

Proximity-induced superconductivity in semi-Dirac materials

Marta García Olmos

Yuriko Baba, Rafael A. Molina, Mario Amado Montero

Nanotechnology Group, USAL—Nanolab and IUFFyM, University of Salamanca, Plaza de la Merced, Edificio Trilingüe, 37008, Salamanca, Spain

Instituto de Estructura de la Materia IEM-CSIC, Serrano 123, E-28006, Madrid, Spain

mgarcia.o@usal.es

Semi-Dirac systems are two-dimensional models that exhibit an anisotropic dispersion relation, characterized by linear dependence in one momentum-space direction and quadratic dependence in the perpendicular direction [1]. In the absence of spin—or equivalently, considering a single spin polarization—such systems can undergo a topological phase transition, leading to the emergence of edge states localized at the upper or lower boundaries of a semi-infinite geometry see Fig. 1(a) [2]. In this work, we theoretically investigate the superconducting properties induced in these edge states through proximity coupling to a conventional s-wave superconductor, in the presence of Rashba spin-orbit interaction and an external Zeeman field [3,4]. Using a low-energy approach, we construct an effective Bogoliubov–de Gennes Hamiltonian by projecting onto the subspace spanned by the edge modes. We show that, for sufficiently separated boundaries, the two edges can be treated independently and mapped onto effective one-dimensional Kitaev chains. As a result, under certain values of the model

parameters the system enters a topological superconducting phase supporting localized zero-energy states at the corners of finite-size samples Fig. 1(b).

References

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Figures

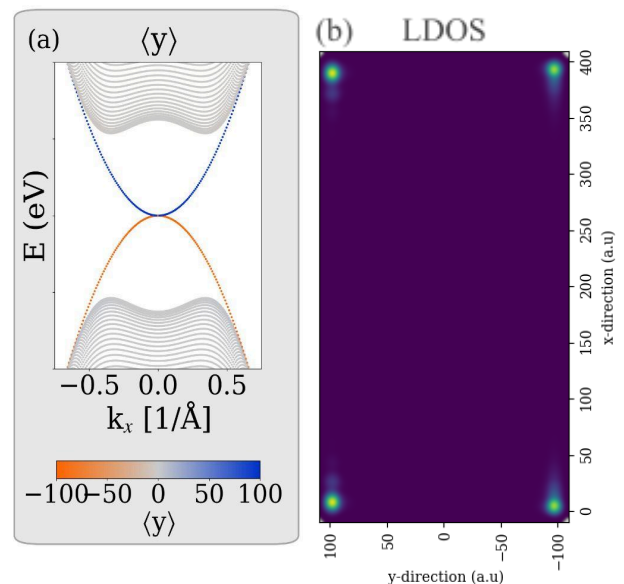


Figure 1: (a) Band structure of a finite system in y-direction with translational symmetry in x-direction. The colormap corresponds to the expectation value of the y-coordinate, which provides information about the spatial localization of the edge states. (b) Local density of states of zero-energy modes.