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Predicting, Realizing and Exploiting Exotic Topological Phases of Quantum Matter[1]

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The revolution started by the discovery of topological insulators a few years ago has turned out to be the proverbial tip of the much larger iceberg of exotic phases harbored by quantum matter. Consideration of electronic states protected by time-reversal, crystalline and particle-hole symmetries has led to the prediction of many novel 3D materials, which can support Weyl, Dirac and Majorana fermions, and to new types of insulators such as topological crystalline insulators and topological Kondo insulators, as well as 2D quantum spin Hall insulators with large band gaps capable of surviving room temperature thermal excitations. [1] In this talk, I will discuss our recent theoretical work aimed at predicting topological materials beyond the standard topological insulators and identify cases where robust experimental evidence has been obtained toward their successful materials realization. [2-10] I will also comment on the potential of topological materials as next generation platforms for manipulating spin and charge transport and other applications. [1] A. Bansil, H. Lin and T. Das, Reviews of Modern Physics (2015). [2] S.-Y. Xu et al., Science 349, 613 (2015). [3] I. Zeljkovic et al., Nature Materials 14, 318 (2015). [4] J. He et al., Nature Materials 14, 577 (2015). [5] S.-M. Huang et al., Nature Communications 6, 7373 (2015). [6] S.-Y. Xu et al., Science Advances (2015). [7] I. Zeljkovic, et al., Nature Communications 6, 6559 (2015). [8] M. Neupane et al., Physical Review Letters 114, 016403 (2015). [9] Su-Yang Xu, et al., Nature Physics 11, 748 (2015). [10] C. P. Crisostomo et al., Nano Letters 15, 6568 (2015).

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