Topological superconductivity and Majorana bound states in 2D superconductors

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In recent years, a renewed interest in arrays of magnetic impurities in superconductors was driven by their potential to host Majorana fermions. I will first present recent results for a single classical magnetic impurity embedded in a two dimension (2D) superconductor and show that the spatial extent of the Shiba bound state is actually long-ranged compared to what was observed in 3D superconductors [1]. I will then report on the direct observation of dispersive in-gap states surrounding magnetic Co domains sandwiched between a single atomic layer of Pb and the substrate Si(111). The observed continuous dispersion across the superconducting gap is interpreted in terms of a spatial topological transition accompanied by a chiral Majorana edge mode and residual gaped helical edge states. I will finally show how a spectroscopic analysis of the spin dependence of the impurity-induced bund states in 2D superconductors can be used to extract important information on the nature of the host such as its order parameter, its degree of anomalous triplet pairing [3] or the amplitude of the spin-orbit coupling [4].

[1] G. Ménard et al., Nature Physics 11, 1013 (2015)

[2] G. Ménard et al., arXiv:1607.06353

[3] V. Kaladzhyan, C. Bena, P. Simon, Phys. Rev. B 93, 214514 (2016); J. Phys.: Condens. Matter 28, 485701 (2016)

[4] V. Kaladzhyan, P. Simon, C. Bena, Phys. Rev. B 94, 134511 (2016)