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Measuring AC susceptibilities of magnetic nanoparticles assemblies and quantifying time with Monte Carlo simulations.

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Résumé

Studying the response to an external AC field of magnetic nanoparticles (MNP) assemblies is of practical interest for applications such as hyperthermia as example. After evaporating the solvent the MNP aggregate in frozen ordered or disordered structures. Here we consider MNP smaller than the critical size for the single domain regime. From a theoretical point of view, they can be studied through an effective one spin model including both the magnetocrystalline energy and a coupling between the dipoles.

The response to the AC field is obtained from the in and out of phase susceptibilities $\chi'(\omega)$ and $\chi''(\omega)$. Those quantities can be computed with time quantified Monte Carlo (MC) simulations (1). In such processes, the natural time unit is a simulation time step and the frequency of the AC field is set from this reference.

Here we will discuss how it is possible to map this simulation time unit with the experimental one and how results from different MC schemes compare. Both the rule of the relaxation time of individual particles as a quantity for measuring time and the minimal set of microscopic parameters necessary to quantify time in our simulations will be discussed. Different cases will be considered ranging from independent particles to long range interacting ones. This study will give new insights for distinguishing between individual and collective behavior with regard to dynamical properties of MNP assemblies.

(1) J.-O. Andersson et al. Phys. Rev. B **56**, 13983 (1997); U. Nowak et al. Phys. Rev. Lett. **84**, 163 (2000); P.V. Melenev et al. Phys. Rev. B **86**, 104423 (2012).

Mots-Clés: Time quantified Monte Carlo, AC Susceptibilities, Magnetic Nanoparticles

*Intervenant