

Andreev Bound States in Topological Insulator Nanowires Proximitized by Superconductors
(Conference, Invited Talk)

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We present studies on topological insulator nanowires (TINWs) proximitized with superconductors, exploring novel transport phenomena and device functionalities. We demonstrate the observation of crossed Andreev reflection in TINW devices[1]. By conducting local and non-local conductance spectroscopy on mesoscopic structures incorporating superconducting niobium contacts, we detect Andreev bound states, and occasional negative non-local conductance—evidence of long-range Cooper pair correlations beyond expected coherence lengths. We attribute this effect to disorder in the proximitized nanowires. We also introduce a new side-etching technique to access both surfaces of TINWs with proximity-coupled superconductors[2, 3]. This setup exhibits SQUID-like oscillations of critical current under magnetic flux, indicative of surface-dominated supercurrents akin to the Fu-Kane junction. Furthermore, we observe a robust Josephson diode effect, highlighting the tunable nature of superconducting junctions in these devices. Together, our findings underscore the potential of TINWs as platforms for exploring and harnessing topological superconductivity, promising for future quantum information applications.

[1] Feng, J., Legg, H.F., Bagchi, M. et al. Nat. Phys. 21, 708–715 (2025).

[2] Nikodem, E., Schluck, J., Legg, H. F., et al. arXiv preprint arXiv:2412.07993 (2024).

[3] Nikodem, E., Schluck, J., Legg, H. F., et al. arXiv preprint arXiv:2412.16569 (2024).