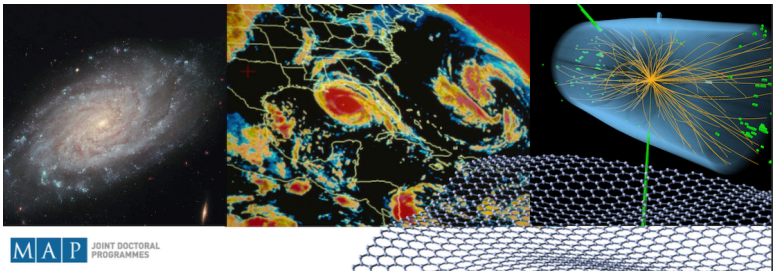

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Bulk Impurities/Vacancies in Nodal Loop Semimetals

Weyl nodal loop semimetals are topological semimetals where the valence and conduction bands linearly touch along one dimensional loops in momentum space. A manifestation of their non-trivial topology is the presence of zero energy surface states, induced by chiral symmetry, on surfaces parallel to the loop plane. Unlike their insulator counterparts, these exotic phases may be unstable to small perturbations that respect their topology-protecting symmetries. Results for symmetry-breaking disorder have been reported (M. Gonçalves, P. Ribeiro, E. V. Castro, and M. A. N. Araújo, Phys. Rev. Lett. 124, 136405 (2020)). However, vacancies preserve chiral symmetry, and remain a largely open problem.

Here, we will discuss the effects of impurities and vacancies in the bulk of a Weyl nodal loop semimetal (M. Gonçalves, P. Ribeiro, E. V. Castro, and M. A. N. Araújo, Phys. Rev. Lett. 124, 136405 (2020)). In an effective low energy model for a nodal loop, an analytical approach is tractable. We focus on the changes in the density of states (DOS), computed via a projected Green's function formalism, and study the localization of the impurity-induced bound states. We have found that a single cell-impurity induces a peak in the DOS, which traverses zero energy as its strength increases, becoming sharper near the Fermi level, in line with known literature (Tao Zhou, Wei Chen, Yi Gao, and Z. D. Wang, Phys. Rev. B, 100:205119, Nov 2019). Contrary to Weyl point semimetals and graphene, our results are consistent with the existence of a finite critical impurity strength that lifts the DOS at zero energy. Moreover, the impurities create bound states, with tails decaying as r^{-4}.

A single cell-vacancy creates broad peaks on both sides of the Fermi level, while the system remains a semimetal. Orbital-vacancies induce a sharp peak at zero energy. Lastly, we also look at the linear optical response of the nodal loop semimetal in the presence of vacancies.

Which topic best fits your talk?

Condensed Matter Physics and Nanomaterials

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