
COLLOQUIA DI DOTTORATO, A.A. 2024/2025

A101, Dipartimento di Fisica
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How to prepare high fidelity quantum registers: theory and practice

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One ingredient that is necessary to achieve effective quantum computation is the ability to prepare high fidelity quantum registers. In this seminar, two distinct approaches that we have taken to address this problem will be discussed.

The first approach comes from quantum information theory flavour, and is based on “dynamic cooling” whereby one qubit is cooled down at the expense of heating up N extra qubits, by means of a global, properly engineered unitary evolution. We demonstrated the method by implementing it on a current quantum computer (IBM’s). The downside of this and similar single qubit preparation methods is that they scale terribly when applied to the preparation of many qubits.

The second approach comes from statistical mechanical flavour, and it bypasses this issue by addressing the quantum register as a whole. The idea is to take advantage of emergent cooperative effects (specifically the phenomenon of spontaneous symmetry breaking) combined with quantum phenomena (e.g. quantum tunneling) to reach high fidelity preparation of large registers. We implemented it on a current quantum hardware (D-wave) and demonstrated the joint preparation of about 5k qubits with the unprecedented global fidelity of 99,5%.

The seminar is in presence up to the maximum occupancy of the lecture hall.