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SPIN ECHOES IN EXCHANGE-COUPLED SYSTEMS

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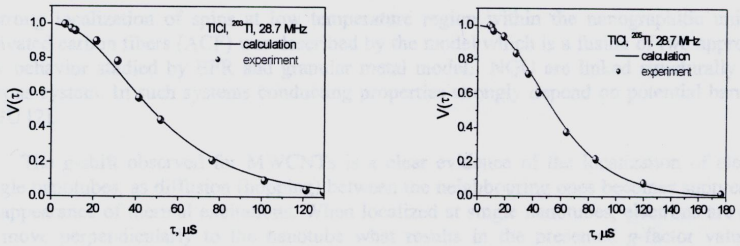
Spin echo technique is one of the most powerful methods for the investigations of the quantum dynamics of the two- and multi-level systems [1-7]. We studied Hahn echo decay in powder thallium chloride TlCl, which comprises unlike spins of two interacting ^{203}Tl and ^{205}Tl isotopes. All ^{203}Tl and ^{205}Tl NMR measurements were carried out at room temperature. The contribution of the dipole-dipole coupling of nuclear spins to the second moment of thallium resonances, calculated using Van Vleck formula [1], are 1,21 kHz^2 for ^{203}Tl and 1,69 kHz^2 for ^{205}Tl NMR, respectively, and are much smaller than the experimental measured values (16,1 kHz^2 for ^{203}Tl and 10,24 kHz^2 for ^{205}Tl NMR, respectively). Thus one concludes that the experimental second moments are predominantly determined by the indirect exchange coupling of thallium nuclei.



(a) (b)

Figure. The decay of Hahn echo signals of (a) ^{203}Tl and (b) ^{205}Tl nuclei in polycrystalline TlCl at a resonance frequency $\nu = 28.7 MHz$. The circles are the experimental data, the solid line is the result of calculation

The multi-particle character of interaction Hamiltonian for the system consisting of two type of nuclei ^{203}Tl and ^{205}Tl does not allow one to calculate explicitly the spin echo decay. Therefore, we present a simple model to calculate the Hahn echo decay of the exchange-coupled nuclear spins in solids. We assume that fluctuations of the NMR resonance frequency are connected with exchange coupling among resonant and off-resonant nuclei. Satisfactory agreement between the calculated and experimentally observed echo decay of the exchange-coupled spins of ^{203}Tl and ^{205}Tl isotopes in thallium chloride TlCl is obtained (figure).

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