A 13: Poster I - Ultra-cold plasmas and Rydberg systems

Zeit: Dienstag 16:30–18:30 Raum: Poster B

A 13.1 Di 16:30 Poster B

Vielteilchen-Effekte in ultrakalten Rydberggasen — •Cenap Ates und Jan-Michael Rost — Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden

Die starke Wechselwirkung zwischen Rydbergatomen eröffnet die Möglichkeit ein nahezu ideales Gas aus Grundzustandsatomen in ein stark wechselwirkendes System durch Anregung von Atomen in Rydbergzustände zu überführen. Ist zusätzlich die Temperatur des Gases so gering, dass thermische Stöße während der Beobachtungsdauer vernachlässigt werden können, weist die Dynamik dieser Systeme viele Parallelen zur Physik von Excitonen in Festkörpern auf. Basierend auf dieser Analogie werden in diesem Beitrag einige Aspekte der stark korrelierten Dynamik in ultrakalten Rydberggasen diskutiert.

A 13.2 Di 16:30 Poster B

Controlling ultracold Rydberg atoms in the quantum regime — •Bernd Hezel[1], Igor Lesanovsky[2], and Peter Schmelcher[1,3] — [1]Physikalisches Institut, Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg, Germany — [2]Institut für Theoretische Physik, Universität Innsbruck, Technikerstr. 25, 6020 Innsbruck, Austria — [3]Theoretische Chemie, Institut für Physikalische Chemie, Universität Heidelberg, INF 229, 69120 Heidelberg, Germany

We discuss the quantum dynamics of ultracold Rydberg atoms in a magnetic Ioffe Pritchard trap. The derived Hamiltonian displays how tight traps introduce finite size effects into the coupling of the atom to the magnetic field. We solve the Schrödinger equation of the system within a given n-manifold. For sufficiently large Ioffe-fields the system of coupled Schrödinger equations decomposes into $2n^2$ decoupled equations that govern the center of mass motion. The analysis of the combined center of mass and electronic quantum states reveals that the spatial extension of the electronic Rydberg state can exceed the extension of the ultracold center of mass motion. Investigating the situation of tight center of mass confinement outlines the procedure to generate a low-dimensional ultracold Rydberg gas.

A 13.3 Di 16:30 Poster B

Signatures of ultra-long-range Rydberg Molecules in photoassociation — •Ivan Liu and Jan-Michael Rost — Max-Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, D-01187, Dresden

The formation of ultra-long-range molecules was predicted in 2000 [1], involving a highly-excited (Rydberg) atom and a nearby ground-state atom. The adiabatic curves exhibit global minima at approximately $1.5n^2$, where n is the principle quantum number of the Rydberg atom, suggesting the enormous size of this dimer. The polyatomic Rydberg molecules have also been predicted [2]. Recently, some features of this molecular curve have been observed in the old experimental data [3]. Yet the direct evidence of the formed bound dimer is still lacking, largely due to the need to understand the photoassociative process.

Using the simplest excitation scheme in an ultracold Rb gas with realistic parameters, we reveal the signatures of such Rydberg molecules. They enter through the characteristic line shape of the free-bound molecular resonance, which was calculated numerically, thereby confirms the experimental realizability. Moreover, the important informations such as the rate of the formation and the life time of the molecules are obtained. They are both of fundamental interest and useful for the delicate quantum engineering of ultra-long-range molecules.

[1]Greene *et al* PRL 85, 2458 (2000)
[2]Liu and Rost EPJD 40, 65 (2006)
[3]Greene *et al* PRL 97, 233002 (2006)

A 13.4 Di 16:30 Poster B

Collective modes in Ultracold Plasmas — •Andrey Lyubonko and Jan-Michael Rost — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Straße 38, 01187 Dresden

Ultracold plasmas (UCP) are relatively new physical systems which have been intensively studied since 1999 [1]. The possibility of creation of finely controlled strongly coupled Coulomb systems on the basis of UCP is one of the motivations. A new feature of UCP was observed recently namely the existence of electronic collective modes (Tonks-Dattner resonances) [2]. Beyond fundamental interest such modes may provide an accurate method to determine the time-dependent electron temperature of UCP.

The first two moments of the collisionless Boltzmann equation assuming a scalar pressure are used to describe the collective modes in UCP. The similar hydrodynamical model was successfully applied to Tonks-Dattner resonances in hot plasma in the past [3] . We will present the results of a similar approach for the resonances in UCP incorporating the additional complication of the finite size of an UCP.

[1] T. C. Killian, S. Kulin, S. D. Bergeson, L. A. Orozco, C. Orzel, and S. L. Rolston, Phys. Rev. Lett., 83(23):4776 (1999)

[2] R. S. Fletcher, X. L. Zhang, and S. L. Rolston, Phys. Rev. Lett., 96:105003 (2006)

[3] J.V. Parker, J.C. Nickel, and R. W. Gould, Phys. Fluids 7, 1489 (1964).

[4] T.C. Killian, T. Pohl, T. Pattard and J M Rost, Physics Reports submitted, (2006), http://arxiv.org/pdf/physics/0612097