# Chiral Andreev edge states in normal-superconducting nanostructures

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The quantum Hall effect (QHE) and superconductivity are fundamental quantum phenomena that, for decades, have been studied in largely separate experimental and theoretical domains. Only in recent years has it become possible to engineer hybrid architectures where fully developed QHE and superconductivity coexist, enabling the investigation of novel physical effects arising from their interplay. In particular, the coupling between topologically protected chiral edge channels and superconducting pairing has led to emergent transport mechanisms, including Andreev reflections constrained by chirality and topology. A particularly intriguing consequence is the formation of chiral Andreev edge states (CAES) along the interfaces between superconductors and QHE or quantum anomalous Hall effect systems. These states consist of unidirectionally propagating coherent superpositions of electrons and holes [1], which in certain regimes can evolve into non-Abelian topological excitations such as Majorana bound states [2].

In this talk, I will present recent advancements in the realization of CAES in hybrid platforms, focusing on structures based on semiconductor two-dimensional electron gasses [3, 4]. I will discuss theoretical frameworks for modeling these devices and demonstrate that the Andreev reflection process induces a mixing of QHE modes at higher filling factors-a phenomenon strictly prohibited in clean, purely electronic systems [3]. Furthermore, I will introduce a novel approach for probing CAES via Aharonov–Bohm interferometry, facilitated by local electrostatic control with a scanning gate. Finally, I will show how non-trivial pairing gap symmetry gives rise to a distinct class of CAES and causes unique, unconventional conductance signatures in the system.

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**References**

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