Q 37: Matterwave Optics I

Time: Wednesday 17:45–19:00 Location: A 320

Q 37.1 We 17:45 A 320

BEC simulations for controlled release from shallow traps — •Holger Ahlers[1], Ernst Maria Rasel[1], and das QUANTUS Team[1,2,3,4,5,6,7,8,9] — [1]Institut für Quantenoptik, LU Hannover — [2]ZARM, Uni Bremen — [3]Institut für Physik, HU Berlin — [4]Institut für Laserphysik, Uni Hamburg — [5]Institut für Quantenphysik, Uni Ulm — [6]MPQ, München — [7]Institut für angewandte Physik, TU Darmstadt — [8]Midlands Ultracold Atom Research Centre, University of Birmingham, UK — [9]FBH, Berlin

Our BEC experiment at the ZARM Droptower aims to realise high precision interferometric measurements with matter waves. In order to exploit the advantage of long expansion times in a microgravity environment, a high degree of control and a detailed understanding of the dynamics during preparation are needed. For this purpose a detailed model of the atom-chip-based experiment has been developed and helps in designing optimized experimental sequences. These simulations allow for investigating the high potential of quantum gases in microgravity for new and challenging experiments.

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Q 37.2 We 18:00 A 320

Applications of Bose-Einstein-Condensates in microgravity — •Hauke Müntinga[1] und das QUANTUS Team[1,2,3,4,5,6] — [1]ZARM, Universität Bremen — [2]Institut für Quantenoptik, LU Hannover — [3]Institut für Physik, HU Berlin — [4]Institut für Laserphysik, Universität Hamburg — [5]Institut für Quantenphysik, Universität Ulm — [6]MPQ, München

We report on the current status of the QUANTUS free fall BEC experiment at the ZARM drop tower in Bremen.

After the first realization of a BEC in microgravity in 2007, we were able to observe condensates after 1 s of free evolution. The extremely shallow traps possible in microgravity and resulting ultralow temperatures of a few nK allow for further studies ranging from coherence properties of condensates to inertial sensors based on matter waves.

In our talk we will focus on the implementation of a matter wave interferometer into our apparatus, which aims to extend measurement times to unprecedented durations and sensitivities, and therefore leads the way to future experiments on other microgravity platforms like sounding rockets and the ISS. These goals are worked on in close cooperation with QUEST and the PRIMUS project.

The QUANTUS project is a collaboration of U Hamburg, U Ulm, HU Berlin, MPQ Munich, ZARM at U Bremen and LU Hannover. It is supported by the German Space Agency DLR with funds provided by the Federal Ministry of Economics and Technology (BMWi) under grant number DLR 50WM0836.

Q 37.3 We 18:15 A 320

Bose-Einstein Condensation Experiments in Microgravity — •Stephan Tobias Seidel[1], Ernst Maria Rasel[1], and das QUANTUS Team[1,2,3,4,5,6,7,8,9] — [1]Institut für Quantenoptik, LU Hannover — [2]ZARM, Uni Bremen — [3]Institut für Physik, HU Berlin — [4]Institut für Laserphysik, Uni Hamburg — [5]Institut fÏr Quantenphysik, Uni Ulm — [6]MPQ, München — [7]Institut für angewandte Physik, TU Darmstadt — [8]Midlands Ultracold Atom Research Centre, University of Birmingham, UK — [9]FBH , Berlin

The successful demonstration of Bose-Einstein-Condensation in microgravity in 2007 opens the way to realize an atom interferometer operated in the unique environment of weightlessness. Within the QUANTUS project (Quantum systems under microgravity) an atom interferometer based on Rubidium 87 will be implemented in the drop tower at ZARM, Bremen. The apparatus produces a BEC of 10^4 atoms at a temperature of a few nK. In this regime it is possible to operate an interferometer with a coherent evolution on a timescale up to 1 second. The Mach-Zehnder atom interferometer is based on Bragg-scattering as a coherent beam splitter mechanism.

Furthermore, the produced BEC has a chemical potential of almost 10^{-31} J and a healing length on the order of $7\,\mu$m. These properties make it an ideal source for the study of quantum transport phenomena in disordered potentials.

The QUANTUS project is supported by the German Space Agency DLR with funds provided by the Federal Ministry of Economics and Technology (BMWi) under grant numbers DLR 50 WM 0835 - 0839.

Q 37.4 We 18:30 A 320

Advanced laser systems for drop tower experiments within QUANTUS II and beyond — •Max Schiemangk[1], Achim Peters[1], and das QUANTUS Team[1,2,3,4,5,6,7,8,9] — [1]Institut für Physik, HU Berlin — [2]Institut für Quantenoptik, LU Hannover — [3]Institut für Laserphysik, Uni Hamburg — [4]ZARM, Uni Bremen — [5]Institut für Quantenphysik, Uni Ulm — [6]MPQ, München — [7]Institut für angewandte Physik, TU Darmstadt — [8]Midlands Ultracold Atom Research Centre, University of Birmingham, UK — [9]FBH, Berlin

In preparation for future quantum gas experiments in space, preliminary experiments are currently performed at the ZARM drop tower in Bremen and a sounding rocket mission is planned for the near future. In this context compact and robust laser systems have been developed.

An overview of the planned laser system capable of performing atom interferometry experiments will be given. The talk will present, e.g., the concepts of a hybrid integrated master oscillator power amplifier (MOPA) and a mesoscopic spectroscopy stabilized reference laser. The MOPA consists of a laser chip, an amplifier, and microoptical components all integrated on a 10×50 mm^2 microbench. The reference laser combines this microbench technology with a macroscopic vapor cell.

The QUANTUS project is a collaboration of LU Hannover, ZARM at U Bremen, U Ulm, U Hamburg, and HU Berlin. It is supported by the German Space Agency DLR with funds provided by the Federal Ministry of Economics and Technology (BMWi) under grant number DLR 50WM0835-0839.

Q 37.5 We 18:45 A 320

A Compact Atom Chip Based Experiment with Bose-Fermi Mixtures in Microgravity — •Waldemar Herr[1], Ernst Maria Rasel[1], and das QUANTUS Team[1,2,3,4,5,6,7,8,9] — [1]Institut für Quantenoptik, LU Hannover — [2]ZARM, Uni Bremen — [3]Institut für Physik, HU Berlin — [4]Institut für Laserphysik, Uni Hamburg — [5]Institut für Quantenphysik, Uni Ulm — [6]MPQ, München — [7]Institut für angewandte Physik, TU Darmstadt — [8]Midlands Ultracold Atom Research Centre, University of Birmingham, UK — [9]FBH, Berlin

The Principle of Equivalence lies at the heart of the theory of General Relativity. Taking the advantage of long free evolution times, mass independent confining potentials and perturbation free environment, QUANTUS2 aims to push the existing frontiers further to perform high precision experiments in the quantum domain. In this context, we realize a new setup fulfilling the criteria of being extremely compact, in order to operate in the catapult mode of the droptower in Bremen doubling the time of microgravity up to 9 seconds. The experiment is planned to use ^{87}Rb and ^{40}K as degenerate Bose-Fermi mixtures in order to carry out experiments on tests of the Weak Equivalence Principle in quantum domain. Up to date progress and future prospects of this ambitious and technically challenging project will be presented in this talk.

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