Max-Planck-Institut für Struktur und Dynamik der Materie

Max Planck Institute for the Structure and Dynamics of Matter

April 23th 2014 – 16:00
CFEL Seminar room V (Bldg. 99, 01.109)

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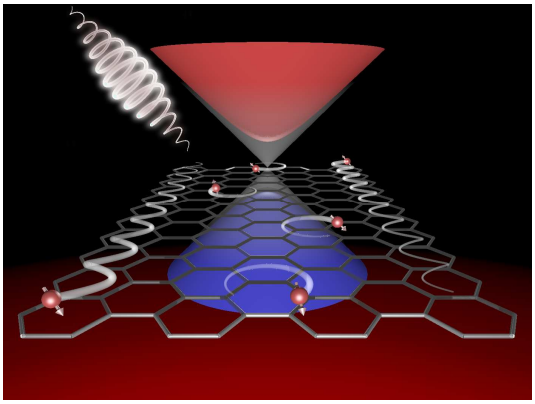
Modulating Berry's curvature with light: Ultrafast topological phase transition in graphene

Pump-probe laser spectroscopy, so far largely limited to the field of atomic and molecular physics, is gaining a surging interest in condensed matter physics. Besides important applications in probing couplings between microscopic degrees of freedom in materials on their ultrashort intrinsic time scales, recent progress suggests that ultrafast quantum control and the creation of novel non-equilibrium states of matter is within experimental reach. While equilibrium band gap engineering has become a major theme since the first synthesis of monolayer graphene, it was only recently proposed that circularly polarized laser light could turn trivial equilibrium bands into topological non-equilibrium bands. I will discuss simulations that observe ultrafast band gap openings and paradoxical gap closings at a critical field strength. Importantly, the gap openings are accompanied by nontrivial changes of the band topology, realizing a photo-induced Haldane multilayer system. We show that pump-probe photoemission spectroscopy can track these transitions in real time via energy gaps exceeding 100MeV. We thus predict a non-equilibrium realization of a tunable Haldane multilayer model with a Berry curvature that can be tipped optically by small changes in external fields on femtosecond time scales. Since we are focused on the physics of chiral Dirac fermions, these results apply equally to all systems possessing Dirac points, such as surface states of topological insulators. I will also discuss some broader perspectives for the emergent field of "Berry curvature engineering" and possible applications to layered systems, such as dichalcogenide materials.

M.A. Sentef, M. Claassen, A.F. Kemper, B. Moritz, T. Oka, J.K. Freericks, T.P. Devereaux, ArXiv:1401.5103



Host: Isabella Gierz / Andrea Cavalleri

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