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Magnetic circular dichroism and the orbital magnetization of ferromagnets IVO SOUZA, University of California and LBNL, Berkeley, DAVID VANDERBILT, Rutgers University — The spontaneous magnetization of ferromagnets has both spin and orbital contributions, $\mathbf{M} = \mathbf{M}_{\rm spin} + \mathbf{M}_{\rm orb}$, which can be separated out via gyromagnetic measurements. Recently[1] it was found that, when expressed as a bulk property of the Bloch electrons, the orbital magnetization itself consists of two terms, $\mathbf{M}_{\rm orb} = \widetilde{\mathbf{M}}_{\rm LC} + \widetilde{\mathbf{M}}_{\rm IC}$, which can be loosely interpreted as the localized and itinerant contributions, respectively. Interestingly, $\widetilde{\mathbf{M}}_{\rm LC}$ and $\widetilde{\mathbf{M}}_{\rm IC}$ are separately gauge-invariant, which raises the possibility that they may be independently measurable. We show that indeed they are related to the magnetic circular dichroism (MCD) spectrum by a subtle sum rule. MCD, the difference in absorption between left- and right-circularly-polarized light, is given by $\sigma^{(2)}_{{\rm A},\alpha\beta}(\omega)$, the absorptive part of the antisymmetric conductivity. We derive the following sum rule for the interband contribution: $\int_0^\infty \vec{\sigma}^{(2)}_{\rm A}(\omega)d\omega = (2\pi ec/\hbar)(\widetilde{\mathbf{M}}_{\rm LC} - \widetilde{\mathbf{M}}_{\rm IC})$, where $\vec{\sigma}^{(2)}_{\rm A}(\omega)$ is a pseudo-vector. Hence, by combining the results of gyromagnetic and magneto-optical experiments, $\widetilde{\mathbf{M}}_{\rm LC}$ and $\widetilde{\mathbf{M}}_{\rm IC}$ can in principle be measured independently.

[1]D. Ceresoli, T. Tonhauser, D. Vanderbilt, and R. Resta, *Phys. Rev. B* **74**, 024408 (2006).

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