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Hyperfine Interactions for Hole Spins in Quantum Dots PERICLES PHILIPPOPPOULOS, McGill University, SEFANO CHESI, RIKEN Center for Emergent Matter Science, WILLIAM COISH, McGill University — Due to the anisotropic nature of the hyperfine coupling for hole spins in semiconductor quantum dots, these systems may show significantly longer coherence times than electron spins given the correct quantum-dot geometry and magnetic field orientation. This advantage of hole spins relies on the hyperfine tensor taking-on an Ising-like form. This form of the hyperfine coupling has been recently called into question with experiments [1] that have been interpreted to indicate a strong hybridization of p-like and d-like components in the valence band of III-V semiconductors. However, this interpretation relies on two assumptions: (1) That spin-orbit coupling is weak in these systems compared to the anisotropic crystal field, and (2) that higher-angular-momentum contributions are negligible. Assumption (1) may break down in light of the fact that the spin-orbit energy is even larger than the principle gap in InAs, and assumption (2) is difficult to justify in any crystal that breaks pure rotational symmetry. Using a generalization of the group-theoretic analysis in [1], we show here that relaxing either of these assumptions can restore the Ising-like nature of the hyperfine tensor, albeit for a particular choice of coupling constants.

[1] E. A. Chekhovich et al. Nature Physics, 2012

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