

Multiple-observable entropic uncertainty relations and entanglement detection

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We review the concepts of entropic uncertainty relations (EUR) and consider the case of multiple observables. We investigate the corresponding additivity properties for both bipartite and multipartite systems where the EUR are defined in terms of the joint Shannon entropy of probabilities of local measurement outcomes. We show that the additivity of EUR holds only for EUR that involve two observables, while this is not the case for inequalities that consider more than two observables or the addition of the von Neumann entropy of a subsystem.

Moreover, we address also the case of a single high dimensional system and show that the amount of complementarity that a quantum system can exhibit depends on which complementary properties one is considering. Complementary properties can be connected to mutually unbiased bases (MUBs): if the value of one property is known (i.e. the system state is in one of the basis states), then the complementary properties are completely unknown: the measurement of another property will find any of its possible outcomes with uniform probability. We show that a 5-dimensional system can have different degrees of complementarity, depending on which three of the six MUBs we choose. The degree of complementarity is assessed using EUR and variance. Interestingly, this result was first found and demonstrated experimentally.

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