From Fermionic Mode Entanglement to Effective Flying Qubits

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Recent breakthroughs in electron quantum optics have enabled unprecedented control over the generation of quantum electrical currents based on single- to few-electron excitations [1,2]. These advances open the door to high-precision applications, ranging from time-resolved sensing of electromagnetic fields [2,3] to the manipulation of electronic flying qubits [4]. However, exploiting fermionic channels for quantum information processing requires realistic modeling of interaction processes and entanglement between electronic wave packets propagating in distinct channels. A key ingredient is fermionic mode entanglement, constrained by superselection rules, from which an effective qubit description can be extracted.

In this talk, we introduce a method to derive a flying-qubit model from interacting electronic modes [5]. Our approach provides a direct and quantitative bridge between electronic transport models of concrete experimental setups and an effective qubit description, while consistently incorporating decoherence and relaxation effects [6].

References

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