Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Group theory analysis of phonon-induced spin relaxation in silicon[1] YANG SONG, Department of Physics and Astronomy, University of Rochester, HANAN DERY[2], Department of Electronic and Computer Science, University of Rochester — Selection rules and leading order matrix element expressions are derived for all important spin flip processes in the multivalley conduction band of bulk silicon. All results are generalized to arbitrary spin orientation directions. Intervalley f-process scattering induced by all phonon modes are analyzed using double group irreducible representation matrices of the Δ axis and independent integrals are identified for transitions between states of either spin. Intervalley g-process and intravalley spin flips are analyzed using the X point single group and detailed selection rules are derived using a four-band basis. Together with electronic states obtained by a spin-dependent k·p expansion, wavevector dependent spin-flip matrix elements are derived for all phonon modes in intravalley and for the leading order phonon mode in g-process scattering. Higher order matrix elements are qualitatively studied. Comparison with deformation potential theory in momentum scattering is made. Integrations for spin relaxation rate are carried out. Symmetry breaking mechanisms such as stress and electric field are discussed and quantified. We benchmark all of our analysis with numerical results of strain-dependent empirical pseudopotential and adiabatic-bond-charge models.

[1]This work is supported by AFOSR Contract No. FA9550-09-1-0493 and NSF Contract No. DMR-1124601 (NEB 2020)
[2]also at Department of Physics and Astronomy

Yang Song
Department of Physics and Astronomy, University of Rochester

Date submitted: 07 Nov 2011 Electronic form version 1.4