Detection of entanglement and of features of quantum evolution with few local measurement and complementary properties

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We will give an overview of several recent results concerning the detection of properties of composite states and of quantum evolutions by employing measurements of complementary properties. Two properties of a quantum systems are called complementary if they are such that, if one knows the value of one property, all possible values of the other property are equiprobable. We will first provide an interpretation of entanglement in composite systems based on classical correlations between measurement outcomes of complementary properties [1]. We will then present a general scheme to detect properties of quantum evolution in open quantum systems and of quantum communication channels. We will show in particular a practically feasible scheme to detect features of quantum channels such as being entanglement breaking or separable [2], and lower bounds to information-theoretic properties [3] that are important to quantify the ability of a quantum channel to transmit information, such as the quantum capacity. Such a scheme is based on the measurement of few local observables that coincide with complementary properties in the case of two-dimensional systems and offers the advantage of avoiding full quantum process tomography, that is a demanding procedure in terms of the number of measurements required. Its efficiency has been successfully tested with polarised photons [4]. We will finally show that a similar scheme can be employed to detect non-Markovianity of quantum evolution, by applying tools from spectral analysis to study the evolution of an open quantum system [5].

References

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