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Exchange Interaction of Transition Metal Dopants in Diamond[1]
VICTORIA KORTAN, CUNEYT SAHIN, MICHAEL E. FLATTÉ, University of Iowa — Advances in single-ion implantation and spectroscopy have permitted direct observation of the exchange interaction between two dopant spins in a semiconductor[1], which is accurately described by tight-binding models of the semiconducting host[1,2]. These advances suggest controllable fabrication and utilization of few-dopant structures to explore fundamental properties and for applications[3]. Transition metal substitutional dopants in tetrahedrally-bonded semiconductors are good candidates for controllable spin manipulation and spin-spin interaction because they offer both highly-localized and much more extended spin-polarized states. For example, both the Ni and Cr dopant have spin-1 ground states in diamond, but with differing spatial extent[4]. We calculate the exchange interaction between pairs of Ni and Cr dopants in diamond using the technique of Ref. 2, but with an spds* tight-binding model. We find strong exchange interactions between pairs of Ni, and pairs of Cr, which are influenced by the differing symmetry of the dopants' ground state. [1] D. Kitchen et al., Nature 442, 436 (2006). [2] J.-M. Tang & M.E. Flatté, Phys. Rev. Lett. 92, 047201 (2004). [3] P. Koenraad & M.E. Flatté, Nat. Mat. 10, 91 (2011). [4] T. Chanier, et. al., Phys. Rev. B 86, 085203 (2012).

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