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The statistical strength of experiments to reject local realism with photon pairs and inefficient detectors YANBAO ZHANG, University of Colorado at Boulder, and National Institute of Standards and Technology, EMANUEL KNILL, SCOTT GLANCY, National Institute of Standards and Technology — Because of the fundamental importance of Bell's theorem, a loophole-free demonstration of a violation of local realism (LR) is highly desirable. Here, we study violations of LR involving photon pairs. We quantify the experimental evidence against LR by using measures of statistical strength related to the Kullback-Leibler (KL) divergence, as suggested by W. van Dam, P. Grunwald and R. Gill [IEEE Trans. Inf. Theory. 51, 2812 (2005)]. Specifically, we analyze a test of LR with entangled states created from two independent polarized photons passing through a polarizing beam splitter. We numerically study the detection efficiency required to achieve a specified statistical strength for the rejection of LR depending on whether photon counters or detectors are used. Based on our results, we find that a test of LR free of the detection loophole requires photon counters with efficiency at least 89.71%, or photon detectors with efficiency at least 91.11%. For comparison, we also perform this analysis with ideal unbalanced Bell states, which are known to allow rejection of LR with detector efficiencies above 2/3.

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