High Chern number van der Waals magnetic topological multilayers $MnBi_2Te_4$/hBN

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Chern insulators are two-dimensional magnetic topological materials that conduct electricity along their edges via the one-dimensional chiral modes. The number of these modes is a topological invariant called the first Chern number C, that defines the quantized Hall conductance as $S_{xy} = Ce^2/h$. Increasing C is pivotal for the realization of low-power-consumption topological electronics, but there has been no clear-cut solution of this problem so far, with the majority of existing Chern insulators showing $C = 1$. Here, by using state-of-the-art theoretical methods, we propose an efficient approach for the realization of the high-C Chern insulator state in van der Waals multilayer heterostructures of the intrinsic magnetic topological insulator $MnBi_2Te_4$ [1,2] and hexagonal boron nitride, $MnBi_2Te_4$/hBN [3]. We show that a stack of n $MnBi_2Te_4$ films with $C = 1$ intercalated by hBN monolayers gives rise to a high Chern number state with $C = n$, characterized by n chiral edge modes (Figure 1). This state can be achieved both under the external magnetic field and without it, both cases leading to the quantized Hall conductance $S_{xy} = Ce^2/h$. Our results therefore pave way to practical high-C quantized Hall systems.

References

[1] M.M. Otrokov et al., Nature 576 (2019) 416
[2] M.M. Otrokov et al., Phys. Rev. Lett. 122 (2019) 107202
[3] M. Bosnar, A.Yu. Vyazovskaya, E.K. Petrov, E.V. Chulkov, M.M. Otrokov, ArXiv:2212.13457 (2022).

Figures

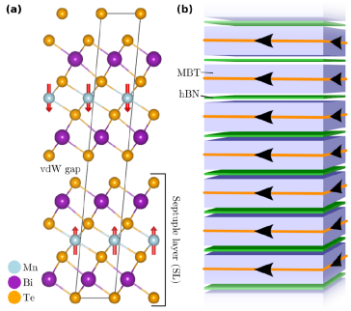

Figure 1: (a) Side view of the bulk $MnBi_2Te_4$ (MBT) crystal structure. Red arrows denote Mn local moments. (b) Schematic depiction of the proposed system: MBT films are separated by hBN monolayers to make a van der Waals multilayer heterostructure with Chern number equal to the number of MBT films, $C = n$. Black arrows depict the direction of the edge currents.