Chez Pierre

Presents ...

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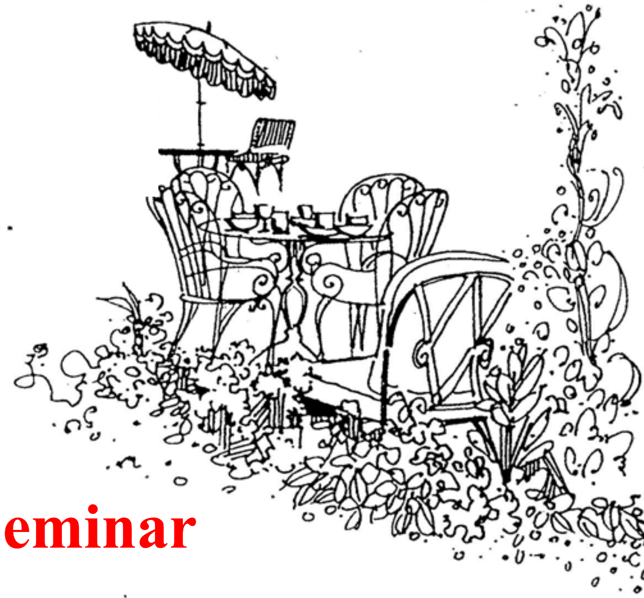

Chez Pierre Seminar

Félix Baumberger – University of Geneva

"Electronic structure of exfoliated van der Waals crystals from micro-focus ARPES"

Two-dimensional crystals of semimetallic van der Waals materials hold much potential for the realization of intriguing states of matter, as exemplified by the recent discoveries superconductivity and correlated insulating states in twisted bilayer graphene [1] and of a robust quantum spin Hall state in monolayer WTe_2 [2]. Understanding these phases is challenging, not least because little is known from experiment about the momentum space electronic structure of such systems.

In this talk, I will discuss direct electronic structure measurements on exfoliated van der Waals crystals. To this end, we produced different van der Waals devices by combining standard nano-fabrication methods with all-dry transfer of exfoliated crystals and used angle resolved photoemission with simultaneous real- and momentum-space resolution to map their electronic structure.

I will first show recent data from twisted bilayer graphene near the magic angle of 1.1° that establish the salient features of its band structure. In particular, the data reveal the flat moiré mini-band responsible for the strong correlation physics of magic angle graphene, hybridization gaps in the dispersive Dirac bands and the gap separating these two electronic systems [3].

In order to extend such measurements to investigate the rich physics of 1T'-WTe_2 – a material which is highly air-sensitive – we fabricate samples under protective atmosphere and encapsulate the active layer with monolayer graphene. We find that the latter protects WTe_2 from degradation up to atmospheric pressure and is suitable for obtaining high-quality spectra [4]. Our data on monolayer 1T'-WTe_2 confirm a sizeable band gap and the *d*-*d* band inversion resulting in the 2D topological insulator phase discovered from measurements of the edge conduction [2]. In the bilayer, we find a vanishing gap and strong signatures of the broken inversion symmetry, consistent with the ferroelectic polarization deduced from recent transport experiments.

[1] Cao, Y. et al., Nature 556, 43-50 (2018) ; Cao, Y. et al., Nature 556, 80-84 (2018)
[2] Fei, Z. et al., Nature Physics 13, 677-682 (2017) ; Wu S. et al., Science 359, 76-79 (2018)
[3] Lisi, S. et al., Nature Physics (2020). https://doi.org/10.1038/s41567-020-01041-x
[4] Cucchi, I. et al., Nano Letters 19, 554-560 (2019)