PHYSICS

PHYSICS COLLOQUIUM

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Visualizing correlated and topological quantum phases of matter

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Electronic correlations and topology promote the formation of new quantum phases of matter, and leave distinct electronic fingerprints that can be detected with scanning tunneling microscopy (STM). In this talk, I will first describe a series of experiments that demonstrate how the combined influence of magnetism and superconductivity on the one-dimensional topological edge state of bismuth gives rise to a Majorana zero mode (MZM) (1). Using high-resolution spectroscopy and spin-sensitive measurements with an STM, we visualize the localized nature of the MZM in this material platform, and we provide direct evidence for its non-trivial nature. Second, I will discuss the unusual quasiparticle spectrum of the flat bands in magic angle twisted bilayer graphene observed in STM experiments. Our measurements of the local density of states reveal deviations from a single-particle band structure description at partial flat band fillings. These findings can be captured in terms of an extended Hubbard model, demonstrating the significant impact of local correlations on the low-energy electronic properties of that material (2).

(1) B. Jäck et al., Science 364, 1255-1259 (2019).

(2) Y. Xie et al., Nature 572, 101–105 (2019).