UNIMORE Dipartimento di Scienze Fisiche, Informatiche e Matematiche

UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

CNRNANO MODENA S3

FIM-S3 SEMINAR

On the possible use of excited states in Si Quantum Dots

Thursday June 13th, 2024 – 9.45 (sharp)

Room L1.3, Physics building

Speaker

Eleonora FANUCCHI

Abstract

Hole-spin qubits in semiconductors are a mature platform for quantum technologies [1]. Specifically, the well-advanced fabrication techniques of Si devices, along with the small hyperfine interaction protecting the qubit from dephasing, make Si a very promising material for quantum computing. Moreover, holes in Si present a large spin-orbit coupling, which makes the qubit sensitive to all-electrical manipulation. We investigate the properties of the hole eigenstates in Si quantum dots, obtained from the exact diagonalization of the six-band Luttinger-Kohn Hamiltonian [2]. Indeed, a crucial role is played by the multiband character of the hole state, which induces a significant dependence of the physical properties of the qubit on the dot geometry. This specifically affects its coupling to the external fields and its manipulation properties [3]. In this seminar we are going beyond the qubit picture, where the only relevant states are the ones belonging to the ground doublet. Instead, we aim to show the interesting features displayed by the excited states and their possible use for assisting in the process of qubit encoding and manipulation. In particular, we show that the first excited doublet is characterized by a higher degree of tunability of the band mixing with respect to the ground doublet. This results in Rabi frequencies for the transitions involving the excited states that are one or two orders of magnitude larger than those between the ground states [4,5].

References

[1] L. Bellentani et al., '*Toward Hole-Spin Qubits in Si p-MOSFETs within a Planar CMOS Foundry Technology*', Phys. Rev. Applied 16, 054034 (2021)

[2] A. Secchi et al., '*Interacting holes in Si and Ge double quantum dots: From a multiband approach to an effective-spin picture*', Phys. Rev. B 104, 035302 (2021)

[3] G. Forghieri et al., '*Quantum estimation and remote charge sensing with a hole-spin qubit in silicon*', Phys. Rev. Research 5, 043159

[4] E. Fanucchi et al., '*On the possible use of excited states in Si Quantum Dots*', in preparation

[5] E. Fanucchi, '*Exploiting excited states for the manipulation of hole-spin qubits in silicon Quantum Dots*' Master Degree Thesis, University of Modena and Reggio Emilia (2023), https://morethesis.unimore.it/theses/available/etd-10022023-133552/

Host: Paolo Bordone

In collaboration with

Finanziato dall'Unione europea NextGenerationEU

Ministero dell'Università e della Ricerca

Italiadomani

ecosister