Berry Phase and intrinsic Hall effects in van-der-Waals graphene-based *EX-SO-TIC* structures

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Two-dimensional Van-der-Waals materials focus enormous attention due to a variety of electronic and magnetic properties that might be controlled by external fields. A special group of van-der-Waals materials are so-called ex-so-tic structures where one can turn the time-reversal symmetry on and off on demand by electric gating. This leads to the swap between an exchange (ex) and spin-orbit (so) coupling. An example of such an ex-so-tic structure is bilayer graphene (GG) sandwiched by a 2D ferromagnet Cr2Ge2Te6 (CGT) and a monolayer of transition metal dichalcogenides, e.g., WS2. Swapping between the exchange and spin-orbit coupling in CGT/GG/WS2 is possible due to the interplay of gate-dependent layer polarization in bilayer graphene and short-range spin-orbit and exchange proximity effects affecting only the layer of graphene in contact with the sandwiching materials.
Within effective Hamiltonian, derived from symmetry considerations and DFT study [1], we derived electronic and topological properties of CGT/GG/WS2. We present, among others, a behaviour of Berry curvature as a function of characteristic parameters defining the Hamiltonian and discuss possible topological phase transitions for the ex - so -tic structure. Furthermore, we present detailed characteristics of intrinsic anomalous, spin and valley Hall effects [2] that may appear in specific phases.

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References

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