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Theoretical Study of Dynamical Nuclear Spin polarization in Semiconductor Quantum Dots CHIA-WEI HUANG, XUEDONG HU, University at Buffalo, The State University of New York — Dynamical nuclear spin polarization (DNSP) can be achieved optically in a semiconductor quantum dot (QD) via the hyperfine interaction between the optical oriented electron and nuclear spins. Here we explore several mechanisms, combined with the hyperfine interaction, to investigate how efficiently they can transfer the electron spin polarization to nuclei. Specifically, to ensure energy conservation during the spin transfer, we consider both a combination of electron spin-orbit and electron-phonon interactions, and cotunneling processes. Based on these interactions we evaluate the buildup time for DNSP in a semiconductor QD. Our results show that the DNSP buildup time of spin-orbit associated with the hyperfine interaction, accompanied by phonon emission, is of the order of seconds. This is much longer than that of the recent experimental findings. [1] The calculated nuclear spin polarization rate also shows a different Zeeman-energy-dependence from what is observed experimentally. [1] We thus conclude that hyperfine interaction combined with electron level broadening due to cotunneling processes between the QD and the nearby reservoir is more likely to be responsible for the fast buildup of nuclear polarization in experiments. [1] P.Maletinsky, A.Badolato, and A. Imamoglu, Phys. Rev. Lett. 99, 056804 (2007).

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