Berry curvature dipole and non-linear Hall effect in two-dimensional materials

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In recent years, it has been discovered that inversion symmetry broken quantum systems can exhibit non-linear Hall effect even under time-reversal symmetric conditions [1]. The underlying quantum object leading to this effect is the first order moment of the Berry curvature, termed the Berry curvature dipole. Such non-linear Hall effects open up different possibilities for direct applications, such as non-linear photocurrents and terahertz radiation detection [2]. However, despite such promise for exciting physics and applications, the Berry curvature dipole induced non-linear Hall effect has been experimentally realized only in a handful of materials. It is, therefore, of vital importance to find materials with large and controllable Berry curvature dipole.

In this talk, I will give examples from our work where such a controllable Berry curvature dipole has been predicted. First, we propose Janus monolayers of transition metal dichalcogenides as a promising materials platform to explore the non-linear Hall effect and Berry curvature dipole physics [3]. Here the topology and the Berry curvature dipole are tunable by chemical composition. Second, we discover a giant non-linear Hall effect in the elemental buckled honeycomb lattices -- silicene, germanene, and stanene [4]. In this case, the Berry curvature dipole is tunable by a transverse electric field which breaks inversion symmetry. We demonstrate that the electric field induced topological phase transitions are associated with a giant Berry curvature dipole near the critical field.

References:

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