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Asymptotically optimal lower bounds on confidence for rejecting local realism YANBAO ZHANG, University of Colorado at Boulder, and National Institute of Standards and Technology, SCOTT GLANCY, EMANUEL KNILL, National Institute of Standards and Technology — In a test of local realism (LR), the confidence for rejecting LR is usually estimated by comparing Bell-inequality violation to experimental standard deviation (SD). However, it is important to have methods to assign a rigorous confidence to rejecting LR based on experimental data. We propose a method to lower-bound the rejection confidence by a prediction-based ratio test. The test gives a rigorous lower bound even if the prepared quantum state and maximum likelihood LR prediction are allowed to change depending on previous experiments and their outcomes. If the prepared state does not vary in time, the bound is asymptotically optimal. We study violations of LR by unbalanced Bell states $\cos(\theta)|00\rangle + \sin(\theta)|11\rangle$, which are experimentally achievable by a parametric down-conversion photon-pair source within a Sagnac loop. Our results show that the method based on experimental SD gives less confidence than our method when θ is small, i.e., $\theta < 33^\circ$, while it gives too much confidence when θ becomes larger. Given photon-pair production probability, detection efficiency and visibility , numerically we find the optimal states and measurement settings which give the highest confidence gain rate per event.

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