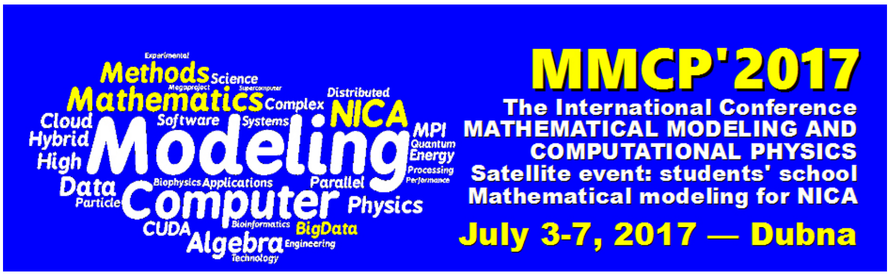

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Fractional Langevin equation model for characterization of anomalous Brownian motion from NMR signals

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Nuclear magnetic resonance (NMR) is non-destructive and one of the best developed tools to study random motion of spins in different systems, including soft tissues such as the brain, heart and muscles. In the long-time limit the current mathematical description of the experiments allows proper interpretation of measurements of normal and anomalous diffusion. The all-time dynamics is correctly considered only in a few works that however do not go beyond the standard Langevin description of the Brownian motion (BM). In the present contribution, the attenuation function S(t) for an ensemble of spins in a magnetic-field gradient is calculated by accumulation of the phase shifts in the rotating frame that result from the motion of spin-bearing particles. The found S(t), expressed through the particles'mean square displacement (MSD), is applicable for any kind of stationary stochastic dynamics of spins with or without a memory. We have studied in detail the model of the fractional BM and obtained in a simple way the MSD of particles trapped in a harmonic potential. The solution is used for the calculation of S(t). In the limit of free particles coupled to a fractal heat bath, the results compare favorably with experiments acquired in human neuronal tissues.

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