

Physics/Astrophysics
Planning Group Members: Frank Goehmann and Takaaki Koga

Cold Quantum Gasses

Speaker:

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Title: Towards single atom devices built from quantum gases

Atom optics and the physics of ultracold quantum gases belong to the fastest growing fields in experimental physics of the last decade and have led to many fascinating discoveries. Atomic quantum gases represent powerful tools for the study of many body phenomena and for precision measurements since they are very pure and homogeneous systems with many possibilities to perfectly control external as well as internal degrees of freedom, ranging from external trapping parameters over the precise control of atomic states to even the control of the interaction among the particles. Most of the research in the field clearly aims at fundamental aspects. However, the above mentioned possibilities of control, the unique properties of degenerate quantum gases, and the experimental techniques that have been developed also open novel ways of generating structured materials and therefore link the field to applied sciences. Our current efforts aim at the use of a degenerate quantum gas to deposit well defined arrays of single atoms with accurately known lattice spacing and accuracy on the nanometer scale on a crystal surface. Our approach will not only make use of external fields to control the deposition but also of inter atomic interactions to achieve exact number control[1,2], which is a new concept in atom lithography[3]. Combining the two fields of Bose-Einstein condensation[4,5] and atom lithography will therefore allow for an increase of control in material sciences, even on the quantum and single atom level, and therefore pave the way for the generation of materials with well defined structures, that cannot be produced with current techniques.

References

The following references provide also links to nice reviews on Bose-Einstein condensation/ultracold quantum gases:

- [1] *The Mott insulator: <http://www.quantum.physik.uni-mainz.de/bec/faqs/mottinsulator.html>*
- [2] *Quantum gases in optical lattices: <http://physicsweb.org/articles/world/17/4/7>*
- [3] *Nanofabrication using neutral atomic beams: <http://www.physics.utoronto.ca/~jht/reprints/AtomLithReview97.pdf>*
- [4] *The JILA BEC Homepage: <http://jilawww.colorado.edu/bec/>*
- [5] *BEC Review article on PhysicsWeb: <http://physicsweb.org/articles/world/10/3/3>*