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Fachbereich Physik, Universität Stuttgart
Max-Planck-Institut für Festkörperforschung
Max-Planck-Institut für Intelligente Systeme

Ansprechpartner: Prof. Harald Giessen
E-Mail: giessen@physik.uni-stuttgart.de
Telefon: 0711 - 685-65111

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Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart-Vaihingen

Gastgeber: Prof. Jörg Wrachtrup, Universität Stuttgart, Telefon: 0711 - 685-65278

Non-classical Atom-Interferometry and Interaction-free Measurements

Wolfgang Ertmer
Universität Hannover

Abstract

Highly sensitive quantum sensors based on ultra-cold atomic ensembles open for new horizons in inertial sensing. In addition, new developments and experimental tricks allow for fundamental tests and experiments.

Entanglement, one of the most intriguing features of quantum mechanics, is nowadays a valuable resource for quantum engineering. For instance, an entangled input state can improve the sensitivity of an interferometer beyond the shot noise limit. Most prominently, quadrature-squeezed and spin-squeezed states are useful for this application. We experimentally demonstrate that the state is useful for sub-shot-noise interferometry.

The quantum Zeno effect predicts that a quantum mechanical transition can be suppressed by frequent measurements. Here, we demonstrate that a quantum phase transition can be suppressed by the continuous detection of the output phase. In our experiment we investigate spin-changing collisions in a Rb-87 Bose-Einstein condensate. For the first time, it is thus possible to detect the quantum Zeno effect indirectly. Our setup allows for interesting applications such as interaction-free measurements on the basis of neutral atoms.