Charge localization in hybrid superconductor-semiconductor nanowire devices

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Hybrid devices that couple superconductors and semiconductor nanowires have attracted considerable attention in recent years owing to their potential to realize topological superconductivity and Majorana zero modes. The topological phase is predicted to result from a combination of induced superconductivity, spin-orbit coupling and spin polarization in the semiconductor nanowire. Crucially, the one-dimensional character of such a system must be preserved over micron-length scales for the topological phase to the established - a requirement that is not so straightforwardly met in realistic materials. This talk will address experiments performed in InAs-based hybrid superconductor-semiconductor nanowire devices, in which signatures of charge localization are detected. Importantly, we demonstrate that even when seemingly absent, charge localization may play an important role in the transport properties of semiconductor nanowires. Even further, we show that the resulting superconductor-quantum dot system is associated with different physical effects that, while non-topological in nature, yield transport signals that mimic some of the expected signatures for Majorana zero modes. This talk will focus on the sub-gap Andreev/Shiba states associated with a proximitized quantum dot. In particular, we report on a quantitative study of the scaling of such Andreev states, as well as a demonstration of their spin polarization. Our findings hold relevance in relation to experiments aimed at detecting Majorana modes and constitute important milestones towards pursuing proposals targeted at realizing a topological superconductor from quantum dot arrays.