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Stern-Gerlach detection of neutral atom qubits in a state dependent optical lattice FELIPE GIRALDO MEJIA, AISHWARYA KUMAR, TSUNG-YAO WU, DAVID WEISS, Pennsylvania State University — Using a technique conceptually similar to the Stern-Gerlach experiment [Z. Phys. 9, 349-352 (1922)], we have developed a high-fidelity state measurement for neutral atom qubits that induces no loss. The measurement fidelity of 0.9994 has roughly 20 times lower error than any previous state detection for neutral atom arrays [Phys. Rev. Lett. 119, 180504 (2017), Phys. Rev. Lett. 119, 180503 (2017)], and also significantly exceeds the fidelity of any other qubit array (including ion and superconducting qubit arrays) with more than four qubits [Nature 536, 63-66 (2016), Phys. Rev. Lett. 112, 190504 (2014)]. The measurement is based on coherent spatial splitting of the atoms' wavefunctions, but using state-dependent light traps instead of magnetic fields as in the original Stern-Gerlach experiment. Our measurement causes no loss and the fidelity is basically independent of the number of qubits. We demonstrate here that we can reuse the atoms after detection even when background gas collisions have caused atom losses, by using our 3D atom sorting [Nature 561, 83–87 (2018)].

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