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ABSTRACT:

Evidence of a Broad Flat Band at the Lifshitz Transition with a Novel Ordered Supergraphene obtained by Erbium Intercalation

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This work is part of the current race to explore graphene and its behavior at a critical point of its Brillouin zone, the van Hove singularity where the Lifshitz transition takes place, in order to obtain, more particularly "flat" bands where important electron-electron correlation effects are expected with the emergence of new physical properties (e.g.unconventional superconductivity). The doping of graphene can be achieved in different ways, one of them is to insert atoms between two layers of graphene or between the graphene and its substrate: functionalization by intercalation [1]. This is the case of Graphene on SiC (0001). The intercalation is simply done by evaporating under ultra high vacuum, the element of interest followed by annealing at different temperatures.
Most elements can be intercalated and, by analogy with the graphite intercalation compounds (GICs), the prospect of realizing batteries, but also the observation of a supercondutive transition, the alkalis atoms such as Li, Na, K, Rb and Cs continue to be widely studied. Some teams, including ours, have been interested in the lanthanide series, which allows to reach record levels of doping as for Tb intercalation [2], and more recently with the intercalation of Yb followed by the deposition of K on the surface, it has made it possible to reach and then exceed the Lifshitz transition [3].
In this talk we will present new results on the intercalation of Erbium. We have recently highlighted a new ordered structure, a "supergraphene", obtained by the ordered intercalation of Er-atoms under the graphene surface [4]. This 1.4 nm non-Bravais (honeycomb) network, which looks like a Moiré pattern obtained by the superposition of two graphene layers rotated by 10° (but we have only one layer of graphene here!) presents a Fermi surface topology with a flat band where the Lifshitz transition is reached and even exceeded, and this for the first time here, without any adding doping atoms on top of the graphene.
We think to observe here a Kékulé distortion marked by the topology of the Fermi surface at the Lifshitz, contrary to what has been observed with a Fermi level close to the Dirac point with quantum interference around the defects (QPIs) giving the standard (Ö3xÖ3) R30° reconstruction [5]. We have shown that the Fermi surface topology at the Lifshitz transition was dependent on a strong Spin-Orbit coupling which is expected in the case of intercalated Er. Results from XMCD at the M4.5 threshold of Er obtained recently on the DEIMOS line of Soleil-Synchrotron will also be shown and discussed.

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