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Zero-Energy Vortex Bound State in the Topological Superconductor Fe(Se,Te)

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A vortex core of a topological superconductor is an ideal platform of Majorana fermions. Although several experimental efforts have been made to detect Majorana fermions in the vortex cores as a zero-energy vortex bound state (ZVBS) [1,2], existence of the Majorana fermions is still controversial. Using a dilution-refrigerator scanning tunneling microscope [3], we have systematically examined a large number of vortices in the superconducting topological surface state of $FeTe_{0.6}Se_{0.4}$. We found that a certain number of vortices possess the ZVBS below 20 μeV suggesting its Majorana bound-state origin, but others do not. Interestingly, emergence of the ZVBS is not related to the preexisting quenched disorders, and the fraction of vortices with the ZVBS decreases with increasing magnetic field [4]. Moreover, our time dependent measurements of tunneling spectra on a creeping vortex indicate that the ZVBS disappears after the creep (Fig. 1). These findings suggest that inter-vortex interaction plays an important role in the ZVBS formation [5].

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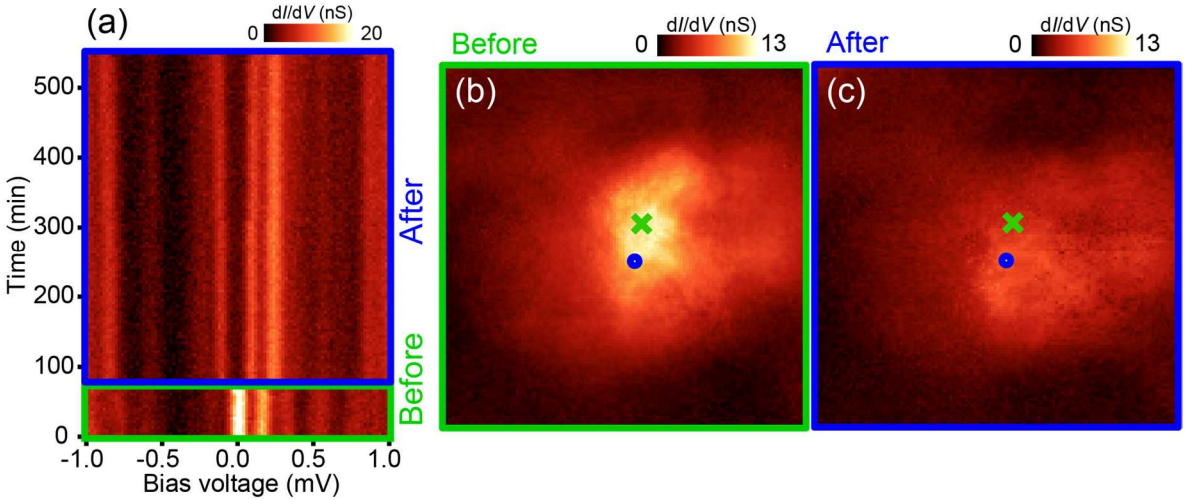

Fig. 1: (a) Time dependence of the tunneling spectra taken at a vortex core. (b) and (c) The zero bias conductance maps on 16 nm x 16 nm FOV before (b) and after (c) the vortex jump. Green cross and blue circle indicate the highest intensity points before and after the jump, respectively.

Keywords: Topological superconductor, Majorana fermion, Scanning tunneling microscope, Vortex