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Orbital currents and orbital magnetism in magnetic solids

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The coherent treatment of spin and orbital currents provides the ultimate basis for a proper description of magnetic phenomena. In the first part of the talk a quantum-mechanical description of the magnetic shape anisotropy, that is usually ascribed to the classical magnetic dipole-dipole interaction, is presented [1]. This is achieved by including the Breit interaction, that can be seen as an electronic current-current interaction in addition to the conventional Coulomb interaction, within fully relativistic band structure calculations. The major sources of the magnetic anisotropy, spin-orbit coupling and the Breit interaction, are treated coherently this way. This seems to be especially important for layered systems for which often both sources contribute with opposite sign to the magnetic anisotropy energy. The second part of the talk deals with the definition for the orbital magnetisation of magnetic solids. Recent work on this issue makes use of a Bloch representation of the electronic structure [2]. Results for the spin-orbit induced magnetisation of Fe, Co and Ni based on this approach were presented by various authors [3]. To avoid the approximations and limitations of these investigations we present a coherent relativistic definition for the total magnetisation that is derived from the interaction of the total electronic current density with an external magnetic vector potential. Representing the electronic structure in terms of the Green function using the KKR band structure method leads to two terms that can be related to the Van Vleck and Landau contributions of the magnetic susceptibility [4]. A decomposition of the total magnetisation may be obtained by subtracting the spin part, that can be unambiguously determined, from the total magnetisation. Another route is to make use of the Gordon decomposition of the total electronic current density leading in a natural way to a spin and orbital contribution. Numerical results for the elemental ferromagnets Fe, Co and Ni will be presented and discussed.

References

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