Seminar: Hard Condensed Matter Theory

Room: Galileo room, 01-128 (Staudinger Weg 7)
Time: Tuesday, 25.10.2016, 14:00

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Spin-orbit twisted spin waves in magnetic quantum wells

Spin-wave based transistors are an appealing alternative to the traditional charge-based transistor, since spin waves carry information with reduced dissipation compared to charge currents. However, one still has to develop efficient methods for controlling the spin waves with low energy cost, a condition not satisfied by the manipulation with magnetic fields. Spin-orbit coupling (SOC) for conduction electrons is a quantum-relativistic interaction emerging for spin-wave control. For itinerant spins, like in a ferromagnetic metal or in a magnetic two-dimensional electron gas (2DEG), the precessing spins of a spin wave belong to conducting electrons, so the precession of the interacting spins, the charge motion, and the SOC are all interrelated. However, one still must disentangle the interplay between the above three protagonists to gain a full understanding of spin-wave control via SOC. Here, we address this challenge by studying a magnetic 2DEG. Our findings can be summarized as follows: we introduce a novel "spin-orbit twist" effect:10 the spin-orbit coupling causes a periodical twist of the spins, resulting in a two-dimensional wave vector shift of the spin-wave dispersions and damping rate. Chiral shifts in the dispersion have already been observed in the literature, but they were described, by empirical parameters like the Dzyaloshinskii-Moriya constant3 or a macroscopic spin-orbit field enhanced by interactions. Here, we predict the amplitude and direction of the chiral wave-vector shift of spin waves using a transformation of the many-body Hamiltonian. This lead us to the possibility of optically tuning the electron density to modify and even reverse the group velocity of the spin waves. Thus, in itinerant spin systems, our findings show that SOC offers the possibility to control both the direction and velocity of spin waves without affecting the damping rate

All interested are cordially welcome!

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