

Abstract

The main theme of this thesis is the characterization of *quantum behaviors* by employing algebraic techniques from the framework of polynomial optimization, specifically utilizing sum of squares decompositions that can be translated into semidefinite programs. In particular, we explore generalized Bell scenarios where the measurements act on subsystems that may overlap, as well as an algebraic approach to uncertainty relations. Additionally, we develop algebraic tools to perform computations with partially commutative variables, which can be readily applied to a variety of problems in quantum information.

The motivation for characterizing which physical models can be reproduced with quantum theory and separating them from other theories, both classical and post-quantum, is twofold. On the one hand, it is practically important to identify quantum behaviors that provide advantages in tasks such as cryptography, computation, and information processing. On the other hand, it holds fundamental significance to identify experimental settings that cannot be adequately described by the current state of quantum theory. Overcoming such limitations may hint at a more fundamental theory, such as quantum gravity, which could accommodate new phenomena responsible for such transgressions.