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Valley Splitting in a Silicon Two-Dimensional Electron Gas[1] SRIJIT GOSWAMI, MARK FRIESEN, University of Wisconsin-Madison, J.L. TRUITT, Lincoln Laboratory, MIT, CHARLES TAHAN, Cavendish Laboratory, Cambridge, U.K., J.O. CHU, IBM T. J. Watson Research Center, D.W. VAN DER WEIDE, S.N. COPPERSMITH, ROBERT JOYNT, M.A. ERIKSSON, University of Wisconsin-Madison — We have performed low-temperature microwave transport spectroscopy of low-lying valley states in a silicon two-dimensional electron gas. The magnitude of this splitting determines whether the ground state is degenerate for purposes of quantum computing with spins. The valley splitting varies linearly with magnetic field from 0.3 to 3 T, reaching 75 μeV, with no sign of saturation. We unambiguously identify the observed resonance as a valley excitation by comparing with Shubnikov-de Haas oscillations. The origin of the splitting is the coupling of the two z conduction valleys in the silicon band structure, due to quantum well confinement. Previous theory suggests that the valley splitting can be of order 1 meV. However, we present a theory incorporating atomic steps, which are present in experimental systems. The theory leads to small valley splittings at zero magnetic field, and a linearly increasing splitting at nonzero fields, as observed in experiments.

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