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# Spin-dependent dynamics of topological matter

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The electron spin plays an important role in topological matter because the lifting of the spin degeneracy by the spin-orbit interaction is crucial. Moreover, the interaction of topological insulators with ferromagnets enables novel effects such as the quantum anomalous Hall effect. Spin- and angle-resolved photoemission is an efficient probe of the spin-dependent occupied electronic structure.

Performing the spin- and angle-resolved photoemission experiment in an ultrafast way by a 1.5 eV pump and a 6 eV probe pulse on the 100 fs time scale, we gain valuable insight into the carrier dynamics of topological insulators such as Bi2Te3 and Sb2Te3. We witness the occupation of the upper half of the Dirac cone surface state and find that its decay is slowed down by a bottleneck effect.

The creation of a spin-polarized surface current by circularly polarized 1.5 eV light has been claimed in transport experiments. By our pump-probe experiment, we can directly prove this interpretation through the time-dependence of the circular dichroism signal. Adding spin resolution reveals another interesting result: While the ground state spin texture is predominantly in the surface plane, the circularly polarized pump pulse rotates the spin out of the surface plane along the propagation direction of the light. Furthermore, the orientation of the spin is controlled by the light helicity. Analysis of the dynamics reveals that the excited spin decays twice as fast as the excited charge.

These carrier dynamics depend very much on the bulk insulating property of the topological insulator. We found that the typical decay times of about 2 ps for metallic samples increase dramatically when the material composition of the topological insulator is such that the chemical potential is in the bulk band gap. We observe a persistent photovoltage and interpret it as being due to a band bending effect.

Going beyond the currently used 6 eV lasers will enlarge the available range of electron wave vectors k. This holds for 2D as well as 3D momentum space.

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