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Efficient quantification of experimental evidence against local realism YANBAO ZHANG, University of Colorado Boulder, and National Institute of Standards and Technology, SCOTT GLANCY, EMANUEL KNILL, National Institute of Standards and Technology — It is highly desirable to have reliable experimental demonstrations of violations of Bell inequalities for rejecting local realism. A potential problem is that due to statistical fluctuations, a finite set of data points generated by a local realistic model can violate a Bell inequality. In order to statistically quantify the evidence against local realism in an experiment, one needs to compute an upper bound of the probability according to local realism of a violation at least as high as that observed. Such bounds not only help to reliably demonstrate violations of local realism, but also help to prove the security of quantum key distribution or certify the generation of genuine randomness. We describe an efficient protocol for computing such a bound from any set of Bell inequalities for any number of parties, measurement settings, or outcomes. The bound depends on the choice and number of Bell inequalities, and generally, more inequalities make the bound asymptotically tighter. We find that even trivial Bell inequalities such as no-signaling conditions can improve the tightness of the bound. In addition, this protocol can be adapted to any test with linear witnesses, such as tests for entanglement or system dimensionality, without a full analysis of the relevant probability space.

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