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Experimental Violation of Heisenberg's Precision Limit by Weak Measurements ARDAVAN DARABI, LEE A. ROZEMA, DYLAN H. MAHLER, ALEX HAYAT, Centre for Quantum Information and Quantum Control, and Institute for Optical Sciences, Department of Physics, University of Toronto, YASAMAN SOUDAGAR, Ecole Polytechnique de Montreal, University of Toronto, AEPHRAIM M. STEINBERG, Centre for Quantum Information and Quantum Control, and Institute for Optical Sciences, Department of Physics, University of Toronto — Along with the uncertainty principle, Heisenberg postulated another set of relations, which set a lower limit on the disturbance caused by a measurement [1]. These relations were shown by Ozawa to be inaccurate [2], shedding doubt on widely accepted bounds on the information left in a system after a measurement, and offering new insights into the foundations of quantum physics and quantum information. A theoretical scheme for testing Ozawa's precision-disturbance relations was proposed [3]. In this proposal the hurdle of destructive measurements is addressed by the weak value approach [4]. This scheme is based on a 3-qubit quantum circuit that requires two CNOT gates of variable strength with a common control qubit. Here, we present an experimental realization of Heisenberg's precision limit violation based on weak value measurements. We implement a technique inspired by the one-way quantum computing using entanglement as the substrate for quantum gates. In this way, we demonstrate a violation of Heisenberg's relation for measurement disturbance, confirming the revised bound due to Ozawa.

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[1] Z. Phys. 43 172(1927); [2] Ann. Phys. NY 311 350(2004); [3] New J. Phys. 12 093011(2010); [4] Phys. Rev. Lett. 60 1351(1988)

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