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Aharanov-Casher Effect for Spin Waves in a Ferromagnet[1]
TIANYU LIU, GIOVANNI VIGNALE, Department of Physics and Astronomy, University of Missouri, Columbia — Spin dynamics of an electronic system in the presence of spin-orbit interaction is described in terms of the spin-spin response function. Starting from the double-exchange model in a system consisting of one itinerant electron and two localized ions each of which carries a spin 1/2 we calculate the transverse spin response function of the two localized spins and arrive at a first-principle derivation of the Aharanov-Casher effect on the phase of spin waves in ferromagnetic materials. Next we consider a system of classical localized spins embedded in an electron gas (in the weak coupling limit, this reduces to the RKKY model). By solving the coupled equation of motion for the itinerant and localized electron spins in the presence of spin-orbit coupling we obtain the expected quadratic dispersion relation for spin waves in long wave-length approximation: however, the spin-wave momentum is shifted by a spin-dependent factor in the presence of an electric field. This fact indicates that the spin wave in real space will get a corresponding phase factor under the influence of Aharanov-Casher effect.

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