Seminario tecnico

Quantum-enhanced and portable optical magnetometry

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Abstract

Optically pumped magnetometers (OPMs), in which an atomic ensemble is optically polarized and its spin evolution is optically detected, represent a paradigmatic quantum sensing technology that applies to medical diagnostics, geophysics, space science, navigation, and searches beyond the standard model.
In this talk, after a general overview of optical magnetometry [1], I will present recent results on the miniaturization of atomic sensors by using MEMS cells [2] as well as a novel approach based on laser-written vapor cells (LWVCs) [3], in collaboration with the CNR-IFN. After that, I will describe portable magnetic gradiometers [4] developed at Princeton University, which can operate with femtotesla sensitivity up to Earth-scale fields and have enabled the first detection of biomagnetism in unshielded environments [5]. I will also discuss the quantum enhancement of a high-density OPM using squeezed light [6], work carried out at ICFO.

[1] D. Budker and M. Romalis "Optical Magnetometry", Nature Physics 3, 227–234 (2007)
[2] M. Tayler et al. "Miniature biplanar coils for alkali-metal-vapor magnetometry", Phys. Rev. Applied 18, 014036 (2022)
[3] V. G. Lucivero et al. "Laser-written vapor cells for chip-scale atomic sensing and spectroscopy", Optics Express 30, 27149-27163 (2022)
[4] V. G. Lucivero et al. "Femtotesla nearly quantum-noise-limited pulsed gradiometer at Earth-scale fields" Phys. Rev. Applied 18, L021001 (2022)
[5] M. E. Limes et al. "Portable magnetometry for detection of biomagnetism in ambient environments", Phys. Rev. Applied 14, 011002 (2020)
[6] C. Troullinou et al. "Quantum-enhanced magnetometry at optimal number density", Accepted in Phys. Rev. Lett. (2023)

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