Guided exchange-dipole spin wave in monolayer CrSBr

D. Wang, J. K. Vejpravová
Department of Condensed Matter Physics, Charles University, Czech Republic

CrSBr is an air-stable van der Waals antiferromagnet with high Néel temperature. We calculated the spin-wave spectrum for magnetization polarized along the three principal crystallographic axes of spin-wave wave guides based on a monolayer of CrSBr, which is the building block of bulk CrSBr, by considering the various magnetic interactions present in CrSBr, including the ferromagnetic exchange interaction, the triaxial anisotropy energy, the Zeeman interaction, and the magnetic dipolar interaction. Due to the symmetry of the considered interactions, the spin-wave state is characterized by definite parity under space inversion. In contrast to its short-range counterparts, the long-range dipolar field acts statically as a confining potential for the exchange-dipolar spin wave under investigation, while the dynamic dipolar interaction couples the spin and orbital motion of a magnon, thus giving rise to magnonic doublets (cf. Figure 1) with definite momentum. Effect of hybridization with acoustic phonons was investigated within the same framework. The numerical calculation tallies well with results obtained by micromagnetic simulation. Our study on the spin-wave eigenmode for a monolayer of CrSBr sheds light on the nature of exchange-dipole spin wave in a thin ferromagnetic slab; we confirm particularly that there is no topological protection for the Damon-Eshbach mode. Moreover, a thorough knowledge on the spin-wave eigenmode in monolayer CrSBr itself represents a step forward to understanding the more complicated antiferromagnetic resonance in bulk CrSBr.

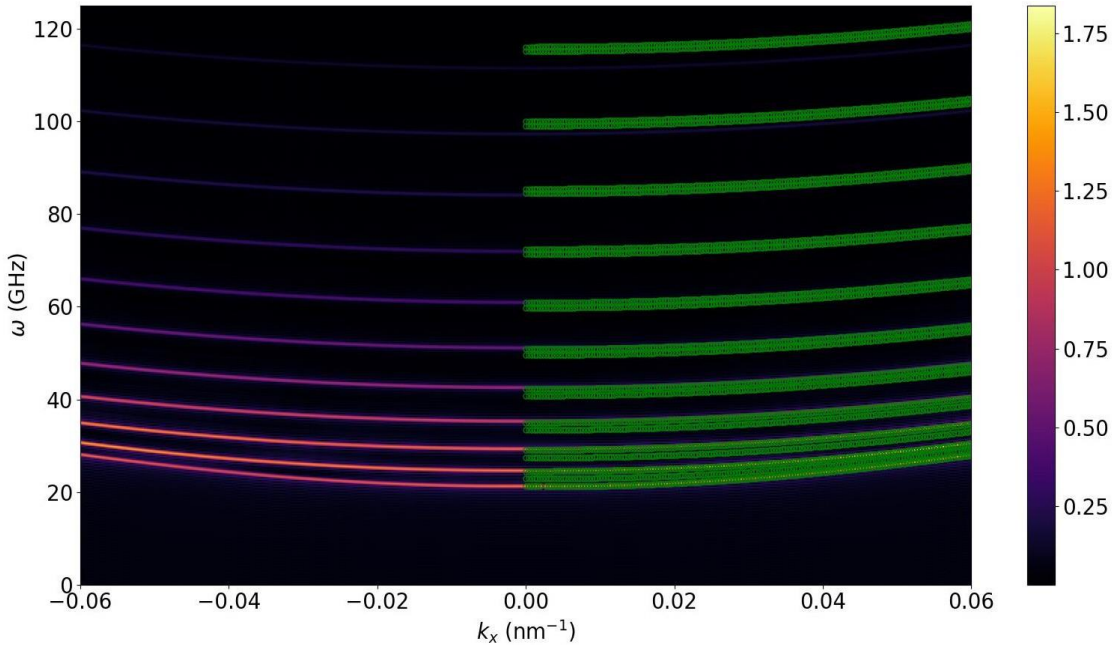

Fig. 1. Theoretically calculated (green circles) and OOMMF simulated dispersion relation for a monolayer of CrSBr with magnetic field B=0.7 T applied perpendicular-to-plane. The dimension of the monolayer is 16384 nm × 256 nm.