Chirality dependent magnon lifetime in a compensated half-metallic ferrimagnet

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We report a first-principles, all-electron investigation of magnetic excitations in the compensated half-metallic ferrimagnet[1] $CrMnSb$. The dispersion relationship of spin waves is studied through both a semiclassical solution of the Heisenberg model hamiltonian, with exchange integrals computed ab initio via the magnetic force theorem[2]; and the direct calculation of the dynamic transverse spin susceptibility[3], via diagonalization of the energy loss matrix and the fluctuation-dissipation connection[4]. All calculations are performed within the Korringa, Kohn and Rostoker multiple scattering framework [5, 6].

As a result of spin-compensation between the otherwise inequivalent magnetic sublattices of Cr and Mn, both theoretical approaches provide comparable outcome in the form of two acoustic transverse magnon modes, characterized by linear dispersions with equal spin wave velocities as in a simple antiferromagnet.

Dynamic spin susceptibility calculations reveal however half-metallicity to produce a crucial difference in terms of an asymmetric Landau damping between the two branches. The minority gap protects the magnon against decay into up-to-down electronic spin-flip excitations, whereas down-to-up excitations are gapless. This is confirmed by preliminary investigation of the influence of Fermi level placement within the gap, as tunable by simulating doping effects.

References

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