dynamics on various facets of quantum information is presented. The subtleties arising due to non-Markovian dynamics, in computing the two time correlations are also highlighted. Further, the problem of quantifying the degree of quantumness of channels is addressed and a measure is proposed for the same. In chapter 5, the nonclassicality of light is studied in a cavity system embedded with two atomic ensembles of two level atoms. $\mathcal{PT}$ symmetry and its interplay with various nonclassical properties is studied in detail in chapter 6. The conclusion is made in chapter 7.