Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Nanomechanical single-qubit gates and iSWAP gate of single-electron spins in a carbon nanotube HENG WANG, GUIDO BURKARD, University of Konstanz, Germany — A universal gate set for quantum computation can be built with one-qubit and iSWAP gates. We theoretically investigate mechanically-induced single-electron spin resonance in a quantum dot [1] and a phonon mediated iSWAP gate of two separate single electron spins in two quantum dots on a suspended carbon nanotube which is driven by an external electric field. The intrinsic spin-phonon coupling between the spin and the mechanical mode is induced by the spin-orbit coupling. Arbitrary-angle rotations about arbitrary axes of the single electron spin can be achieved by varying the frequency and the strength of the external electric driving field. If two single-electron spins in two quantum dots couple to the same vibrational mode simultaneously, the two spins are indirectly coupled via phonon exchange. Both electron spin resonance and the iSWAP gate can be turned off by suppressing the spin-phonon coupling by electrostatically shifting the electron wave function on the nanotube. Combining iSWAP and single spin gates, maximally entangled states of two spins can be generated in a single step. [1] H. Wang and G. Burkard, Phys. Rev. B 90, 035415 (2014).

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Date submitted: 12 Nov 2014 Electronic form version 1.4