Spin wave propagation in a chiral monoaxial crystal $CrNb_3S_6$

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In a magnetic crystal with structural chirality, chiral spin soliton lattice (CSL) emerges as the ground state when a magnetic field (*H*) is applied perpendicular to helical axis. The CSL is a spin phase object of a nonlinear periodic array of 2π kinks and exhibits phase coherence over macroscopic length scale. Materials with such properties are excellent candidates for spintronics applications [1] as the CSL phase may be seen as a 'naturally' occurring nanostructured system whose magnetic texture is highly reconfigurable and topologically protected by the crystalline structure [2, 3]. In this respect, it is very interesting to examine the spin wave properties in materials exhibiting the CSL structure [4, 5, 6]. We present results on the spin wave propagation conditions of micro-sized lamellae of the chiral monoaxial helimagnetic crystal $CrNb_3S_6$. In these experiments, a microwave antenna (emitter) generates a spatially non-uniform field with well-defined wavevector emission spectra, k_i, which excites a spin wave packet on one end of the micro-sized crystal. The spin wave packet propagates in the direction perpendicular to the axis of the emitter, towards the other end of the crystal, and is efficiently detected by a second antenna (receiver) [7]. We investigate the propagation conditions in the directions perpendicular *(I)* and parallel *(II)* to the helical axis of the crystal. The non-reciprocal behavior, $\omega(k_i) \neq \omega(-k_i)$, is examined by reversing the propagation direction at both positive and negative applied magnetic fields. In *(I)*, magnetostatic surface spin waves are excited, in agreement with Damon-Eshbach (*k* perp. *M*) configuration [8]. Here, magnetic field tunable spin wave intensity and frequency non-reciprocity are found and their origin is attributed to combined asymmetric interface conditions and DMI [9]. In *(II)* where *k* is parallel to both *M* and *H*, backward volume spin waves are excited [8]. Here, intensity and frequency non-reciprocity are observed. Interestingly, it is found that the helical phase enables enhanced propagation of the spin waves. These results may further the development of highly efficient, field tunable and non-reciprocal spin wave devices.

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