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Effective time-reversal symmetry breaking in the spin relaxation in a graphene quantum dot PHILIPP STRUCK, GUIDO BURKARD, University of Konstanz — We study the relaxation of a single electron spin in a circular gate-tunable quantum dot in gapped graphene [1]. Direct coupling of the spin to out-of-plane phonons via the intrinsic spin-orbit coupling leads to a lowered relaxation time T_1 at intermediate B-fields. At low fields, T_1 increases as $\propto B^{-2}$ due to the suppression of the phonon density of states at long wavelengths in a finite system. We also find that Rashba spin-orbit induced admixture of opposite spin states in combination with the emission of in-plane phonons provides various further relaxation channels via deformation potential and bond-length change. In the absence of valley mixing, spin relaxation takes place within each valley separately and thus time-reversal symmetry is effectively broken, thus inhibiting the van Vleck cancellation at $B = 0$ known from GaAs quantum dots. Both the absence of the van Vleck cancellation as well as the out-of-plane phonons lead to a behavior of the spin relaxation rate at low magnetic and intermediate fields which is markedly different from the known results for GaAs. At high fields there is a crossover to $T_1 \propto B^{-2}$ or $\propto B^{-4}$.

[1] P. R. Struck and G. Burkard, Phys. Rev. B **82**, 125401 (2010).

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