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Investigation of the $IrTe_2$ Phase Transitions with Photoemission Spectroscopy and Development of a Femtosecond Photoemission Experiment.

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This work presents the results of fundamental experimental studies in the field of condensed matter physics, i. e. systems involving a large number of (strongly) interacting particles. The synthetic solid $IrTe_2$ is a crystal and an example of this family of materials. This crystal undergoes several phase transitions as a function of temperature. During these transitions, the atoms composing the crystal reorganize themselves in a new state in a collective way due to the change of electronic environment, so that new periodicities emerge from the system. Further emergent behavior in this material appears in the form of superconductivity in Pt-doped $IrTe_2$ samples [1] or in the stabilization of a reconstruction phase under chemical strain by the substitution of Tellurium atoms by Selenium atoms [2], suggesting strong susceptibility of the phases to external perturbations.

A powerful method to investigate the behavior of an $IrTe_2$ single crystal is an analysis of the electronic band structure. Electron spectroscopy, and more specifically angle-resolved photoemission spectroscopy, provides unique insights into the electronic degree of freedom which is central to understand the physics of $IrTe_2$ (and many other materials) over a wide energy range. These measurements allow us to identify the distribution of electrons in the reciprocal space of solids and also to detect exotic properties that arise from phase transitions.

[1] Sunseng Pyon, Kazutaka Kudo, and Minoru Nohara. Superconductivity induced by bond breaking in the triangular lattice of IrTe2. Journal of the Physical Society of Japan, 81(5):053701, 2012.

[2] G. L. Pascut, T. Birol, M. J. Gutmann, J. J. Yang, S.-W. Cheong, K. Haule, and V. Kiryukhin. Series of alternating states with unpolarized and spin-polarized bands in dimerized IrTe2. Phys. Rev. B, 90:195122, Nov 2014.

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