Ferromagnetic resonance on biogenic and synthetic magnetite nanoparticles

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A series of biogenic and synthetic magnetite nanoparticles (MNP) have been studied by ferromagnetic resonance (FMR). Samples including bacteria, isolated MNP extracted from bacteria, synthetic MNP in various sizes and complexes were deposited on a mica surface in the presence and absence of external magnetic fields and measured by FMR in the X-band frequency range. The intact chains of MNP produced by the bacterium Magnetospirillum gryphiswaldense MSR-1 (wild type) and the mutant MSR-1K exhibit a distinct feature in the FMR spectra with secondary derivative peaks at relatively small external fields. For other isolated MNP, a broad secondary derivative peak is always found on a high field side of the main absorption field. The size, the shape distribution and the magnetostatic interaction among MNP are represented in the FMR spectra. The dependence of FMR absorption on the biasing field orientation has been investigated. The origins and natures of magnetic anisotropies have been studied by a numerical simulation.