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Non-exponential relaxation: multiscale or nonlinear phenomenon?

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A distribution of relaxation times results in a relaxation described by formulae more complex than a single decreasing exponential function. A known example is the stretched exponential function [1] often treated as a continuous linear combination of purely exponential decays [2]. An experiment providing the relaxation function and the appropriate impulse response, i.e. the response of the system to the Dirac's delta-like perturbation would be an evidence of a multiscale origin of the phenomenon. On the other hand, a non-exponential decay may result from a relaxation of a single anharmonic element without any recourse to different time scales. The amplitude-dependent response functions will be presented and the selected experimental data will be analyzed with both methods of description. Criteria will be proposed to distinguish the multiscale and nonlinear [3] mechanisms of non-exponential decay. A sonic effect of reverberation with continuous and discrete distribution of relaxation times will be used to demonstrate how the ordinary exponential and non-exponential regimes affect the intelligibility of speech and music.

References

[1] R. Metzler, J. Klafter , Journal of Non-Crystalline Solids 305 (2002) 81
[2] see e.g. M.N. Berberan-Santos, E.N. Bodunov, B. Valeur. Chemical Physics 315 (2005), 171
[3] P. Zieliński, Physica B Condensed Matter 316 (2002) 603

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