Ground state properties and spin excitations in ferromagnetic nanostructures.

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The confinement of electrons in one or more dimensions of space in ferromagnetic nanostructures has pronounced consequences for most magnetic properties. The reason is the cooperative or collective nature of ferromagnetism which implies a fundamental influence of the coordination and of local symmetry. On the other hand, with the shrinking dimensions of devices like high density magnetic memories the related phenomena become technologically more and more relevant. In this presentation experimental results on epitaxial ultrathin films and nanostructures are discussed on the following aspects:

enhanced ground state magnetic moments
interface magnetic anisotropies
spin excitations and phase transitions.

Characteristic changes are observed when the transition is made from bulk material to ultrathin films in the monolayer range and from extended films to artificially patterned dot arrays with sub-micrometer dot diameter. In particular, the magneto-crystalline anisotropy at an interface is affected by the reduced symmetry and coordination. In addition to the well-known out-of-plane surface anisotropy an in-plane interface anisotropy is found which shows a universal behavior and has the opposite sign compared to the respective volume anisotropy. It is demonstrated that this effect is exclusively determined by the specific lattice symmetry (bcc or fcc).

Finally, it is shown that reduced dimensions significantly alter the spectrum and energies of spin excitations. Especially, continuously enhanced thermal spin excitations and a lowering of the Curie temperature, T_C, are observed when the film thickness is reduced to a few atomic layers and when a continuous film is patterned into circular dots with decreasing diameter. The effect of magnetic anisotropies on spin wave excitations and on T_C predicted by theory is discussed with respect to second order (uniaxial) and fourth order anisotropies.