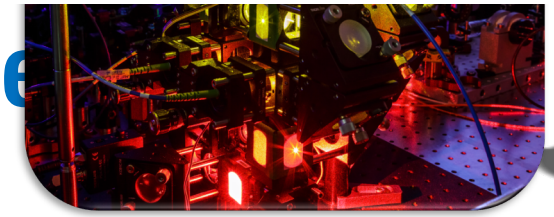
Dipolar Quantum Gase



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Theory Experiments

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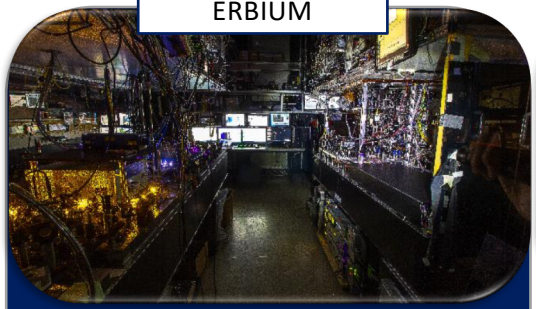
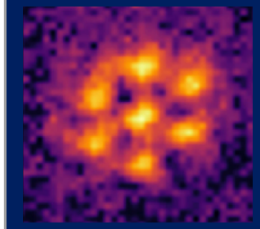
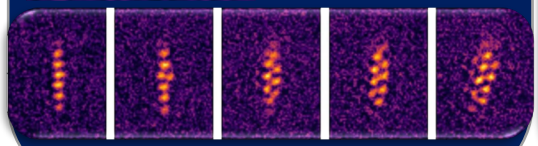
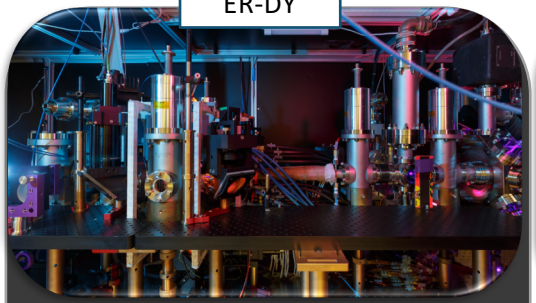


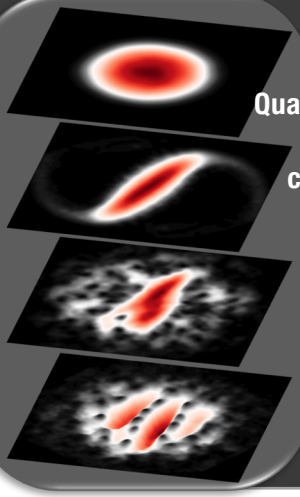


The discover of Supersolidity and Bloch Oscillations



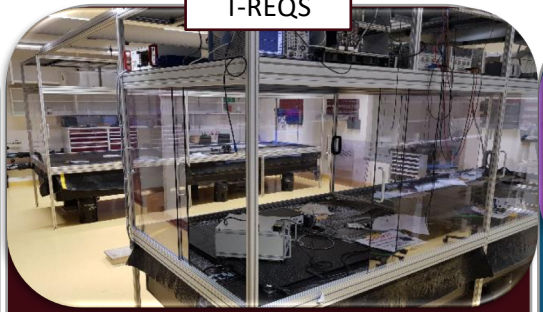
ER-DY



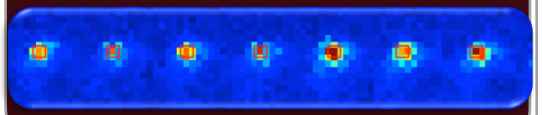


Quantum Vortices with high connectivity

T-REQS

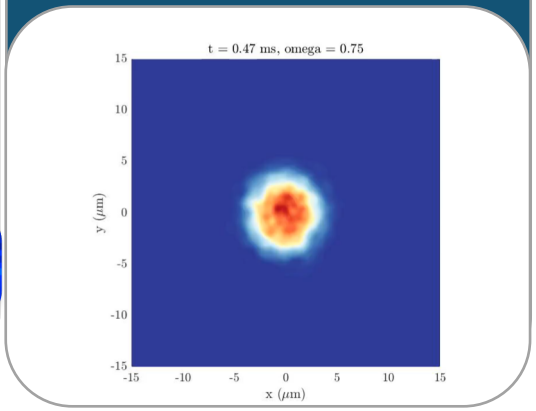


Single atomic magnet in an array of tweezers for quantum info



Theory

Simulation of the behavior of dipolar quantum gases



Dipolar Quantum Gases

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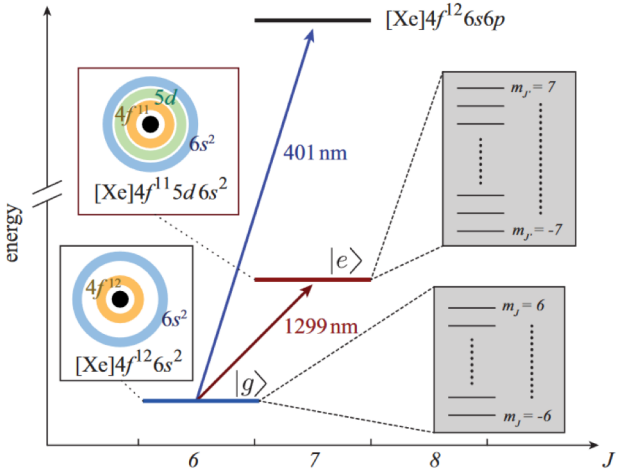
Observation of a narrow inner-shell orbital transition in atomic erbium at 1299 nm

A. Patscheider, B. Yang, G. Natale, D. Petter, L. Chomaz, M. J. Mark, G. Hovhannesyan, M. Lepers, and F. Ferlaino
Phys. Rev. Research **3**, 033256 – Published 17 September 2021



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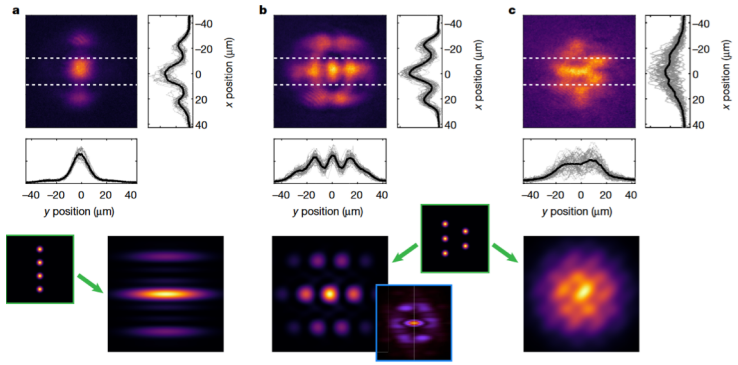
Article | Published: 18 August 2021

Two-dimensional supersolidity in a dipolar quantum gas

Matthew A. Norcia, Claudia Politi, Lauritz Klaus, Elena Poli, Maximilian Sohmen, Manfred J. Mark, Russell N. Bisset, Luis Santos & Francesca Ferlaino



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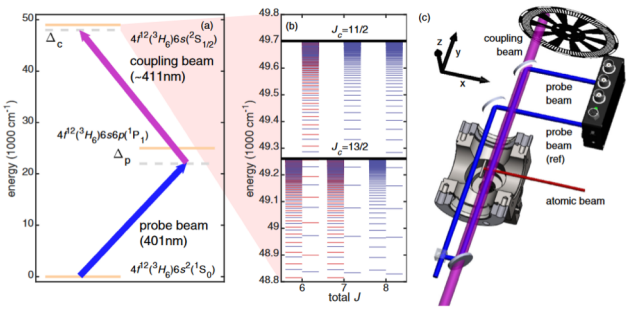
Spectroscopy of Rydberg states in erbium using electromagnetically induced transparency

A. Trautmann, M. J. Mark, P. Ilzhöfer, H. Edri, A. El Arrach, J. G. Maloberti, C. H. Greene, F. Robicheaux, and F. Ferlaino
Phys. Rev. Research **3**, 033165 – Published 19 August 2021



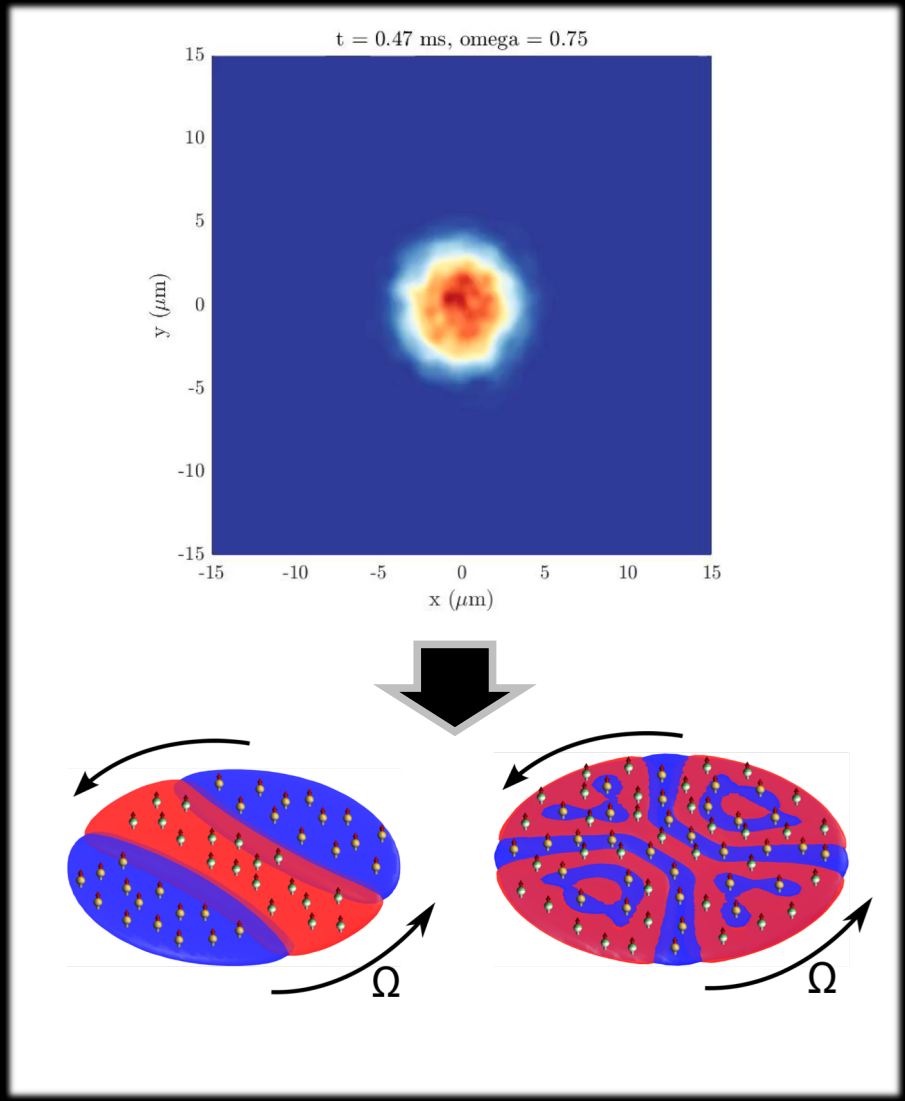
Master Project

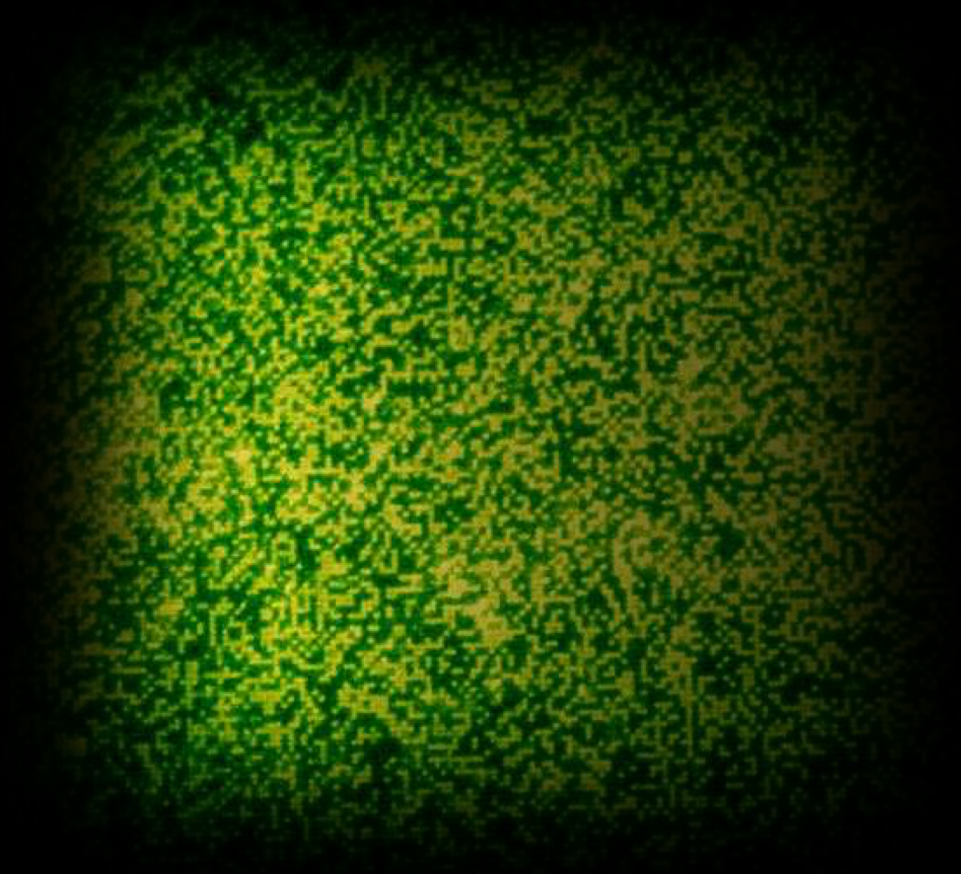
1. Quantized vortices in two-dimensional dipolar mixtures

Quantum gases of ultracold neutral atoms offer a unique platform to study phenomena like Bose-Einstein condensation (BEC), superfluidity and so-called quantized vortex nucleation. In recent years, there has been a growing interest in studying two-component quantum fluids. Here, miscible and immiscible regimes of the two components due to relative strength of inter-species and intra-species interactions open the possibility to investigate different phases. Dipolar mixtures, where atoms interact with long-range anisotropic interactions, offer even more phases including the possibility to develop a spontaneous density modulation.

You will learn:

- How to perform numerical simulations with extended Gross-Pitaevskii equation.
- How to simulate the dynamics of a rotating dipolar BEC.
- Properties of dipolar mixtures and vortices.





Master Project

2. Tunable 2D lattice for quantum gas microscopy at 532nm

This project aims to improve on our existing experiments by adding a 2D lattice with tunable periodicity using the “accordion” technique. In particular, the student will use an exisiting off-resonant laser at 532nm to build and implement an optical setup to create these tunable lattices.

You will learn:

- 2D Lattice physics
- How to build a stable optical setup
- Electronic control and stabilization

Master Project

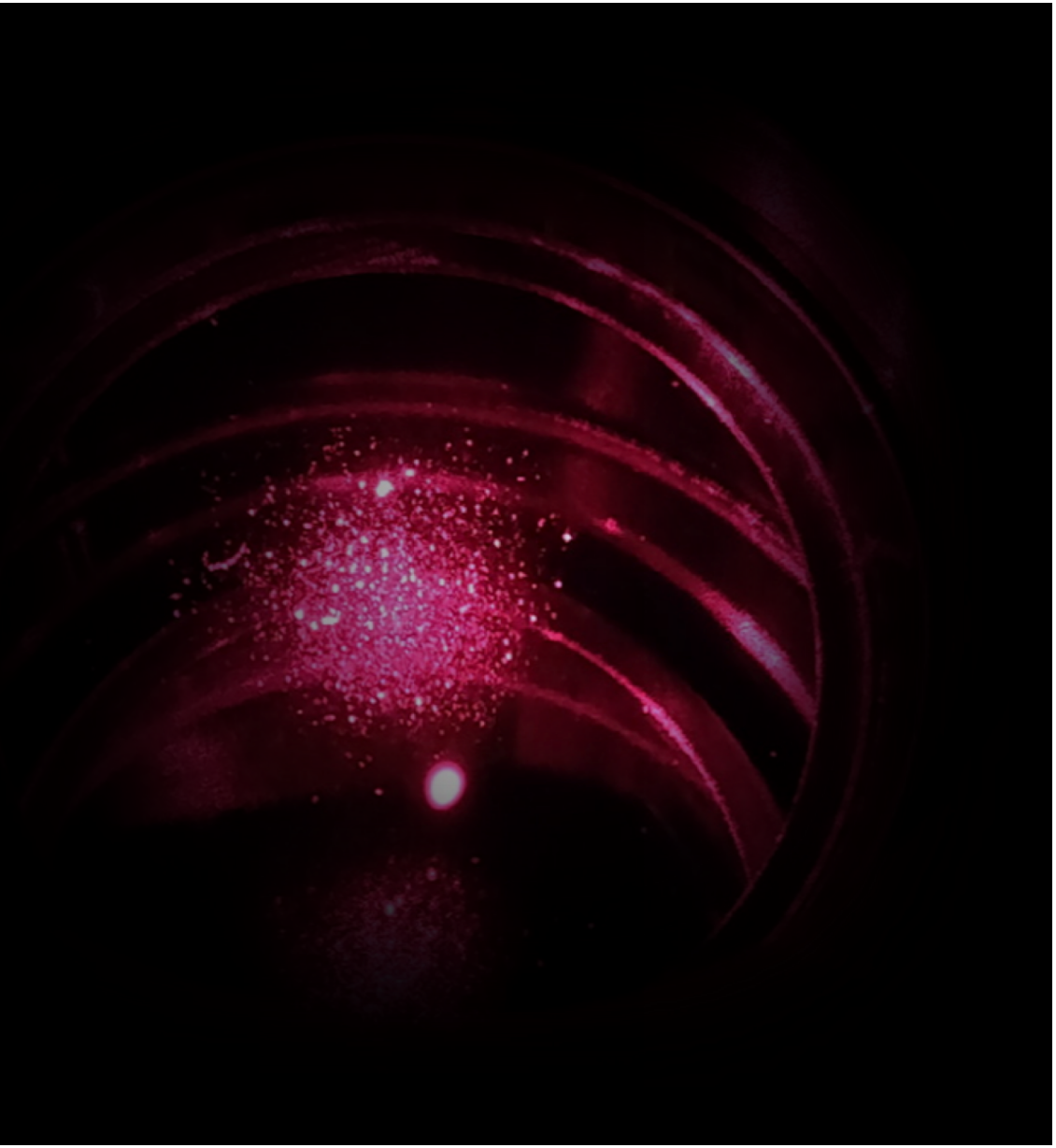
3. Build-up and implementation of a narrow-line laser cooling system at 631nm

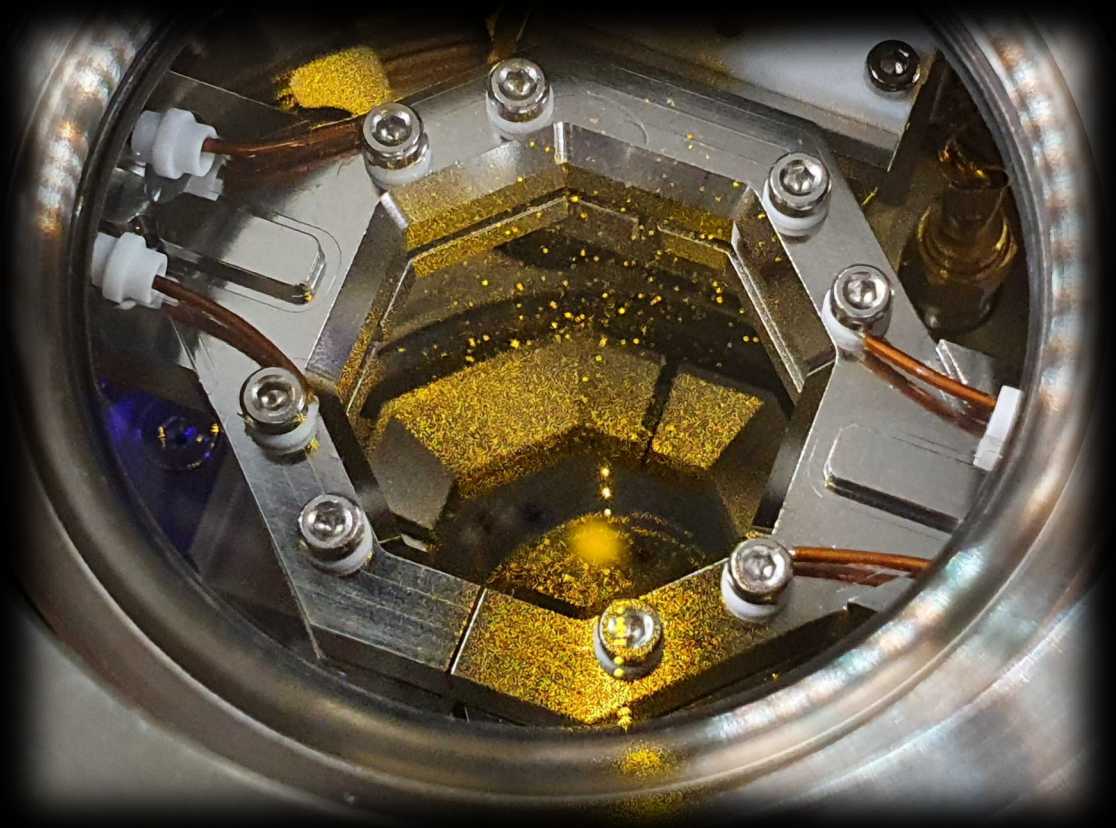
This project aims to improve on our existing experiments by adding an extra stage in the process of cooling atoms, needed for faster generation of degenerate quantum gases.

In particular, the student will control a homebuilt laser, lock it to a cavity and distribute the light to the running experiment.

You will:

- Learn cavity & laser physics
- Build an optical setup
- Learn electronic control & stabilisation
- Contribute to a running experiment





Master Project

4. Electric field control for the detection of Rydberg atoms

The goal of this project is to create a setup for the control of electric fields in the context of manipulation and detection of Rydberg atoms and ions. The setup will then be integrated with the main experiment on erbium atoms in arrays of optical tweezers.

You will learn:

- How to design and build a setup for the manipulation of electric fields
- Electronic control of equipment
- Physics of Rydberg atoms in fields

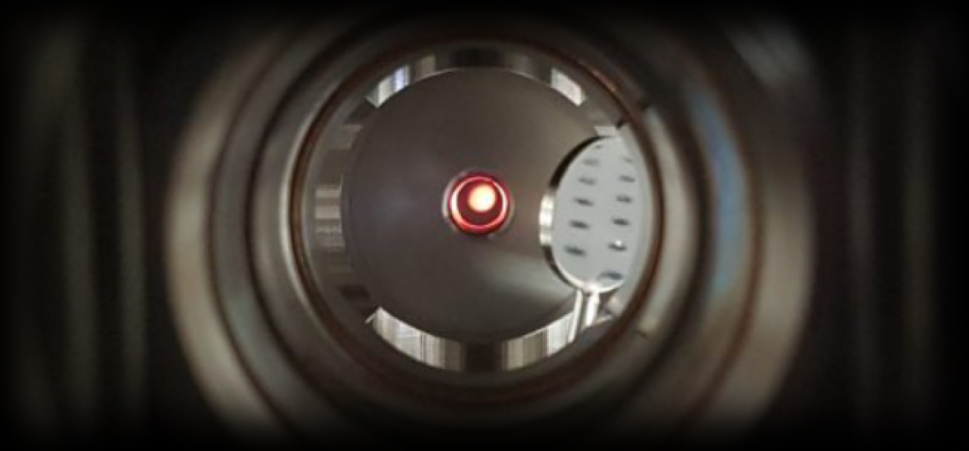
Master Project

5. Build-up and testing of a new setup for ultracold atomic experiments

This project aims at the build up of a new test platform for phyisical effects and techincal improvements that would be later applied to our main experiment on erbium atoms in optical tweezers. The setup will require first to build a new vacuum chamber and an atomic beam source, including all related electronics for its monitoring and control. Later, optical setups for cooling and imaging of the atoms will be implemented, followed by the implementation of optical cooling and trapping.

You will learn:

- How to build an ultra-high vacuum system
- How to set up laser systems and optical elements for the manipulation of light beams
- Physics of optical atomic cooling, atomic control and imaging



Contact Us

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manfred.mark@uibk.ac.at

Bachelor Projects

1. Many-body quantum phases in ultracold mixtures: from quantum droplets to alternating-domain supersolids
2. Bloch oscillations: Atom Interferometry
3. AC-polarizability of multi-electron atoms: Beyond the two-level system
4. An optical quantum memory based on optical tweezers
5. Rydberg interactions in controlled micro-ensembles

Master Projects

1. Quantized vortices in two-dimensional dipolar mixtures (Theory)
2. Tunable 2D lattice for quantum gas microscopy at 532nm
3. Build-up and implementation of a narrow-line laser cooling system at 631nm
4. Electric field control for the detection of Rydberg atoms
5. Build-up and testing of a new setup for ultracold atomic experiments