AMPERE NMR SCHOOL

ABSTRACTS

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LINESHAPE OF KUBO - ANDERSON OSCILLATOR WITH TWO STATE FREQUENCY MODULATION

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The stochastic oscillator two state jump model with a stochastic fluctuating frequency have found wide applications in condensed phase physic ranging from magnetic resonance spectroscopy, nonlinear optical spectroscopy to problem of decoherence and dephasing in spin-based solid state quantum computers. This model is described by Kubo-Anderson master equation of the form [1]

$$\dot{x} = i\omega(t) \cdot x \ , \tag{1}$$

where the stochastic frequency $\omega(t)$ can take the value of either Δ or $-\Delta$.

Recently, using the continuous time random walks theory (CTRW), it has been obtained the solution of Eq. (1) for the arbitrary sojourn time probability density function PDF $\psi(t)$ [2]. It has been shown that in the case when $\psi(t)$ decay as $t^{5/2}$ at long times, new type of the resonance peaks and narrowing behavior have been observed. However, the similar motional behavior has obtained in the case when it was assumed that the mean sojourn time $\tau^{-1} = W$ fulfills the Arhenius activation law $\tau = \tau_0 \exp(E_a / kT)$, and the activation energy E_a is the stochastic variable, driven by a bistable process of telegraphic type [3].

In the present work it has been obtain the solution of Eq.(1) for the following model: the mean sojourn time W of $\omega(t)$ is the stochastic function of the time and the distribution of all possible values W is described by the function $p(W)$; the jumps from one value $W(t)$ to other are independent and distributed uniformly over the time with density ν_C (the value $\nu_C dt$ determines the average jumps value happen on the time interval dt). Using the method of the differentiation formulae, described in [4], we obtained the following expression for the Laplace transform of $\langle x(t) \rangle$

$$\langle x(z) \rangle = \frac{1}{z + \Delta^2 f(W)}, \tag{2}$$

where

$$f(W) = \frac{(z+\nu_C)\cdot r(W)}{1-[\nu_C(z+\nu_C)+\Delta^2]\cdot r(W)} \quad \text{and} \quad r(W) \equiv \int_0^\infty dW \cdot \frac{p(W)}{(z+\nu_C)(z+\nu_C+2W)+\Delta^2} \ .$$

The obtained expression (2) has been applied to the case of the log-normal and the Gauss distributions of W. It has been shown that for the log-normal distributions unusual type of the motional narrowing phenomenon is observed. The obtained results have been applied to interpretation of the temperature transformation of ^{1}H NMR spectrum of the diffused water molecules in the mineral natrolite.

References

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