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**Reliable Entanglement Verification** JUAN MIGUEL ARRAZOLA, OLEG GITTSOVICH, JOHN MATTHEW DONOHUE, JONATHAN LAVOIE, KEVIN RESCH, NORBERT LÜTKENHAUS, Institute for Quantum Computing and Department of Physics, University of Waterloo — Entanglement plays a central role in quantum protocols. It is therefore important to be able to verify the presence of entanglement in physical systems from experimental data. In the evaluation of these data, the proper treatment of statistical effects requires special attention, as one can never claim to have verified the presence of entanglement with certainty. Recently increased attention has been paid to the development of proper frameworks to pose and to answer these type of questions. In this work, we apply recent results by Christandl and Renner on reliable quantum state tomography to construct a reliable entanglement verification procedure based on the concept of confidence regions. The statements made do not require the specification of a prior distribution nor the assumption of an independent and identically distributed (i.i.d.) source of states. Moreover, we develop efficient numerical tools that are necessary to employ this approach in practice, rendering the procedure ready to be employed in current experiments. We demonstrate this fact by analyzing the data of an experiment where photonic entangled two-photon states were generated and whose entanglement is verified with the use of an accessible nonlinear witness.

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