Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Coherent probing and manipulation of valley states in silicon double quantum dot devices with fast pulses[1] JOSHUA SCHOENFIELD, BLAKE FREEMAN, HONGWEN JIANG, Department of Physics and Astronomy, UCLA; Los Angeles, CA 90095, USA, JASON PETTA, Department of Physics, Princeton University, Princeton, NJ 08544, USA — We report the coherent manipulation of a qubit based on two valley states of an electron confined in a silicon quantum dot. Coherent evolution between the states, which have a relatively small energy splitting of 20 μeV, is excited by a fast electrical pulse and the phase information is projected to a charge state for read-out by a nearby charge sensing channel. Coherent control was demonstrated at multiple charge configurations of the same device. The energy dispersion as a function of detuning as well as the phase coherence time of the valley qubit is obtained by varying pulse height and duration. Such coherent manipulation also provides a method of measuring valley splittings which are too small to probe with conventional methods of magneto-spectroscopy. Using these same techniques, we have produced analogous results in a different device. Coherent time domain oscillations of roughly 350 MHz, corresponding to a valley-like splitting of 1.4 μeV, are observed. Coherence times of up to 15 ns, in excess of reported values for charge qubits, have been observed in this system when a Ramsey-like pulse shape is applied.

[1]This work was supported by the U.S. Army Research Office (W911NF-14-1-0346)

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Date submitted: 09 Nov 2016 Electronic form version 1.4