CRC 1227
Designed Quantum States of Matter

GUEST LECTURE

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(Guest of Prof. Piet Schmidt and Prof. K. Hammerer)

Leibniz Universität Hannover
DQ-mat Colloquium

29 Februar 2024, 16:00 am
Welfengarten 1, Building 1101, Seminar room D326

Title: Atom interferometry: from fundamental physics to inertial navigation

Abstract:

Atom interferometers are high-performance sensors destined to probe the limits of principles in fundamental physics and are already or potentially a technology breakthrough in numerous applications such as gravimetry, geophysics and navigation.
More specifically cold atom interferometers can measure tiny variations of gravity in the lab, or on field [1]. To go towards onboard applications, it is necessary to accept challenges inherent to such sensors, like the deadtimes, the dynamic range and the disruptions due to vibrations and rotations. The hybridization with classical sensors leads to practical solutions. In this frame, new methods have been developed benefiting from Kalman filters [2], and FPGA based real-time compensation of Doppler effects [3] and rotations.
The sensitivity of the atom interferometers can be improved by several orders of magnitude compared to the current state-of-the-art by increasing the interrogation time. Such large-scale factors interferometers can be achieved in large baseline atomic fountain or in Space. The sensitivity can potentially reach levels relevant to probe the limits of the gravitation theories with a test of the equivalence principle for instance [4].
Finally, new multi-photon approaches allow to improve the performances of the sensors. Multidimensional atom optics have been studied theoretically and are promising to design simultaneous multi-axes atom sensors for inertial navigation [5].

[1] Ménoret, V., Vermeulen, P., Le Moigne, N. *et al.* Gravity measurements below 10^{-9} *g* with a transportable absolute quantum gravimeter. *Sci Rep* **8**, 12300 (2018).
[2] P. Cheiney *et al*, *Phys. Rev. Applied* **10**, 034030 (2018)
[3] Simon Templier *et al.*, Tracking the vector acceleration with a hybrid quantum accelerometer triad.*Sci. Adv.***8**, eadd3854 (2022).DOI:10.1126/sciadv.add3854
[4] Battelier, B., Bergé, J., Bertoldi, A. *et al.* Exploring the foundations of the physical universe with pace tests of the equivalence principle. *Exp Astron* **51**, 1695–1736 (2021).
[5] B. Barrett, P. Cheiney, B. Battelier, F. Napolitano, and P. Bouyer, Multidimensional Atom Optics and Interferometry, *Phys. Rev. Lett.* **122**, 043604 (2019)

All DQ-mat members and all interested are cordially invited to attend.