Many-body effects in field emission from arrays of carbon nanotubes

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Field electron emission (FEE) from carbon nanotubes (CNTs) is a crucial tool in electron microscopy, offering stable, low-energy electron beams. Despite experimental advances, a theoretical framework describing low-energy field emission is currently unknown, primarily due to the unavoidable, correlated behavior of one-dimensional (1D) materials. This work aims to develop such a theoretical formalism.

We propose a theoretical formalism based on Tomonaga–Luttinger liquid (TLL) theory, which captures the collective behavior of electrons in 1D systems. We extend the Fowler–Nordheim theory to include TLL effects in local density of states (LDOS) and the tunneling amplitude, enabling the study of electron-electron interaction and temperature effects on FEE.

Furthermore, we present a model for calculating TLL parameters in multiwalled nanotubes (MWNTs), accounting for inter-shell interactions and the distribution of conductive channels among coaxial shells. These results provide a unified framework for understanding FEE from CNTs, with clear predictions that can be validated experimentally.

References

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