Highlights

Other Materials —2017

Entropy spikes as a signature of Lifshitz transition in the Dirac materials

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Entropy is an important fundamental property of many-body systems. It governs their thermodynamics, heat transfer, thermoelectric and thermo-magnetic properties. On the other hand, the entropy was always hard to be directly measured experimentally. It has been revealed very recently that the entropy per particle, $\partial S/\partial n$, where n is the electron density, can be experimentally studied[1].

We demonstrate theoretically that the characteristic feature of a 2D system undergoing N consequent Lifshitz topological transitions is the occurrence of spikes of entropy per particle s of a magnitude $\pm \ln 2/(J - 1/2)$ with $2 \le J \le N$ at low temperatures. We derive a general expression for s as a function of chemical potential, temperature and gap magnitude for the gapped Dirac materials. Inside the smallest gap, the dependence of s on the chemical potential exhibits a dip-and-peak structure in the temperature vicinity of the Dirac point. The spikes of the entropy per particles can be considered as a signature of the Dirac materials. These distinctive characteristics of gapped Dirac materials can be detected in transport experiments where the temperature is modulated in gated structures.

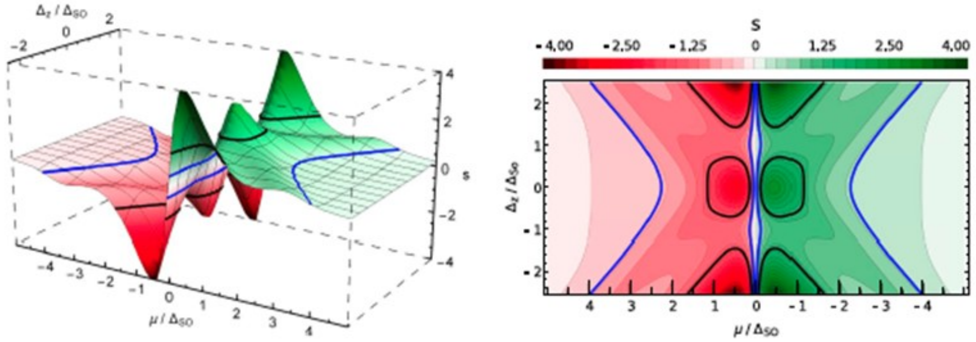

Fig.1: The entropy per electron s as functions of the chemical potential μ and Δ_z in the units of Δ_{SO}. The temperature $T = 0.3\Delta_{SO}$. Left panel: 3D plot. Right panel: Contour plot.

[1]Kuntsevich, A. Y., Pudalov, V. M., Tupikov, I. V. & Burmistrov, I. S. Strongly correlated two-dimensional plasma explored from entropy measurements. Nat. Commun. 6, 7298, doi:10.1038/ncomms8298 (2015).