Skyrmions in van der Waals centrosymmetric materials

Skyrmions can appear in non-centrosymmetric materials due to non-vanishing Dzyaloshinskii–Moriya interactions (DMIs). We investigate the magnetic properties of rhombohedral MX_3 (M: V, Cr, Mn, Fe; X: Cl, Br, I) with van der Waals materials with centrosymmetric lattices. We found that the Dzyaloshinskii–Moriya vector acting between the second nearest neighbor sites of the intralayer is non-zero and large even in MX_3 owing to the breaking of the local inversion symmetry. Large DMIs cause nanoscale magnetic vortices, the so-called skyrmions in MX_3. We observe not only conventional skyrmions in $CrCl_3$ and VCl_3 but also antiferromagnetic skyrmions in $FeCl_3$ and merons in $MnCl_3$. Furthermore, the skyrmions in $CrCl_3$ and VCl_3 have different helicities, indicating the possibility of controlling the helicity by electron/hole doping in MX_3 materials. Van der Waals materials have high degrees of freedom in heterostructures and twisted structures, demonstrating promising potential as skyrmion materials.

[1] Hung Ba Tran, Yu-ichiro Matsushita, arXiv:2209.02333 (2022).