University of Crete
Department of Physics

Physics Colloquium

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Quantum compiling methods

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ABSTRACT

Given a set of quantum gates and a target unitary operation, the most elementary task of quantum compiling is the identification of a sequence of the gates that approximates the target unitary to a determined precision. The Solovay-Kitaev theorem provides an elegant solution which is based on the construction of successively tighter `nets' around the unity comprised by successively longer sequences of gates. The procedure for constructing the nets, according to this theorem, requires accessibility to the inverse of the gates as well. In this talk, I will present a method [1] where we use the theory of random walks for constructing nets around unity without this requirement. The algorithmic procedure is applicable to sets of gates which are diffusive enough, in the sense that sequences of moderate length cover the space of unitary matrices in a uniform way. We prove that the number of gates sufficient for reaching a given precision scales better than for the Solovay-Kitaev algorithm while the pre-compilation time is increased as compared to the Solovay-Kitaev algorithm by a polynomial factor 3/2.

In the second part of this talk, I will present some recent results [2] for a similar problem where now one has the freedom to adjust the single-qubit operations in a given multi-qubit quantum circuit. For this case the results of compiling can be exact but still the identification of the local parameters is a difficult task. The given circuit is first tested against efficiency requirements and then a method for identifying the parameters of the single-qubit operations is applied. The latter extends quantum control techniques developed by G. Harel and V.Akulin [Phys.Rev.Lett. 82, 1 (1999)] and stays computationally tractable for several qubits. The method of compiling is tested using a series of quantum Fourier transform circuits providing a low-count of two-qubit gates.

[1] Quantum compiling with diffusive sets of gates, Y. Zhiyenbayev, V. M. Akulin, A. Mandilara, Phys. Rev. A 98, 012325 (2018).

[2] Quantum compiling with locally adjusted circuits of designated architecture, R. P. Singh and A. Mandilara, arXiv:1908.03994.