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The soft superconducting gap in semiconductor Majorana nanowires[1] SO TAKEI, BENJAMIN M. FREGOSO, HOI-YIN HUI, ALEJANDRO M. LOBOS, SANKAR DAS SARMA, The University of Maryland College Park, THE CONDENSED MATTER THEORY CENTER AND THE JOINT QUANTUM INSTITUTE TEAM — We theoretically consider the mysterious topic of the soft gap in the tunneling conductance of the proximity-induced superconductivity in a semiconductor-superconductor hybrid structure, where the observation of a zero-bias conductance peak has created considerable excitement because of its possible connection with the elusive zero-energy Majorana mode. The observed experimental superconducting tunneling gap in the semiconductor nanowire looks v-shaped with considerable subgap conductance even at very low temperatures in sharp contrast to the theoretically expected hard BCS gap with exponentially suppressed subgap conductance. We systematically study, by solving the appropriate BdG equations both numerically and analytically, a number of physical mechanisms (e.g. magnetic and non-magnetic disorder, finite temperature, dissipative Cooper pair breaking, interface fluctuations), which could, in principle, lead to a soft gap, finding that only the interface fluctuation effect is a quantitatively and qualitatively viable mechanism that is consistent with the experimental observations. Our work indicates that improving the quality of the superconductor-semiconductor interface would go a long way in enhancing the gap in the hybrid structures being used for studying the Majorana mode.

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So Takei
The University of Maryland College Park

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