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SOLID-ECHO IN SOLIDS WITH MOLECULAR MOTIONS. EFFECTS OF NONZERO PULSE WIDTHS.

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It is now well established that NMR solid-echo signal ($90^0 - \tau - 90^0_{90} - t$) can be significantly distorted in the so-called slow-motion regime ($\tau_c^{-1} \approx M_2^{1/2}$) and the nature of this distortion may be used to obtain information about motional parameters [1-9]. It has been assumed almost in all of these considerations that RF pulses are the delta-functions. In this communication we consider the effects of nonzero pulse width on the solid-echo signal in solids with molecular motions.

Assuming the stochastic process describing the thermal motion of the magnetic nuclei is Gauss-Markov we have obtained the following expression for the solid-echo signal

$$V(t_1, \tau, t_2, t, \tau_c) = \exp\{-(\langle M_2\rangle/2)\,[t - (2\tau + t_2 - (t_1/2))]^2 - \Delta M_2 \tau_c^2 f(t_1, \tau, t_2, t, \tau_c)\}, \quad (1)$$

where τ_c is the correlation time of the motion considered; t_1 and t_2 are the widths of the first and second RF pulses; τ is the time interval between the RF pulses and this is the time between the beginnings of the first and second pulses; t is the time where NMR signal is observed and this time is measured from the beginning of the first pulse; $\Delta M_2 = M_2 - \langle M_2\rangle$ and M_2 is the second moment of NMR line in „rigid" lattice, $\langle M_2\rangle$ is the second moment of motionally narrowed NMR line ($\tau_c^{-1} \gg M_2^{1/2}$).

The function $f(t_1, \tau, t_2, t, \tau_c)$ has the form

$$\begin{aligned} f(t_1, \tau, t_2, t, \tau_c) = &-(7/4) + (t/\tau_c) - (3t_1/4\tau_c) - (t_2/\tau_c) \\ &-(1/4)\exp(-t_1/\tau_c) - \exp(-t_2/\tau_c) - (1/2)\exp(-t/\tau_c) \\ &+\exp[-(\tau - t_1)/\tau_c] - (1/2)\exp[-(t - t_1)/\tau_c] \\ &+\exp[-(t_2 + \tau)/\tau_c] + \exp[-(t - \tau)/\tau_c] + \exp[-(t - \tau - t_2)/\tau_c]\,. \end{aligned} \quad (2)$$

From Eqs.(1), (2) it follows that at $\tau_c^{-1} \ll M_2^{1/2}$ („rigid" lattice) and $\tau_c^{-1} \gg M_2^{1/2}$ (motionally narrowed NMR line) the maximum of solid echo signal is observed at $t_e = 2\tau + t_2 - (t_1/2)$ [10]. In the slow-motion regime ($\tau_c^{-1} \approx M_2^{1/2}$) the maximum of solid echo signal is shifted to the end of the second pulse. Comparison of Eq.(1) with the experimental data obtained on polycrystalline benzen demonstrates a good agreement theory with the experiment and shows new possibilities in measuring motion parameters using a simple solid-echo experiment.

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