PhD thesis project at NEEL INSTITUTE Grenoble

Real-time quantum manipulation of electron wave packets in nanoelectronic circuits

GENERAL SCOPE

Coherent manipulation of single electrons in solid-state devices is attractive for quantum information purposes because of their high potential for scalability. Depending on the system used, the charge or spin can encode binary qubit information. A complementary approach compared to static qubits is the use of propagating quantum states as carriers of quantum information, often referred to as flying qubits. A promising example of flying qubits are time-bin qubits made of electron wave packets. The time-bin qubit is expressed as a superposition of two delayed wave packets and has the property of being less affected by phase relaxation. To realize the interaction between such time-bin qubits, ultrafast voltage-controlled gate manipulation must be performed.

OBJECTIVES

In this research project, we will exploit recent advances in quantum nanoelectronics with very short electron wave packets to realize novel flying qubit architectures. To this end, we will inject ultrashort single-electron wave packets into a Mach-Zehnder interferometer and perform time-resolved quantum manipulations. As part of this project, we will demonstrate the first electronic time-bin qubit. In addition, we will apply the developed ultrafast quantum manipulation techniques to perform the Elitzur-Vaidman bomb experiment with ballistic electrons.

FURTHER READING

- Bäuerle et al., Rep. Prog. Phys. 81, 056503 (2018) ; arxiv.org/abs/1801.07497, Edlbauer et al., EPJ Quantum Technology 9: 21 (2022); in COLLECTION ON "QUANTUM INDUSTRY", REVIEW ARTICLE; https://doi.org/10.1140/epjqt/s40507-022-00139-w

COLLABORATIONS AND NETWORKING: This project is part of the priority projects of the French National Strategy on Quantum Technologies. It is realized in close collaboration with the nanoelectronics group in Saclay (C. Glattli & P. Roulleau), the THz group of IMEP-LaHC laboratory at Univ. Savoie Mont-Blanc (J.F. Roux), the theory group of CEA Grenoble (X. Waintal) as well as the Quantum Metrology group (AIST), Tsukuba, Japan (S. Takada) & the Quantum Device group, RIKEN, Japan (M. Yamamoto)

REQUIRED SKILLS:
Master 2 or engineering degree. We are looking for an excellent and highly motivated candidate for an experimental PhD thesis. The candidate should have a strong background in quantum mechanics and solid-state physics. Programming skills in Python are highly appreciated.

FUNDING: QuantAlps PhD Call with deadline March 17th 2023 ; See Call for application.
Foreseen start of the grant: October - November 2023.
Amount : gross salary prior to employee tax deduction about 2300 €.
Duration : 36 months

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