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Weyl and Heusler compounds[1]

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Topological insulators (TIs), Weyl and Dirac semimetals are new quantum states of matter. Heusler compounds are a remarkable class of materials which exhibit a wide range of multifunctionalities including tunable topological insulators [1]. The required band inversion has already been unambiguously identified by angle-resolved photoemission [2]. Weyl and Dirac semimetals open up new research directions and applications that result from the large Berry phases that they exhibit: these lead to giant anomalous Hall effect (AHE) and spin Hall effects [3]. In the C1b Heusler compounds, the inclusion of rare earth atoms allows the use of magnetic exchange fields to induce Weyl points [4] in magnetic fields, which break time-reversal symmetry. In GdPtBi several signatures of a Weyl semimetal have been observed, ranging from a large longitudinal negative Magnetoresistance, to an AHE and a Seebeck effect [4]. Recently Co_2TiSn and other Co_2-Heusler compounds were found to be Weyl semimetals [5]: these materials have an energy-gap for one spin orientation and crossing points in the other spin direction. The Berry phase induces a giant AHE in these ferromagnets. However, even antiferromagnetic Heusler compounds can be designed with large Berry phases as a consequence of Weyl points close to the Fermi energy [6]: this has recently been proven via a giant AHE for single crystals of Mn_3Sn and Mn_3Ge [7]. [1] Chadov, et al., Nat. Mat.. 9,541 (2010), Lin, et al., Nat. Mat. 9, 546 (2010) [2] Liu, et al., N. Nat. Com. 7 12924 (2016) [3] Sun, et al., arXiv:1604.07167 [4] Hirschberger et al. Nat. Mat. (2016) Shekhar, et al. arXiv: 1604.01641 [5] Wang et al., arXiv:1603.00479, Kübler and Felser, EPL 114, 47005 (2016) [6] Kübler and Felser, EPL 108 67001 (2014), Zhang, et al., arXiv:1610.04034 [7] Nayak, et al., Science Advances 2 e1501870 (2016) , Nakatsuji, Kiyohara and Higo, Nature 527 212 (2015)

[1]ERC Idea Heusler