Abstract

The aim of this thesis is a systematic analysis of convex structures typical for quantum information theory. In particular, we discuss particular sets of quantum states, sets of correlations, and sets of assemblages describing quantum composed systems. We consider the separability problem for certain classes of states and we ask the question about the possibility of quantum realization of extreme points within various postquatum sets. Presented results related to the above problems are strongly tie in with the notion of symmetry.

The first chapter serves as a summary of necessary definitions and facts about the notion of convexity and quantum entanglement as well as the quantum paradigm of evolution and measurement procedure.

In the second chapter, we present an original concept of D-symmetric subspace and multipartite D-symmetric states. In particular, we provide a complete description of fully separable states from a specific class of diagonal states and express this characterization within the terms of generalized PPT conditions and well-known moment problem.

Chapter three evokes basics facts describing the notion of Bell experiments and various types of no-signaling correlations including those with quantum and local models. In chapter four we provide a similar presentation related to the notion of steering scenario and convex sets of no-signaling assemblage, quantum assemblages, and assemblages with LHS model. We also recall the notion of steering inequality and biseparable assemblages.

In chapter five we introduce a crucial notion of inflexible assemblage. We use this idea to prove the possibility of quantum realization of nonlocal extreme (exposed) points within the set of all no-signaling assemblages (in the simplest nontrivial case). In particular, we show that for any genuinely entangled pure state from the space $\mathbb{C}^2 \otimes \mathbb{C}^2 \otimes \mathbb{C}^d$, one can obtain an assemblage of the above property. As a consequence of provided reasonings, we also obtain a general construction of a certain class of steering inequalities.

The sixth chapter provides an analysis of the edge assemblages. In this part, we prove

a no-go type results stating that in the simplest nontrivial scenario, it is not possible to obtain an edge assemblage via quantum measurements performed on a three-qubit state with a rank greater than of equal to 3.

In chapter seven we discuss the general paradigm of no-signaling channel steering and we provide a full characterization of this phenomenon in terms of so-called assembles of Choi matrices. In particular, we prove that in the considered framework, there is a possibility for quantum realization of non-local extreme (exposed) points.

Chapter eight is concerning with a generalization of no-signaling sequential steering scenario. Using the introduced concept of sequential quantum assemble in the multipartite model we one more show, that there is a possibility of quantum realization of non-local extreme (exposed) point with this postquantum theory.

In the ninth chapter, we introduce a nontrivial intermediate set of correlations fitting between quantum and no-signaling descriptions. We show that there is a possibility of quantum realization of extreme (exposed) non-local points within this set.

At the end of the presented thesis, we provide a short summary with a few possible topics for further investigations.