

Laser Seminar

Monday, February 19th, 2018

Time 4.45pm

Location ETH Zurich, Hönggerberg, HPF G6

Speaker **Davide Soranzio**
Department of Physics, Università degli studi di Trieste, Italy

Title **Non-equilibrium dynamics in WTe₂ revealed by ultrafast supercontinuum optical and photoelectron spectroscopies**

Abstract Recent studies [1] have shown that the transition metal dichalcogenide and type-II Weyl semimetal [2] WTe₂ presents a large non-saturating magnetoresistance, emerging from its semimetallic electronic structure. This behavior has been explained in other materials as the consequence of perfect carrier compensation. This makes WTe₂ a promising material to obtain an ultrafast control of the electrical conductivity by unbalancing the electron-hole ratio through ultrafast laser pulses. We investigated the out-of-equilibrium optical properties of WTe₂ using time-resolved optical spectroscopy (TR-OS) with an ultrabroadband supercontinuum probe (500-1400 nm). We observe a large dichroism in the differential reflectivity aligning the linearly polarized probe electric field along each in-plane crystallographic axis. This behavior is connected to a two-fold dielectric tensor, as inferred by equilibrium reflectivity. Superimposed to the main relaxation dynamics (timescale ~ 1 ps) due to electron-phonon scattering, we distinguish four different A₁ coherent optical phonons, whose frequencies are $\sim 9, 80, 134$ and 215 cm^{-1} , in agreement with ab-initio and Raman studies [3], obeying a phonon-softening mechanism as the temperature is raised. By using different pump photon energies, we show a selective excitation of these coherent optical phonons. Thanks to the probe spectral breadth and modeling the dielectric function of WTe₂ as a sum of interband optical transitions, we demonstrate that single coherent phonon modes modulate specific optical transitions. Ab-initio calculations will be performed to link such transitions to the electronic band structure and its perturbation due to the periodic lattice distortions. Finally, we performed TR-ARPES experiments around the Fermi energy to prove the possibility to photoinduce a transient imbalance of carrier density. The results have been compared to the TR-OS experiments, where a transient imbalance of high-energy spectral weight has been revealed.

References

- [1] Ali et al., Nature 514 (2014)
- [2] Soluyanov, et al. Nature 527 (2015).
- [3] Kong et al., Appl. Phys. Lett. 106 (2015)

Host Steve Johnson, Ultrafast Dynamics, IQE

More Info <http://www.fastlab.ethz.ch/laser-seminar.html>

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