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Experimental one-way quantum computation using linear optics PHILIP WALTHER, Institute of Experimental Physics, University of Vienna, Boltzmanngasse 5, 1090 Vienna, Austria, KEVIN RESCH, University of Queensland, Physics Department, AUS, TERRY RUDOLPH, QOLS, Blackett Laboratory, Imperial College London, London SW7 2BW, UK, EMMANUEL SCHENCK, Institute of Experimental Physics, University of Vienna, Boltzmanngasse 5, 1090 Vienna, Austria, HARALD WEINFURTER, Department of Physics, Ludwig Maximilians University, D-80799 Munich, Germany, VLATKO VEDRAL, The School of Physics and Astronomy, University of Leeds, Leeds LS2 9JT, UK, MARKUS AS-PELMEYER, ANTON ZEILINGER, Institute of Experimental Physics, University of Vienna, Boltzmanngasse 5, 1090 Vienna, Austria — Standard quantum computation is based on a universal set of unitary quantum logic gates which process qubits. In contrast to the standard quantum model, Raussendorf and Briegel proposed the one-way quantum computer, based on a highly-entangled cluster state, which is entirely different. We have experimentally realized four-qubit cluster states encoded into the polarization state of four photons. We fully characterize the quantum state by implementing the first experimental four-qubit quantum state tomography. Using this cluster state we demonstrate the feasibility of one-way quantum computing through a universal set of one- and two-qubit operations. Finally, our implementation of Grover's search algorithm demonstrates that one-way quantum computation is ideally suited for such tasks.

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