Uses of a Quantum Master Inequality

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Abstract

An inequality in quantum mechanics, which does not appear to be well known, is derived by elementary means and shown to be quite useful. The inequality applies to 'all' operators and 'all' pairs of quantum states, including mixed states. It generalizes the rule of the orthogonality of eigenvectors for distinct eigenvalues and is shown to imply all the Robertson generalized uncertainty relations. It severely constrains the difference between probabilities obtained from 'close' quantum states and the different responses they can have to unitary transformations. Thus, it is dubbed a master inequality. With appropriate definitions the inequality also holds throughout general probability theory and appears not to be well known there either. That classical inequality is obtained here in an appendix. The quantum inequality can be obtained from the classical version but a more direct quantum approach is employed here. A similar but weaker classical inequality has been reported by Uffink and van Lith.

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