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Opportunities of THz-ARPES for studies of solids and interfaces

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There is an increasing interest to control and manipulate the properties of solids with intense light fields. Prominent examples are photo-induced insulator-to-metal transitions, light-induced superconductivity, the observation of Floquet-Bloch states and light-wave driven electrical currents. Experiments along these lines benefit tremendously when the capability of angle-resolved photoelectron spectroscopy (ARPES) is exploited to probe the electronic structure of the material. Here, new opportunities arise in combination with THz excitation and moving beyond pump-probe schemes for time-resolution as demonstrated recently by our observation of THz-driven Dirac currents [1]

In the first subcycle time-resolved ARPES experiment, it has been revealed how the carrier wave of a THz pulse accelerates Dirac fermions in the topological surface state of Bi2Te3. While terahertz streaking of photo-emitted electrons traces the electromagnetic field at the surface, the acceleration of Dirac states leads to a strong redistribution of electrons in momentum space (Fig.1) The electrons carrying the current react inertia-less on the accelerating field and travel ballistically with the Fermi velocity of 410 nm/ps over distances of several hundreds of nanometres. This scenario opens up a realistic parameter space for dissipation-free lightwave-driven electronic devices at optical clock rates.

[1] J. Reimann, J., S. Schlauderer, C.P. Schmid, F. Langer, S. Baierl, K.A. Kokh, O.E. Tereshchenko, A. Kimura, C. Lange, J. Güdde, U. Höfer and R. Huber, Nature 562, 396 (2018).

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