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Experimental Realizations of Magnetic Topological Insulator and Topological Crystalline Insulator¹

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Over the past few years the experimental research on three-dimensional topological insulators have emerged as one of the most rapidly developing fields in condensed matter physics. In this talk, we report on two new developments in the field: The first part is on the dynamic interplay between ferromagnetism and the Z_2 topological insulator state (leading to a magnetic topological insulator). We present our spin-resolved photoemission and magnetic dichroic experiments on MBE grown films where a hedgehog-like spin texture is revealed on the magnetically ordered surface of Mn-Bi₂Se₃ revealing a Berry's phase gradient in energy-momentum space of the crystal. A chemically/electrically tunable Berry's phase switch is further demonstrated via the tuning of the spin groundstate in Mn-Bi₂Se₃ revealed in our data (Nature Physics 8, 616 (2012)). The second part of this talk describes our experimental observation of a new topological phase of matter, namely a topological crystalline insulator where space group symmetries replace the role of time-reversal symmetry in an otherwise Z_2 topological insulator predicted in theory. We experimentally investigate the possibility of a mirror symmetry protected topological phase transition in the Pb_{1-x}Sn_xTe alloy system, which has long been known to contain an even number of band inversions based on band theory. Our experimental results show that at a composition below the theoretically predicted band inversion, the system is fully gapped, whereas in the band-inverted regime, the surface exhibits even number of spin-polarized Dirac cone states revealing mirror-protected topological order (Nature Communications 3, 1192 (2012)) distinct from that observed in Z_2 topological insulators. We discuss future experimental possibilities opened up by these new developments in topological insulators research. This work is in collaboration with M. Neupane, C. Liu, N. Alidoust, I. Belopolski, D. Qian, D.M. Zhang, A. Richardella, A. Marcinkova, Q. Gibson, R. Sankar, Y.J. Wang, T. Chang, H. Jeng, H. Lin, L.A. Wray, J.D. Denlinger, M. Leandersson, T. Balasubramanian, J. Sánchez-Barriga, O. Rader, G. Landolt, B. Slomski, J.H. Dil, F.C. Chou, E. Morosan, N. Samarth, R.J. Cava and M.Z. Hasan.

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