Weak measurements and nonClassical correlations

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Abstract

We extend the definition of quantum discord as a quantifier of nonClassical correlations in a quantum state to the case where weak measurements are performed on subsystem A of a bipartite system AB. The properties of weak discord are explored for several families of quantum states. We find that in many cases weak quantum discord is identical to normal discord and in general the values of the two are very close to each other. Weak quantum discord reduces to discord in the appropriate limits as well. We also discuss the implications of these observations on the interpretations of quantum discord.

1. Introduction

In [1] Ollivier and Zurek view quantum discord [1–3] as a means of quantifying the disturbance on a system B generated by a read out procedure consisting of projective measurements on an apparatus A which has previously interacted with B through a process of pre-measurement. If the discord, defined using projective measurements on A, is zero, then there exists a set of projective measurements on A which do not alter the global state ρ_{AB} of the apparatus and system after the pre-measurement. Subsequently, the definition of quantum discord was expanded to include all possible measurements on A including POVMs and discord was placed in a more general context as a measure of the nonClassical correlations that exist between two quantum systems A and B, moving away from the 'system-apparatus' picture [4]. In constructing quantum discord and related measures [5] as the difference between total correlations and classical correlations in a quantum state, wherein the classical correlations are understood as those correlations that can be 'extracted' through a measurement process on either one or both of the subsystems independently, there is an implicit predisposition to do the best possible job of the measurement within the framework of the definition of each measure. This means that despite the original motivation of Ollivier and Zurek regarding disturbance to the quantum state or parts of it, whether such disturbances occur or not is no longer a significant part of the discussion on various measures of nonClassical correlations.

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