Postdoctoral position on the modeling of Si/SiGe and Ge/GeSi spin qubits

March 31, 2026

A two-year post-doctoral position is open at the Interdisciplinary Research Institute of Grenoble (IRIG) of the CEA Grenoble (France) on the theory and modeling of silicon/germanium electron and hole spin qubits. The selected candidate is expected to start mid-August 2026 or after.

Context:

Silicon/Germanium spin qubits have attracted increasing attention and have made outstanding progress in the past few years. In these devices, the elementary information is stored as a coherent superposition of the spin states of an electron in a Si/SiGe heterostructure, or of a hole in a Ge/SiGe heterostructure. These spins can be manipulated electrically owing to the intrinsic (or to a synthetic) spin-orbit coupling, and get entangled through exchange interactions, allowing for the implementation of a variety of one- and two-qubit gates required for quantum computing and simulation. Si/Ge heterostructures hold various records in semiconductor spin qubit technologies [1, 2], as they provide very clean epitaxial interfaces, and can be made free of nuclear spins that would interfere with the electron or hole spins.

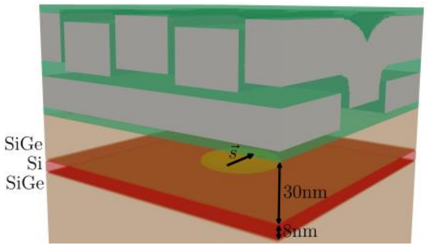

*Fig. 1: TB_Sim model for a Si/SiGe electron spin qubit. An electron is trapped in an 8 nm thick Si well (red) by the potential of a series of overlapping top gates (gray). The yellow shape is an isodensity surface of this electron computed with a two bands **k.p** model developed at CEA [11]. The spin of the electron can be manipulated with radiofrequency signals applied to the gates owing to a synthetic spin-orbit interaction engineered with a micro-magnet (not shown) deposited above the heterostructure.*

It is essential to support the development of these advanced quantum technologies with state-of-the-art theory and modeling. For that purpose, CEA/IRIG is actively developing the “TB_Sim” code. TB_Sim is able to describe very realistic qubit structures down to the atomic scale if needed using atomistic tight-binding and multi-bands **k.p** models for the electronic structure of the materials (see Fig. 1). Using TB_Sim, CEA has made significant progress in the understanding of various aspects of the physics of spin qubits (spin-orbit interactions, valley splittings…), in tight collaboration with the experimental groups in Grenoble and with the partners of CEA in Europe [3-11].

The present position is open in the context of the European project “SPINS”, which aims at developing pilot lines for spin qubit technologies.

Objectives of this position:

The aims of this position are to strengthen our understanding and support the development of electron and hole spin qubit devices based on Si/Ge heterostructures through analytical modeling as well as advanced numerical simulation with TB_Sim. Topics of interests include:

- Structural and electronic properties of Si/SiGe and Ge/SiGe dots (strain inhomogeneities, valley splittings, …)
- Spin manipulation & readout in electron and hole spin qubits (intrinsic & synthetic spin-orbit fields),
- Exchange interactions in 1D and 2D arrays of spin qubits,
- Sensitivity to noise (decoherence) and disorder (variability),

- Shuttling (transport of spins).

The selected candidate will join a lively project bringing together > 40 people with comprehensive expertise covering the design, fabrication, characterization and modeling of spin qubits, as well as related disciplines (cryo-electronics, quantum algorithms and quantum error correction, ...). He/She will have the opportunity to interact with the partners of the SPINS project in Europe (Delft, IMEC, …).

How to apply ?

The candidate should send his/her CV to Yann-Michel Niquet (yniquet@cea.fr), with a list of publications, a motivation letter with a summary of past accomplishments, and arrange for two recommendation letters. The position is open until filled.

Required qualifications: The candidate must have a PhD in Quantum, Condensed Matter or Solid-State Physics (or related topics).

References:

[1] *Universal control of a six-qubit quantum processor in silicon,* S. G. J. Philips, M. T. Mądzik, S. V. Amitonov, S. L. de Snoo, M. Russ, N. Kalhor, C. Volk, W. I. L. Lawrie, D. Brousse, L. Tryputen, B. Paquelet Wuetz, A. Sammak, M. Veldhorst, G. Scappucci, and L. M. K. Vandersypen, Nature **609**, 919 (2022).

[2] *Robust and localised control of a 10-spin qubit array in germanium,* V. John, C. X. Yu, B. van Straaten, E. A. Rodríguez-Mena, M. Rodríguez, S. D. Oosterhout, L. E. A. Stehouwer, G. Scappucci, M. Rimbach-Russ, S. Bosco, F. Borsoi, Y.-M. Niquet and M. Veldhorst, Nature Communications **16**, 10560 (2025).

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[6] *Optimal operation of hole spin qubits,* M. Bassi, E. A. Rodríguez-Mena, B. Brun, S. Zihlmann, T. Nguyen, V. Champain, J. C. Abadillo-Uriel, B. Bertrand, H. Niebojewski, R. Maurand, Y.-M. Niquet, X. Jehl, S. De Franceschi and V. Schmitt, Nature Physics **22**, 75 (2026).

[7] *Electrical manipulation of semiconductor spin qubits within the g-matrix formalism,* B. Venitucci, L. Bourdet, D. Pouzada and Y.-M. Niquet, Physical Review B **98**, 155319 (2018).

[8] *Hole spin manipulation in inhomogeneous and non-separable electric fields,* B. Martinez, J.-C. Abadillo-Uriel, E. A. Rodríguez -Mena and Y.-M. Niquet, Physical Review B **106**, 235426 (2022).

[9] *Hole-spin driving by strain-induced spin-orbit interactions,* J.-C. Abadillo-Uriel, E. A. Rodríguez-Mena, B. Martinez and Y.-M. Niquet, Physical Review Letters **131**, 097002 (2023).

[10] *Variability of hole-spin qubits in planar germanium,* B. Martinez and Y.-M. Niquet, Physical Review Applied **25**, 014018 (2026) [Editor's suggestion].

[11] *Valley physics in the two-band k.p model for SiGe heterostructures and spin qubits*, T. Salamone, B. Martinez Diaz, J. Li, L. Cvitkovich and Y.-M. Niquet, Physical Review B **113**, 115304 (2026) [Editor's suggestion].

Additional informations about the laboratory:
http://www.cea.fr/drf/irig/english/Pages/Departments/DPhy.aspx
http://www.researchgate.net/profile/Yann-Michel_Niquet
http://scholar.google.fr/citations?user=h02ymwoAAAAJ
The group responsible for spin qubits modeling now includes two permanent researchers (Y.-M. Niquet, M. Filippone), two PhD students and two postdocs.

More about Grenoble and its surroundings:
http://www.isere-tourism.com/