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Hole - Nuclear Spin Interaction in Semiconductor Quantum Dots

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Spins of localized electrons in semiconductor quantum dots (QDs) are attractive for future spintronic and quantum information devices since they are not subject to the classical spin relaxation mechanisms known for free carriers [1]. It is now well established that the main spin dephasing mechanism in QDs is due to the coupling of conduction electron spin with the randomly fluctuating nuclear spins (Fermi contact term) [2-5]. For a valence electron (or hole), this coupling is expected to be much weaker because of the p-symmetry of the valence band states and no experimental evidence of such a hole-nuclear spin interaction has been reported so far [6]. We have measured the carrier spin dynamics in p-doped InAs/GaAs quantum dots by pump probe and time-resolved photoluminescence experiments. We demonstrate that the hole spin dynamics in these QDs is governed by the interaction with randomly fluctuating nuclear spins [7]. Our calculations based on dipole-dipole coupling between the hole and the quantum dot nuclei lead to a hole spin dephasing time for an ensemble of dots of 15 ns in close agreement with experiments.

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