# 物性研究所談話会

**標題：**THz-ARPES band structure movies of Dirac surface currents
**日時：**2019 年 11 月 1 日(金)　午後４時～午後５時
**場所：**物性研究所本館 6 階 大講義室(A632)
**講師：**Ulrich Höfer
**所属：**Department of Physics, Philipps-University of Marburg, Germany
**要旨：**

Time-resolved photoelectron spectroscopy combines femtosecond pump-probe techniques with angle-resolved photoelectron spectroscopy (ARPES). New opportunities for this powerful technique arise in combination with THz excitation. As an example, I will explain how THz-ARPES can be used to measure electron transport in the Dirac surface state of a three-dimensional topological insulator in a contact-free fashion and with femtosecond time-resolution. We induce electrical currents in these states with strong THz transients and directly access their dynamics in momentum space with subcycle time resolution. As a result of spin-momentum locking, the accelerated spin-polarized electrons reach ballistic mean free paths of several hundreds of nanometers. Topological insulators are thus promising materials for future lightwave-driven electronics [1].

Subcycle THz-ARPES does not only provide a way of observing carrier transport directly in non-trivial band structures. The method may well herald a new era of time-domain investigations of surface and bulk band structures of new materials and phenomena, ranging from topology to high-temperature superconductivity. I will briefly discuss perspectives as well as experimental diffi-culties of the technique.

[1] J. Reimann, 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).

講師紹介

Ulrich Höfer 先生は、表面物理科学の分野で世界的に著名な研究者です。主に時間分解二光子光電子分光を用いた固体表面・界面電子や吸着分子が示す超高速な光励起ダイナミクスを対象とした研究を展開されています。談話会では、先生の研究グループが世界で初めて成功したテラヘルツポンプ角度分解光電子分光について解説して頂く予定です。物性研における光科学・表面科学そしてそれらの融合研究との関連性も深い内容で、興味深いお話が伺えると思います。是非、皆様ご参加下さい。

**標題：Entropic elasticity and negative thermal expansion in a simple cubic crystal**
**日時：2019 年 11 月 28 日(木)　午後４時～午後５時**
**場所：物性研究所本館 6 階 大講義室(A632)**
**講師：Igor Zaliznyak**
**所属：Brookhaven National Laboratory**
**要旨：**

While most solids expand when heated, some materials show the opposite behavior: negative thermal expansion (NTE). NTE is common in polymers and biomolecules, where it stems from the entropic elasticity of an ideal, freely-jointed chain. The origin of NTE in solids had been widely believed to be different, with phonon anharmonicity, and specific lattice vibrations that preserve geometry of the coordination polyhedra - rigid unit motions (RUMs) - as leading contenders for explaining NTE. Our neutron scattering study of a simple cubic NTE material, ScF3, overturns this consensus [1]. We observe that the correlation in the positions of the neighboring fluorine atoms rapidly fades on warming, indicating an uncorrelated thermal motion, which is only constrained by the rigid Sc-F bonds. These experimental findings lead us to a quantitative theory of NTE in terms of entropic elasticity of Coulomb floppy network crystal, which is applicable to a range of open framework ionic solids featuring floppy network architecture [2]. Our theory is in remarkable agreement with experimental results in ScF3, describing NTE, the phonon frequencies, the structural phase transition governed by entropic stabilization of criticality, and the entropic compressibility. We thus find that NTE in a family of insulating ceramic crystals stems from a simple and intuitive physics of entropic elasticity of an under-constrained floppy network, which has long been appreciated in soft matter and polymer science but has been broadly missed by the hard condensed matter community. Our results reveal the formidable universality of the NTE phenomenon across soft and hard matter [1,2].

[1] D. Wendt, et al., Sci. Adv. 5: eaay2748. (2019).
[2] A. V. Tkachenko, I. A. Zaliznyak. arXiv:1908.11643 (2019).

講師紹介

Igor Zaliznyak 先生は、強相関・磁性分野の中性子散乱研究で世界的に著名な研究者です。主に非弾性散乱分光器を用いて、量子スピン系や高温超伝導物質のダイナミクスを対象とした研究を展開されてきました。談話会では、固体物理とソフトマターの負の熱膨張現象をフロッピーネットワーク理論でユニバーサルに解釈可能であることを、ScF3 の負の熱膨張を例に解説していただく予定です。是非、皆様ご参加下さい。