Fast Monte Carlo method and its Applications

Altbir, Dora,[1] Vargas, P,[2] Castro, J.D.A.,[3] and Mejia-Lopez, J[4]

[1] *Departamento de Fisica, Universidad de Santiago de Chile*
[2] *Departamento de Fisica, Universidad Tecnica Federico Santa Marìa*
[3] *Instituto de Fisica, Universidade Federal do Rio de Janeiro*
[4] *Facultad de Fisica, P. Universidad Catolica de Chile*

In the last decades, the study of the magnetic properties of nanostructures has become one of the most active areas of research in Condensed Matter Physics. Such systems exhibit rather interesting properties, which result from the combination of several factors such as finite size and quantum interference effects, as well as competition between the interactions which the magnetic moments within the structures are subjected to.

Regarding magnetic nanoparticles, interest has been focused on the determination of their internal magnetic structure, of fundamental importance for practical applications. From the theoretical point of view, the determination of the internal magnetic structure is by no means a simple task. Particles in the size range currently produced may have over 10^7 magnetic moments, which are subjected to both short-ranged (exchange and anisotropy) and long-ranged (dipolar) interactions. As a consequence, with present standard computational facilities, the determination of the magnetic configuration of such particles based on the investigation of their individual magnetic moments becomes prohibitively time-consuming. Therefore, one has to resort to approximations in order to deal with these systems theoretically.

In this communication we present an alternative approach for the study of magnetic nanostructures. It combines the standard Monte-Carlo and scaling techniques to allow the magnetic properties of nanostructures to be obtained from results of calculations for much smaller systems. We illustrate the method by applying it to the well known problem of determining the single domain limit of a cubic magnetic particle with an easy axis parallel to one of the cube directions. The existence of scaling relations which when combined with the Monte-Carlo technique provides a fast and reliable method for investigating the magnetic properties of nanostructures represents a useful tool for studying magnetic nanostructures. The potential of the method is illustrated presenting results for different nanoparticles array.