Electric field induced quantum anomalous Hall effect in two-dimensional antiferromagnetic triphenyl-lead lattice

HYUN-JUNG KIM, Korea Inst for Advanced Study, CHAOKAI LI, International Center for Quantum Materials, Peking University, JI FENG, Peking University, ZHENYU ZHANG, University of Science and Technology of China, JUN-HYUNG CHO, Hanyang University — The tuning of topological states is of significant fundamental and practical importance in contemporary condensed matter physics, for which the extension to two-dimensional (2D) organometallic systems is particularly attractive.[1] Using first-principles calculations, we find that a 2D hexagonal triphenyl-lead lattice composed of only main group elements is susceptible to a magnetic instability, characterized by an antiferromagnetic (AFM) insulating state with a renormalized valley gap with gap difference of 24 meV due to the spin and valley coupling. This AFM state will be subject to an anomalous valley Hall effect under the action of Berry curvature-induced spin and valley currents via, for example, injection of circularly polarized light.[2] Furthermore, such a AFM band insulator can be tuned into a topologically nontrivial quantum anomalous Hall state with a Chern number of one by the application of an out-of-plane electric field. These findings further enrich our understanding of 2D hexagonal organometallic lattices for potential applications in spintronics and valleytronics. [1] M Z. F. Wang, Z. Liu, and F. Liu, Nat. Comm. 4, 1471 (2013) [2] X. Li, T. Cao, Q. Niu, J. Shi, and J. Feng, Proc. Natl. Acad. Sci. 110, 2738 (2012)