

Abstract Submitted  
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**Tests of nonlocality with hyperentangled photons**<sup>1</sup> CHRISTOPHER K. ZEITLER, JOSEPH C. CHAPMAN, ERIC CHITAMBAR, PAUL G. KWIAT, University of Illinois at Urbana-Champaign — Entanglement represents a valuable resource for enhanced communication. It is often necessary to both verify and quantify the entanglement shared through a quantum channel. Tests of nonlocality, such as Bell tests and steering, can be used to certify shared entanglement. For pairs of entangled qubits, the standard CHSH Bell inequality is a sufficient entanglement certification. However, the CHSH inequality is unable to measure increasing degrees of entanglement, as exists in hyperentangled photons. We use a bipartite Bell test with four settings to demonstrate that a measured 4-dimensional state is genuinely hyperentangled, in polarization and time-bin, by showing that its Bell parameter exceeds the maximum value possible with a pair of entangled qubits. In addition, we present a scheme for using quantum steering to verify that a state contains multipartite entanglement.

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