A 27: Ultracold collisions (jointly with Q)

Zeit: Freitag 10:30–12:30 Raum: 6G

Hauptvortrag A 27.1 Fr 10:30 6G

Quantum effects in collisions of ultracold atoms with walls and nanostructures — •Javier Madroñero, Florian Arnecke, Alexander Jurisch, and Harald Friedrich — Physik Department, Technische Universität München, München

Collisions of ultracold atoms with walls and nanostructures are, at sufficiently low energy, dominantly influenced by quantum effects, e.g. quantum reflection in the nonclassical region of an attractive atom-surface potential and dominance of low partial waves in the elastic scattering by nanospheres. We discuss possibilities of exploiting such effects to probe atom-surface potentials or to trap atoms without the help of auxiliary fields.

A 27.2 Fr 11:00 6G

Ellastic collisions in a mixture of Yb and Rb atoms — Sven Kroboth, •Nils Nemitz, Florian Baumer, Claudia Höhl, and Axel Görlitz — Institut für Experimentalphysik, Universität Düsseldorf

The collisional properties of atoms play an important role in determining the features and realizability of quantum gases.

We report on an experimental study of inter-species collisions in a mixture of cold ytterbium and rubidium atoms. The Yb atoms are held in a bichromatic optical dipole trap designed to have minimal effect on the evaporatively cooled ^{87}Rb atoms which are held in a Ioffe-Pritchard type magnetic trap.

Collisions are observed through sympathetic cooling of Yb by Rb. In our experiment, the Yb temperature decreases from initially 50μK to near the Rb temperature of 20μK on a time scale of a second for the isotopes ^{174}Yb and ^{176}Yb. In contrast, a much smaller thermalization rate found for ^{172}Yb indicates a significantly smaller cross-section for collisions with Rb.

Our results are an important step towards the creation of a mixed quantum gas and heteronuclear Yb-Rb molecules.

A 27.3 Fr 11:15 6G

Wechselwirkungen ultrakalter Li-Rb-Gemische — •Carsten Marzok, Benjamin Deh, Philippe W. Courteille und Claus Zimmermann — Physikalisches Insitut, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen

Gemische ultrakalter Gase erleben in den letzten Jahren rasant wachsendes Interesse. BEC–BCS–Übergänge sowie reichhaltige Phasendiagramme in optischen Gittern im Falle von Fermi–Bose–Gemischen ebenso wie Wechselwirkungen in Doppel–BECs im Falle von Bose–Bose–Gemischen sind Beispiele für das breite Spektrum an beobachtbaren Effekten. Dem System Li–Rb kommt mit seinem großen Massenunterschied eine besondere Rolle zu, da man sich dem Gültigkeitsbereich der Born–Oppenheimer–Näherung annähert. Das ^{6}Li–^{87}Rb Fermi–Bose–Gemisch kann damit in einem optischen Gitter prinzipiell als Modellsystem eines Festkörpers verwendet werden. Repulsive Wechselwirkungen im Bose–Bose–Gemisch ^{7}Li und ^{87}Rb hingegen könnten das instabile ^{7}Li BEC im Hyperfeinzustand $|F, m_F\rangle = |2, 2\rangle$ stabilisieren. Um diese Effekte zu studieren, benötigt man Informationen und Kontrolle über die gegenseitigen Wechselwirkungen, ausgedrückt in der s–Wellen–Streulänge. Magnetische heteronukleare Feshbachresonanzen können hier sowohl als Bestimmungsgröße als auch als wertvolles Werkzeug dienen. Beide $^{(6/7)}$Li–^{87}Rb Gemische konnten wir durch sympathetisches Kühlen zu ultrakalten Temperaturen bringen und heteronukleare Wechselwirkungsparameter bestimmen.

A 27.4 Fr 11:30 6G

Magnetic noise in atom chips: impact of finite wire size — •Bo Zhang and Carsten Henkel — Institute fuer Physik, Universitaet Potsdam,Germany

We provide a detailed analysis of spin-flip transitions in atom chips, taking into account complex geometries. We focus on metallic wires of different shapes and cross-sections deposited on dielectric substrates. Our results show that the finite thickness and width of a metallic wire have an obvious impact on the atom trap lifetime. The spin orientation makes a big difference for magnetic noise above finite wires, in striking contrast to infinitely extended planar structures. Different interpolation formulas and approximations for magnetic field fluctuations in the near field of the wire are compared to exact numerical calculations. We work with surface integral equations and the boundary element method. Comparing to the surface impedance approximation familiar from microwave engineering, we find significant differences when the distance between the atom and the metallic surface is smaller than the skin depth.

A 27.5 Fr 11:45 6G

Interacting Rubidium and Caesium Atoms — •Claudia Weber, Michael Haas, Shincy John, Vanessa Leung, Lars Steffens, Daniel Frese, Dietmar Haubrich, Arno Rauschenbeutel, and Dieter Meschede — Institut für Angewandte Physik, Universität Bonn, Wegelerstr. 8, 53115 Bonn

In our experimental set up we simultaneously store Rubidium and Caesium in a magnetic trap. We use species-selective microwave cooling on the Rubidium groundstate hyperfine transition. Caesium is sympathetically cooled via elastic collisions with Rubidium. We are thus able to cool down the mixture to temperatures below 1 μK. Below 4 μK we observe strong losses of Caesium.
Analysing the dynamics of sympathetic cooling we are able to estimate a lower limit for the Rubidium-Caesium s-wave scattering length.

A 27.6 Fr 12:00 6G

Interactions of metastable neon atoms in magnetic and optical traps — •N. Herschbach[1], W.J. van Drunen[1], W. Ertmer[2], and G. Birkl[1] — [1]Institut für Angewandte Physik; Technische Universität Darmstadt, Schlossgartenstr. 7, D-64289 Darmstadt, Germany — [2]Institut für Quantenoptik; Leibniz Universität Hannover, Welfengarten 1, D-30167 Hannover, Germany

We investigate the cooling and the phyisics of interactions of metastable neon atoms. We measured elastic and inelastic collisional properties of cold metastable neon (^{3}P$_2$ state) in a magnetic trap. We found suppression of Penning ionization and achieved a 200-fold increase in phase space density by rf-forced evaporative cooling in the magnetic trap with ^{22}Ne [1]. However, efficiency of evaporative cooling has to be improved in order to reach quantum degeneracy.

Therefore we implemented a crossed optical dipole trap, which we can load from a magneto-optical trap as well as from a magnetic trap. This enables us to investigate the magnetic field dependence of collisional properties of metastable neon. More importantly, we can now trap metastable neon in states which cannot be trapped magnetically.

As a result we trapped, for the first time, neon in the ^{3}P$_0$ metastable state. Measurements of the number decay of trapped atoms will allow to infer the rate coefficient for two-body loss of neon in the ^{3}P$_0$ metastable state for both bosonic isotopes ^{20}Ne and ^{22}Ne. For this purpose, a careful characterization of the optical trap is required.
[1] P. Spoden et al., Phys. Rev. Lett. 94, 223201 (2005)

A 27.7 Fr 12:15 6G

Laser cooling of relativistic C^{3+} beams at the ESR — •M. Bussmann[1], U. Schramm[2], D. Habs[3], M. Steck[3], T. Kühl[3], P. Beller[3], B. Franzke[3], F. Nolden[3], T. Stöhlker[3], W. Nörtershäuser[3], C. Geppert[5], S. Reinhardt[4], S. Karpuk[5], and C. Novotny[5] — [1]Department f. Physik, Ludwig-Maximilians-Universität München, Garching — [2]Forschungszentrum Dresden Rossendorf, Dresden — [3]Gesellschaft f. Schwerionenforschung, Darmstadt — [4]Max-Planck-Institut für Kernphysik, Heidelberg — [5]Institut für Physik, Johannes-Gutenberg-Universität Mainz, Mainz

We report on new results for laser cooling of bunched C^{3+} beams at the ESR stored at an energy of 1.46 GeV. We observe a longitudinal momentum spread one order of magnitude smaller compared to conventional electron cooling.
Using a setup of two cw Ar^+ lasers, one at a fixed frequency, the other constantly detuned with respect to the first, we were able to increase the momentum acceptance of the laser force compared to recent experiemnts [1]. If laser cooling is assisted by moderate electron cooling 3D cold beams can be achieved.
The focus of the talk lies on the dynamical aspects of the transition from temperature dominated beams to space charge dominated beams.

[1] U. Schramm, M. Bussmann, D. Habs, M. Steck, T. Kühl, P. Beller, B. Franzke, F. Nolden, G. Saathoff, S. Reinhardt, S. Karpuk, *AIP Conf. Proceedings* **821** (2006), 501-509