Extremely long relaxation times of dynamicly polarized nuclei in 3-electron spin-blockade regime in GaAs vertical double quantum dot

A. O. Badrutdinov[a,b], S. M. Huang[a], K. Ono[a], K. Kono[a], and D. A. Tayurskii[b]

[a]Low Temperature Physics Laboratory, ASI, RIKEN, Wako, 351-0198, Japan
[b]Institute of Physics, Kazan Federal University, 420008, Kazan, Russia

We report about recent study of GaAs vertical double quantum dot. The charge stability diagram of investigated sample shows clear spin blockade area in the vicinity of N=3 Coulomb diamond in the external magnetic field of 3 T. This 3-electron spin blockade is formed when the charge transport through double dot is stuck in 3-electron (1s, 1s1p) charge state, with all the spins aligned, and Pauli exclusion principle preventing (1,2) - (0,3) transition. Within the spin-blockade area, dependence of current through the dot on source-drain voltage shows some steplike features. Position of these features clearly depends on prehistory of measurement, indicating some mechanisms of dynamic nuclear polarization. We study this dependence in detail and develop a phenomenological model. Within the model, we show that nuclei could be polarized in both directions relative to external field, depending on pumping conditions. Furthermore, we study relaxation of pumped nuclei under several conditions, and find out that relaxation times can be really long, so it takes about one day for nuclei to relax completely. We also investigate temperature dependence of relaxation in the range of 200 mK - 1 K.
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