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Field ionization of individual donors in Si measured with a single electron transistor K. R. BROWN, L. SUN, B. E. KANE, University of Maryland — Many proposals for spin qubits in semiconductors rely on spin-charge conversion combined with charge measurement for determination of the final state. In pursuit of such a measurement we have engineered devices consisting of a single electron transistor (SET) on a lightly n-doped, oxidized (thickness 25 nm) Si wafer. A p++-doped region 250 nm below the oxide serves as a back gate for donor ionization, creating an electric field towards the SET island and perpendicular to the surface. It also pins the Fermi level in the substrate, so that we can empty or fill the donors above by applying an appropriate bias. To empty the donors we apply a strong positive voltage to the back gate, pulling any donor electrons into the substrate. To fill the donors we apply a negative voltage and momentarily shine an LED at the sample, flooding it with electron-hole pairs. We will present recent results that give strong evidence for the filling and emptying of donors and for their ionization and recapture in an electric field as measured by an SET. We will conclude with a discussion of our efforts to extend these techniques to a measurement of spin.

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