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Manipulating a spin qubit by sequential adaptive partial measurements

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Sala Fubini, Dipartimento di Fisica, via P. Giuria 1, Torino

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Abstract

In contrast to classical physics, quantum measurements foster an intriguing interplay between information gain and system disturbance. Although the outcome of the measurement is probabilistic, the back-action imparted on the measured system is accurately described by quantum theory, given the measurement outcome. Therefore, quantum measurements can be used to manipulate a quantum system without the need for control fields.

In this seminar, I will report on the realization of quantum control using sequential partial measurements with real-time feedback on a nuclear spin qubit in diamond. We control the measurement strength via an ancilla qubit (electron spin of a nitrogen-vacancy center). Using post-selection, controlled wavefunction collapse and quantum weak values (spin exceeding 10) are observed. We then exploit a variable-stop quantum non-demolition measurement on the ancilla qubit to enable repetitive measurements without post-selection. By incorporating real-time feedback, we demonstrate measurement-only control of a quantum system. Adaptive measurements are an essential building block for measurement-based quantum computing and enhanced-sensitivity quantum metrology.

The speaker

Cristian Bonato graduated at the University of Padova with a thesis on quantum cryptography in satellitar communications. He obtained his PhD at the University of Padova, during which he worked on quantum interferometry with entangled photons in collaboration with the Sergienko/Saleh/Teich group of the Boston University. In a first post-doctoral appointment he worked at the Leiden University on self-assembled quantum dots in cavities (micropillars and photonic crystals) for quantum information applications. He currently holds a post-doctoral appointment at the Delft University of Technology, where he works on quantum measurements and magnetometry based on NV centers in diamond.