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INVESTIGATING QUANTUM COHERENCE IN 3D SEMICONDUCTOR NANOWIRE ARRAYS FOR ADVANCED QUANTUM TECHNOLOGIES

The investigation of quantum coherence in nanostructures is a vital area of research with significant implications for the development of quantum information, communication, and sensing technologies. Traditionally, studies have focused on coherent tunneling phenomena within a limited set of quantum nanostructures, such as quantum dots or rings, resulting in the formation of delocalized molecular states with strong electron and hole coupling. These interconnected quantum dots and rings, acting like artificial molecules, show promise for the creation of quantum gates through coherent coupling, thereby forming the basis for essential components in quantum technologies.

In this presentation, we will discuss our latest theoretical advancements in nanowire coupling. Specifically, we focus on the coherent transverse coupling within three-dimensional arrays of closely packed, vertically aligned nanowires. These nanowires exhibit a discontinuous charge distribution along their axial direction, which has allowed us to observe significant redistribution of carrier populations across various excited states within the array.

In addition to our theoretical work, we are actively involved in developing actual prototypes using cutting-edge epitaxial growth and nanowire self-assembly techniques. While the fabrication of these prototypes is still underway, this effort is a crucial step toward validating our theoretical predictions in practical settings. Successfully creating these prototypes will not only deepen our understanding of quantum coherence in nanostructures but also pave the way for advancements in quantum computing and sensing technologies.

Keywords

Coherence, Nanowires, Devices

Reference

R. Méndez-Camacho and E. Cruz-Hernández, Tunneling between Parallel One-Dimensional Wigner Crystals, Sci Rep. 12, 4470 (2022).

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