Kolloquium des
Instituts für Angewandte Physik

TECHNISCHE UNIVERSITÄT DARMSTADT

Zeit: **Dienstag, 08.07.2025, 16:00 Uhr**
Ort: **Gebäude S2|15, Raum 134**

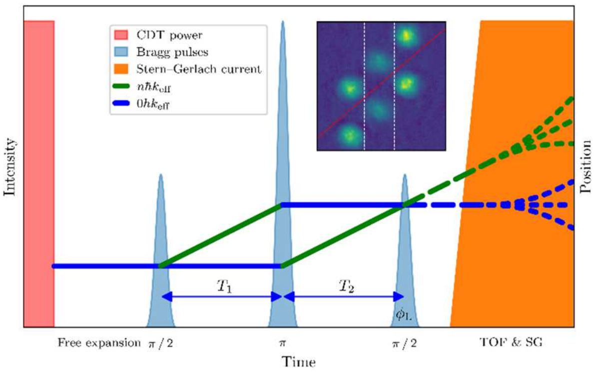
Novel Techniques for Atom Trapping and Large-Momentum-Transfer Atom Interferometry

Dominik Pfeiffer, M. Sc.

Institut für Angewandte Physik – TU Darmstadt

Matter-wave interferometry has emerged as a vital addition to high-precision measurements of fundamental constants like the gravitational constant G and the fine-structure constant α, while enabling stringent tests of foundational principles such as the Einstein equivalence principle. Current efforts aim to extend these techniques towards inertial sensing, magnetometry and gradiometry, gravitational-wave detection and dark-matter searches through enhanced sensitivity.

The ***At**om **O**ptics with **Mic**ro **S**tructures* (ATOMICS) experiment at the Technische Universität Darmstadt provides a versatile platform for the investigation of ^{87}Rb Bose-Einstein Condensates (BEC) in optical dipole potentials and atom interferometry. The interaction between light fields and atoms is used to precisely manipulate BECs in phase space. Light fields generated by conical refraction in biaxial crystals are used to trap ultra-cold atoms in a single-beam repulsive potential, minimising spontaneous photon scattering, crucial for quantum sensing and quantum computing. Two-photon Bragg processes are employed to transfer momentum to the atoms and couple different momentum states of a BEC. This enables the coherent splitting and recombination of ensembles and is used to implement atom interferometers in the Mach-Zehnder configuration for the measurement of magnetic field gradients (see Figure). Digital micromirror devices (DMD) are utilised to dynamically shape optical potentials, enabling the adiabatic generation of up to four ultracold ensembles from a single thermal reservoir via dimple traps.



This talk aims to present the recent advances for atom trapping and interferometry at the ATOMICS experiment. Optical trapping techniques for BEC using conical refraction and DMDs are discussed. Implementations of Mach-Zehnder interferometers using (higher-order) Bragg diffraction are presented. State-selective measurements, advanced evaluation and error-mitigation techniques aiming towards increasing the precision of such interferometers are introduced.

Der Sprecher wird betreut von Prof. Dr. G. Birkl