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THEORETICAL STUDY OF MAGNETODYNAMICS IN BCC IRON NANOPARTICLES

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Abstract The theory of magnetodynamics is a well established area of magnetism and is based on the Landau-Lifshitz equation (LLE) of motion. This dynamical theory forms the basis of the formalism of ferromagnetic resonance (FMR) and spin wave resonance (SWR). The classical theory has been adapted to many magnetic systems, from bulk samples to magnetic thin films and multilayers. Low dimensional systems such as the latter require additional considerations of the surface or boundary conditions which permit the evaluation of the allowed standing spin wave mode wave vectors. In the case of thin films and multilayers the problem can be reduced to one dimension, i.e. in the direction perpendicular to the film plane. Other low dimensional systems, such as nanogranular, nanoparticles and nanostructured materials will be more complex since we must take into account the three dimensional nature of the problem. In recent years, with interest in nanometric systems increasing enormously, attention has been directed to these ends. Of particular concern is the manner in which the surface spins should be treated, since for such small structures the number of surface spins, with reduced magnetic coordination compared to bulk spins, will be a significant number of the total. As such surface magnetic properties in these systems can dominate, thus allowing us to manipulate magnetic properties via a control of particle size. In this paper we outline the formalism for obtaining the excitation spectrum, and in particular, the FMR characteristics, of a nanoparticle using a many-spin approach. In addition to this we simulate BCC iron nanoparticles taking account the environment of each spin, and in particular its positionally specific resonance condition. We present the results of simulations which show that we can determine the separate contributions from core and surface.