A de Finetti representation theorem for infinite-dimensional quantum systems: tests of robustness

Abstract

R. Renner and J.I. Cirac recently proved a new version of the quantum de Fintetti theorem which is valid in the case of infinite-dimensional Hilbert spaces, provided some experimentally verifiable conditions are satisfied (we call this experimental test 'energy diagnostic').
Firstly we summarize the conditions needed for the theorem to work and express them with respect to quantities with a clear physical meaning. In a second step we show that in certain circumstances we can replace this set of conditions by more easily testable ones.
We review the basic properties of homodyne detection which allows one to measure the quadratures of a signal field and thus potentially allows one to perform an 'energy diagnostic'. Firstly we consider to what extent the cryptographic scheme exposed in the article is robust against fluctuations of the phase and of the strength of the local oscillator in homodyne detection. In a second step we summarize various approaches in the literature which give a feeling of the true nature of the standard approximation. We conclude that this approximation may be problematic in our cryptographic context and that it may not be justified to use homodyne detection as 'energy diagnostic'. We show that it is possible to use other measurents as 'energy diagnostic' and we present two possibilities of measurements which are not subject to the 'standard approximation problem' and which fit with the cryptographic scheme. Finally we consider a simple way to model an experimentally realisable measurement and find sufficient conditions it has to satisfy in order to be used for the 'energy diagnostic'.