Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

Laboratory name: Institut de Physique Théorique, CEA Saclay
CNRS identification code: UMR 3681
Internship director'surname: Sangouard, Nicolas
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Internship location: CEA Saclay, l'Orme des Merisiers, Bâtiment 774

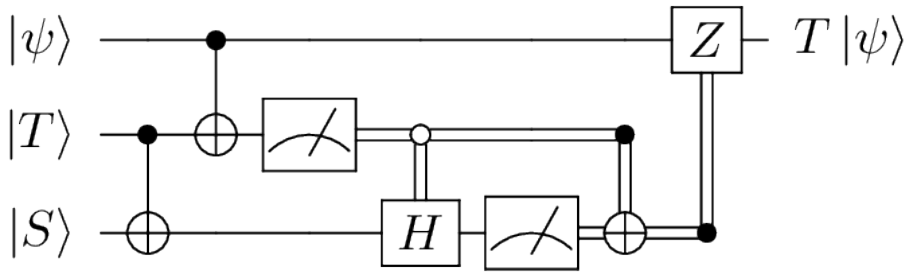
Thesis possibility after internship: YES/~~NO~~
Funding: YES/~~NO~~ If YES, which type of funding: EU

Automated design of quantum circuits by reinforcement learning

The proposed project aims to facilitate the implementation of quantum computers by improving known quantum computation circuits, that is, to reduce their complexity and increase their resistance to noise. To go beyond what has been accomplished by hand, we intend to combine efficient simulators of quantum circuits with machine learning techniques for the automated design of optimized circuits.

To this end, the intern will have to finely understand the specificities of quantum algorithmic and error correction codes, and use them to develop his/her own simulator of quantum circuits able to handle operations that are usually not considered, but that might improve significantly quantum computations, such as using previous measurement results to choose the following gates. Moreover, an appropriate combination of the Schrödinger and the Heisenberg pictures might significantly reduce the simulation overhead compared with existing state-of-the-art simulators.

This simulator will then be combined with reinforcement learning to automate the construction of small quantum circuits that are repetitively used in larger algorithm, such as Shor's factorization algorithm. For that the intern will have to find a suitable method and choose the appropriate parameters. Optimization of large circuits might also be considered.



The internship might be followed by a PhD thesis depending on the student motivations.

For recent publications by the group that are relevant for the project, see
A. Melnikov, P. Sekatski & N. Sangouard, Phys. Rev. Lett. 125, 160401 (2020) ; arXiv:2005.01697
E. Gouzien & N. Sangouard Phys. Rev. Lett. ???? ; arXiv:2103.06159

Condensed Matter Physics: ~~YES~~/NO Soft Matter and Biological Physics: ~~YES~~/NO
Quantum Physics: YES/~~NO~~ Theoretical Physics: YES/~~NO~~