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Role of local orbital angular momentum in the electronic structure under inversion symmetry breaking

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Orbital angular momentum (OAM), usually ignored in solids (OAM quenching), is found to play an important role in the electronic structure for a broad range of materials [1,2]. It will be shown how one can detect existence of OAM by using circular dichroism angle resolved photoemission (CD-ARPES). CD-ARPES is used to study a topological insulator Bi2Se3. The result reveals that not only spins but also OAM forms chiral structure, and the energy scale is mostly determined by the interaction of asymmetric charge distribution and electric field. This observation is different from the conventional understanding of the Rashba effect and suggests that we must consider a new effective Hamiltonian based on OAM. The new Hamiltonian along with crystal field and atomic spin-orbit coupling (SOC) should determine the surface electronic structures. We further investigated surface states with various atomic SOC strengths to study such mechanism. It is shown experimentally and theoretically that, as the atomic SOC strength decreases, the OAM in different Rashba bands change from anti-parallel to parallel configuration. The split energy in such case is found to come from atomic SOC (parallel and anti-parallel alignment of the spin to OAM). Local OAM is found to play an important role in the electronic structure for a wide range of materials with inversion symmetry breaking. We will show some examples where OAM is quite strong, such as semi-conductors with zinc blende structure and transition metal oxide surface states.

[1] S. R. Park, Phys. Rev. Lett.,108, 046805 (2012).
[2] S. R. Park, Phys. Rev. Lett.,107, 0156803 (2011).