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Topological States in Multi-Orbital Honeycomb Lattices of HgTe Quantum Dots CHRISTOPHE DELERUE, IEMN, Lille, France, WOUTER BEUGELING, TU Dortmund, Germany, EFTERPI KALESAKI, University of Luxembourg, YANN-MICHEL NIQUET, Grenoble Alpes University and CEA, Grenoble, France, DANIEL VANMAEKELBERGH, CRISTIANE MORAIS SMITH, University of Utrecht, The Netherlands — Recent works demonstrate that 2D single-crystalline sheets of semiconductors forming a honeycomb lattice can be synthesized by oriented attachment of semiconductor nanocrystals. Inspired by these results, we have performed atomistic tight-binding calculations of the band structure of CdSe [1] and HgTe [2] sheets with honeycomb nano-geometry. In the case of CdSe [1], we predict that their conduction band exhibits Dirac cones at two distinct energies. The lowest one has s-orbital character. The bands higher in energy present a Dirac cone and nontrivial flat bands because of their p-orbital character. We show that lattices of HgTe [2] combine the effects of the honeycomb geometry and strong spin-orbit coupling. The conduction bands can be described by a tight-binding lattice model as in graphene, but including multi-orbital degrees of freedom and spin-orbit coupling. This results in very large topological gaps and a flattened band detached from the others. Honeycomb structures of HgTe constitute a promising platform for the observation of a fractional Chern insulator or a fractional quantum spin Hall phase. [1] E. Kalesaki et al., Phys. Rev. X 4, 011010 (2014). [2] W. Beugeling et al., Nat. Commun. doi: 10.1038/ncomms7316 (2015).

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