Benjamin Sparkes
(Universität Melbourne)

An Ultracold Electron and Ion Source using Coherent Rydberg Excitation

B. M. Sparkes, D. Murphy, R. W. Speirs, D. J. Thompson, A. J. McCulloch, and R. E. Scholten

A cold atom electron and ion source (CAEIS) is one example of how cold atom physics can be applied to real-world applications. In this case, photo-ionisation of laser-cooled and trapped atoms translates to bright and highly-focusable electron and ion bunches. The electron bunches have the potential for creating a 'molecular movie' – the holy grail of ultrafast electron diffraction as it would allow us to determine the dynamics of biologically important molecules such as membrane proteins with atomic spatial and temporal resolution. Similarly, the ions produced have the potential to achieve sub-nanometer focused beams, an important limit for characterisation and fabrication of ever-shrinking semiconductor devices.
Rydberg atoms are of great interest across a range of fields from quantum information through to simulating star clusters. One of the main reasons for this is the phenomenon of Rydberg blockade where, due to their large dipole moments, an atom in a Rydberg state will affect the internal energy levels of neighbouring atoms, preventing simultaneous excitation. Combining a CAEIS with coherent excitation to Rydberg states has enormous potential for improving its functionality: reducing disorder-induced heating effects; increasing excitation efficiencies via stimulated Raman adiabatic passage (STIRAP); and, if combined with the next-generation cold atom-beam source being developed, could allow for the creation of a high-speed quasi-deterministic single-ion source.
I will present the latest theoretical and experiment results from the University of Melbourne CAEIS, demonstrating single-shot cold electron diffraction imaging of gold foil, increased beam brightness through STIRAP, temperature reduction through Rydberg blockade, and simulations showing the predicted performance of a cold atom single ion source with orders of magnitude improvement in terms of both current and focusability over other sources available.

13. Mai 2016, 9:45 Uhr

Universität Stuttgart, NWZII, Raum 3.123
Pfaffenwaldring 57, 70569 Stuttgart