SEMINARIO
Departamentos de Física Teórica I y II
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TITULO: Novel platforms for topological phases in 2D materials

LUGAR: FACULTAD DE CIENCIAS FÍSICAS UCM
DÍA: 27 de enero, 2015 (Martes)
HORA: 14:30
AULA: Seminario Depto. Física Teórica I, Planta 3ª

ABSTRACT:

We [1] study the possibility to create a time-reversal-invariant topological insulator state in two-dimensional (2D) crystals of transition metal dichalcogenides (TMDCs). We note that, at low doping, TMDCs under shear strain will develop spin-polarized Landau levels residing in different valleys. We argue that gaps between Landau levels in the range of 10-100 Kelvin are within experimental reach. In addition, we point out that a superlattice arising from a Moiŕ e pattern can lead to topologically non-trivial subbands. As a result, the edge transport becomes quantized, which can be probed in multi-terminal devices made using strained 2D crystals and/or heterostructures. The strong d character of valence and conduction bands may also allow for the investigation of the effects of electron correlations on the topological phases.
On the other hand, and motivated by recent STM/STS experiments [2], we study graphene (Gr) on iridium (Ir), with islands of an ordered lead (Pb) monolayer intercalated between them. While the Gr layer is structurally unaffected by the presence of Pb, its electronic properties change dramatically. Regularly spaced resonances appear. We interpret these resonances as the effect of strong and spatially modulated spin-orbit fields induced in Gr layer by the proximity of Pb. We present a phenomenological theory including all the spin-orbit terms allowed by the

reduced symmetry of the Gr/Pb system, which reproduces qualitatively the reported STS spectra. According to this model, the electronic spectrum has, in addition to confined electronic states, a series of gaps with non trivial topological properties which resemble the Bernevig-Zhang model of the quantum spin Hall effect.

[1] M. A. Cazalilla, H. Ochoa, and F. Guinea, Physical Review Letters 113, 077201 (2014).

[2] Fabĭan Calleja, Héctor Ochoa, Manuela Garnica, Sara Barja, Juan Jesús Navarro, Andrés Black, Amadeo L. Vázquez de Parga, Francisco Guinea, and Rodolfo Miranda, Nature Physics, doi:10.1038/nphys3173.