

Quantum Optoelectronics of Graphene Nanoribbons

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Graphene nanoribbons (GNRs), narrow strips of graphene with atomically defined widths and edges, provide a powerful platform to explore how atomic structure governs electronic excitations, light emission, and charge transport in low-dimensional carbon materials. Recent developments in on-surface synthesis have enabled the fabrication of GNRs with atomic precision and have demonstrated remarkable tunability of their electronic structure [1]. However, exploring their optoelectronic properties at the single-ribbon level remains highly challenging. In this context, advanced scanning tunneling microscopy (STM)-based techniques offer a unique route to probe the optoelectronic response of individual GNRs with atomic-scale resolution.

In this talk, I will present our recent results on electroluminescence from individual GNRs, including 7-armchair GNRs [2] and edge-extended ribbons [3], probed by STM-induced luminescence. I will also discuss quantum transport measurements on edge-engineered ribbons performed using the STM lift-off approach [4]. Both phenomena are closely connected to localized electronic states engineered within the ribbon. Our experiments show that electroluminescence can arise from a GNR hosting an isolated localized state, whereas a sequence of localized states can hybridize into a delocalized channel that supports unconventional charge transport. Together, these studies demonstrate how the design and coupling of localized states can be used to control both optical excitations and charge transport in atomically precise GNRs.

References

- [1] H. Wang et al., *Nat. Rev. Phys.* 3, (2021) 791-802.
- [2] S. Jiang, et al., *Science* 379, (2023) 1049-1054.
- [3] S. Jiang, T. Neuman, G. Schull, in preparation.
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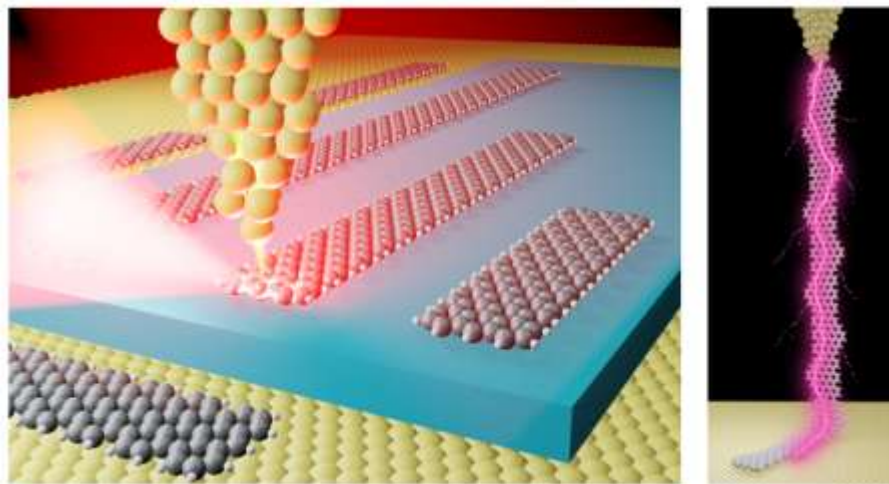


Figure 1: Exploring Optoelectronic Properties of Graphene Nanoribbons with STM