Spécialité de Master « Optique, Matière, Paris »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition :

Responsable du stage / *internship supervisor*:			
Nom / *name*:	Ferrini	Prénom/ *first name* :	Giulia
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Nom du Laboratoire / *laboratory name*: Chalmers University of Technology			
Code d'identification :		Organisme :	
Site Internet / *web site*: http://www.chalmers.se/en/			
Adresse / *address:* Maskingränd 2, 412 58 Gothenburg, Sweden			
Lieu du stage / *internship place*: Chalmers, Gothenburg			

Titre du stage / *internship title*: Theory of Quantum Computation with Continuous Variables

Résumé / *summary*

Quantum computers, i.e. devices in which quantum information can be encoded, processed and read out, are expected to solve certain computational tasks faster than classical computers. This property is referred to as *quantum advantage*. Despite the optimism towards the possible forthcoming achievements in quantum technologies, a conclusive experimental evidence of quantum advantage is still lacking: it has not yet been possible to build a quantum computer with a number of qubits that is large enough to practically beat classical machines.

The Continuous-Variable (CV) approach is emerging as a promising alternative to the use of qubits for information encoding. While qubits are encoded on two-level quantum systems, the CV approach relies on quantized variables with a continuous spectrum: for instance, the position and momentum of a particle, or the amplitude (q) and phase (p) quadratures of the quantized electromagnetic field. Up to one-million optical modes have been entangled in CV in 2016, which represents a striking progress with respect to DV systems, where only a few tens of qubits can be entangled nowadays. Therefore, CV systems are promising to overcome the problem of scalability. Furthermore, CV implementations beyond the purely optical realm are started to being studied, namely in opto-mechanics, or with microwaves coupled to superconducting devices.

In this project we will study theoretically the performances of several protocols of CV quantum computation: from sub-universal models [1, 2], that allow one to efficiently sample from a probability distribution that cannot be efficiently sampled with a classical computer, to the adiabatic model. We will assess whether simple criteria for quantum advantage with CV architectures can be provided, and test these criteria in the case of known examples.

For this project, we seek for a motivated master student to join us at Chalmers University of Technology in Gothenburg. Regular exchanges with the experimentalists working on superconducting qubits at Chalmers are in order.

[1] *Continuous-Variable Instantaneous Quantum Computing is hard to sample*, T. Douce, D. Markham, E. Kashefi, E. Diamanti, T. Coudreau, P. Milman, P. van Loock, and G. Ferrini, Phys. Rev. Lett. **118**, 070503 (2017).
[2] *Continuous-Variable Sampling*, U. Chabaud, T. Douce, D. Markham, P. van Loock, E. Kashefi, and G. Ferrini, preprint at arXiv:1707.09245 (2017).

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : yes**
Si oui, financement de thèse envisagé/ *financial support for the PhD***:** **yes**

Lumière, Matière, Interactions		Lasers, Optique, Matière	

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