A 24: Atomic Clusters IV

Time: Friday 10:30–12:15 Location: F 303

Invited Talk A 24.1 Fr 10:30 F 303

Interacting Bosonic and Fermionic Atoms in 3D Optical Lattice Potentials — •Sebastian Will, Thorsten Best, Simon Braun, Philipp Ronzheimer, Ulrich Schneider, Michael Schreiber, Kin Chung Fong, Lucia Hackermüller, and Immanuel Bloch — Ludwig-Maximilians-Universität München, Schellingstraße 4, 80799 München, Germany

In recent years, ultracold atoms in optical lattices have begun to reveal their potential to simulate condensed matter systems with the exceptional control offered by atomic physics. We perform experiments directed towards quantum simulation using ultracold bosonic ^{87}Rb and fermionic ^{40}K atoms loaded to a 3D optical lattice, that features tunability of the underlying harmonic confinement. Additionally harnessing intra- and interspecies Feshbach resonances as a direct control knob for interactions, we investigate strongly interacting quantum systems along several routes: Using repulsively interacting ^{40}K Fermi-Fermi mixtures we have been able to realize an implementation of the Fermi Hubbard model. A direct measurement of compressibility allowed us to identify metallic, Fermi liquid and band insulating phases as well as an emergent Mott insulating phase. In ^{87}Rb-^{40}K Bose-Fermi mixtures we have characterized the shift of the bosonic superfluid to Mott insulating transition finding interaction-induced self-trapping to be the dominant cause. Recently, we have been able to peek beyond the single-band Hubbard model in a purely bosonic ^{87}Rb system: A precision measurement of the absolute interaction energies on the sites of a deep optical lattice revealed the presence of coherent multi-body interactions.

Invited Talk A 24.2 Fr 11:00 F 303

Dressing of Ground State Atoms by Rydberg States in a Ioffe-Pritchard Trap — •Michael Mayle[1], Igor Lesanovsky[2], and Peter Schmelcher[1] — [1]Zentrum für Optische Quantentechnologien, Universität Hamburg — [2]School of Physics and Astronomy, University of Nottingham, UK

Atomic Rydberg states possess extraordinary properties. Exploiting these qualities is demonstrated to create new handles for the manipulation of ultracold atoms. Taking the external motion of magnetically trapped (Rydberg) atoms as an example, we discuss how the specific features of the Rydberg state can be mapped onto the ground state by means of an off-resonant two-photon laser dressing. In particular, it is demonstrated that the interplay between the spatially varying quantization axis of the considered Ioffe-Pritchard field and the fixed polarization of the laser transition provides a possibility of substantially manipulating the ground state trapping potential.

A 24.3 Fr 11:30 F 303

Optical spectroscopy of metal doped silicon clusters in rare gas matrices — •Vicente Zamudio-Bayer[1], Konstantin Hirsch[1], Thomas Möller[1], Alexandre Rydlo[2], Stefan Minniberger[2], Wolfgang Harbich[2], Bernd von Issendorff[3], and Tobias Lau[4] — [1]Technische Universität Berlin, Institut für Optik und Atomare Physik, EW 3-1, Hardenbergstraße 36, D-10623 Berlin — [2]Institut de Physique des Nanostructures, EPFL, CH-1015 Lausanne — [3]Albert-Ludwigs-Universität Freiburg, Fakultät für Physik/FMF, Stefan-Meier-Straße 21, D-79104 Freiburg — [4]Helmholtz-Zentrum Berlin für Materialien und Energie, Wilhelm-Conrad-Röntgen Campus / BESSY II, Institut für Methoden und Instrumentierung der Synchrotronstrahlung (G-I2), Albert-Einstein-Str. 15, D-12489 Berlin

Although theoretical studies predict technologically relevant optical properties for certain species of metal doped silicon clusters, such as large HOMO-LUMO gaps, these have not been studied experimentally. The reason for this is the very small achievable target density. In order to overcome this obstacle, we have taken our intense cluster source and combined it with a rare-gas matrix isolation apparatus at EPFL. With this setup it was possible to study the fluorescence and measure the excitation spectra of such clusters. This talk will cover the experimental setup and some preliminary results.

A 24.4 Fr 11:45 F 303

Ionization dynamics of NaCl-nanocrystals in strong laser fields — •Christian Peltz[1], Thomas Fennel[1], Egill Antonsson[2], Burkhard Langer[2], Jürgen Plenge[2], and Eckart Rühl[2] — [1]Institut für Physik, Universität Rostock, Universitätsplatz 3, 18051 Rostock — [2]Institut für Chemie und Biochemie, Freie Universität Berlin, Takustr. 3, 14195 Berlin

Insight into the ultrafast ionization dynamics of dielectrics in intense laser fields is of major interest for laser-based nanomachining and dielectric damage. The time-scale and nature of the mechanisms governing material modification and energy deposition, such as avalanche breakdown effects and plasma heating, are of central importance for realizing well-controlled material damage [1]. As finite and scalable gas phase model systems for solid dielectrics, NaCl-nanocrystals are promising systems to explore the time- and size-dependence of the coupling process. Experiments on these systems show pronounced pump-probe effects in the ion and electron emission with moderate laser intensities ($\sim 10^{13}$W/cm^2). To investigate the microscopic ionization dynamics in such multi-component system we apply molecular dynamics simulation originally developed for intense laser-cluster interactions [2]. The simulation results, which are in good agreement with the experimental findings, reveal that avalanche-like metallization of the nanocrystals and resonant collective electron heating are the key to explain the observed timing effects on the ionization dynamics.

[1] L. Englert et al., Appl. Phys. A **92**, 749 (2008)
[2] T. Fennel et al., Phys. Rev. Lett. **99**, 233401 (2007)

A 24.5 Fr 12:00 F 303

Charge state selective double color landscapes of highly charged ions from clusters exposed to intense laser pulses — •Truong Nguyen Xuan, Josef Tiggesbäumker, and Karl-Heinz Meiwes-Broer — Institut für Physik, Universität Rostock, 18055 Rostock

We use the pulse shaping technique to investigate the interaction of intense femtosecond laser fields with embedded clusters. Colored double-pulses are used to systematiclly study the dependence of the extreme charging on the pulse energy, the pulse separation as well as the pulse intensity ratio. The prepulse intensity thresholds which have been extracted been extracted from the data show as remarkably low values which are nearly constant irrespective of the chosen charge state.