Efficiently Certifying Large Amounts of Entanglement in High-Dimensional Quantum Systems

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Abstract: Real-world platforms for enabling quantum information technologies are varied and imperfect; therefore, the quantum resources they provide must be characterized before they can be used. For some tasks, such as secure communication, resources like entanglement must be guaranteed, or certified. In large quantum systems, traditional approaches demand an intractable number of measurements. We demonstrate a practical method for quantifying high-dimensional entanglement from extremely limited data that does not require numerical optimization techniques. Using only 6,456 measurements, we certify over 7 ebits of entanglement-of-formation shared by entangled photon pairs in a joint-measurement space exceeding 68 billion dimensions.