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Optimized quantum sensing with adaptive measurements on a single solid-state spin

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Sala Wataghin, Istituto di Fisica, via P. Giuria 1, Torino

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Abstract

Quantum sensors based on single solid-state spins promise a unique combination of sensitivity and spatial resolution. The key challenge in sensing is to achieve minimum estimation uncertainty within a given time and with a high dynamic range. Adaptive strategies have been proposed to achieve optimal performance but their implementation in solid-state systems has been hindered by the demanding experimental requirements.

In this talk, I will report on our recent demonstration of adaptive d.c. sensing, using a single electronic spin in a nitrogen-vacancy center in diamond. By adapting the spin readout basis in real time based on previous outcomes we report a sensitivity in Ramsey interferometry surpassing the standard measurement limit. Furthermore, we find by simulations and experiments that adaptive protocols offer a distinctive advantage over the best-known non-adaptive protocols when overhead and limited estimation time are taken into account. Using an optimized adaptive protocol we achieve a magnetic field sensitivity of 6.1 ± 1.7 nT $Hz^{-½}$ over a wide range of 1.78 mT. These results open up a new class of experiments for solid-state sensors in which real-time knowledge of the measurement history is exploited to obtain optimal performance

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.