A 1: Plasma Interactions / Rydberg Atoms

Zeit: Montag 10:45–12:30 Raum: VMP 6 HS-B

Preisträgervortrag A 1.1 Mo 10:45 VMP 6 HS-B

Optimierter und selbst-optimierender magnetischer Einschluß — •Friedrich Wagner — Max-Planck-Institut für Plasmaphysik, Teilinstitut Greifswald, EURATOM Association — Träger der Stern-Gerlach-Medaille

Der Stand der Tokamakline erlaubt den Bau des ersten experimentellen Fusionskraftwerks. ITER soll in D-T Plasmen 500 MW Fusionsleistung erzeugen. Der Stellarator ist ein alternativer Vertreter des toroidalen Einschlusses, wobei mit Wendelstein 7-X das am weitesten fortgeschrittene Konzept dieser Linie in Greifwald realisiert wird. Die Optimierung beider Systeme gilt der Qualität der thermischen Isolation des Plasmas. Der Tokamak profitiert von seiner reduzierten Dimensionalität; das Stellaratorplasma ist notwendigerweise 3-D erreicht aber durch die Optimierung eine Quasisymmetrie der für den Einschluss bedeutsamen Größen. Die Spulenformgebung erlaubt beim Stellarator eine rigorose Systemoptimierung u.a. mit dem Ziel, den *laminaren* Anteil am radialen Transport auf das niedrige Niveau kontinuierlich symmetrischer Systeme zu senken. Fusionsplasmen sind andererseits offene Systeme, wobei der Einschluß in Tokamaks und optimierten Stellaratoren durch Turbulenzprozesse gegeben ist. Selbst-organsierende Prozesse bestimmen die Plasmaeigenschaften. Der selbst-induzierte Übergang in die H-Mode (high confinement) verbessert die Einschlussqualität um einen Faktor der erlaubt, die Systemgröße zu reduzieren und damit die Baukosten deutlich zu senken. Korrelationen im Turbulenzfeld führen zu einer makroskopischen Strömung im Plasma, welche die Turbulenz letzlich unterdrückt. Mechanismen turbulenter klassischer Systeme finden sich auch in Hochtemperaturplasmen wieder.

A 1.2 Mo 11:30 VMP 6 HS-B

Mapping the composite character of magnetically trapped Rydberg atoms — •Michael Mayle[1], Igor Lesanovsky[2], and Peter Schmelcher[1,3] — [1]Theoretische Chemie, Universität Heidelberg — [2]School of Physics and Astronomy, University of Nottingham, UK — [3]Physikalisches Institut, Universität Heidelberg

By investigating the quantum properties of magnetically trapped $nS_{1/2}$ Rydberg atoms, it is demonstrated that the composite nature of Rydberg atoms significantly alters their trapping properties opposed to point-like particles with identical magnetic moment. Employing an off-resonant two photon coupling scheme, a setup is proposed which allows to observe the signatures of the Rydberg trapping potential using a gas of ground state atoms. In addition, such a scheme provides new possibilities for designing trapping potentials for ground state atoms.

A 1.3 Mo 11:45 VMP 6 HS-B

Ionization–Recombination Balance in the Cold Rydberg Gas — •Yurii V. Dumin — Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

A well-known property of the cold Rydberg gas (formed, for example, in the magneto-optical traps) is its spontaneous ionization, resulting in ultracold plasmas [1]. Although this phenomenon is commonly treated as individual acts of ionization and recombination, such an approach is hardly appropriate for a sufficiently dense gas, whose Thomson radius exceeds the interparticle distance. Just this situation was implemented recently in the cryogenic gas jets [2]. A more adequate description of such systems should be based on the consideration of multi-particle interactions *ab initio*. This can be performed in the model of quasi-localized electrons, moving in the effective centrifugal potentials formed by the nearest ions; while influence of the distant particles is treated as a thermal bath with the effective virial temperature [3]. Such an approach enables us to derive the electron partition function, which can be efficiently used to calculate the probabilities of free and captured electronic states, thereby giving the degree of ionization of the strongly-coupled Rydberg plasma.

[1] T.C. Killian *et al.*, *Phys. Rep.* **449**, 77 (2007).
[2] J.P. Morrison *et al.*, *Phys. Rev. Lett.* **101**, 205005 (2008).
[3] Yu.V. Dumin, *J. Low Temp. Phys.* **119**, 377 (2000).

A 1.4 Mo 12:00 VMP 6 HS-B

Mesoscopic Rydberg Gate based on Electromagnetically Induced Transparency — •Markus Müller[1], Igor Lesanovsky[1], Hendrik Weimer[2], Hans-Peter Büchler[2], and Peter Zoller[1] — [1]Institute for Theoretical Physics, University of Innsbruck, and Institute for Quantum Optics and Quantum Information of the Austrian Academy of Sciences, Innsbruck, Austria — [2]Institute for Theoretical Physics III, University of Stuttgart, Germany

We demonstrate theoretically a parallelized CNOT gate which allows to entangle a mesoscopic ensemble of atoms with a single control atom in a single step, with high fidelity and on a microsecond timescale. Our scheme relies on the strong and long-ranged interaction between Rydberg atoms triggering Electromagnetically Induced Transparency. By this we can robustly implement a conditional coherent transfer of all ensemble atoms among two logical states, depending on the state of the control atom. As an application, we outline a many-body interferometer which allows a comparison of two many-body quantum states by performing a measurement of the control atom. Finally, we discuss perspectives of the gate as a building block for quantum simulators of Hamiltonians with few-body interactions.

A 1.5 Mo 12:15 VMP 6 HS-B

Partial Auto-Ionization Rates of Doubly Excited States in Helium — •Maximilian Schmidt[1], Celsus Bouri[1], Javier Madronero[2], and Andreas Buchleitner[1] — [1]Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg — [2]Technische Universität München, James-Franck-Strasse, 85747 Garching

The spectrum of helium consists of a complex structure of stable, resonant and single continuum states. All doubly excited states are resonances and coupled to some single continuum channels, to which they decay due to electronic correlations. The Complex Rotation Method is a powerful technique to access resonant energies, widths and wave functions directly by diagonalizing the rotated two electron Hamiltonian in a $\mathcal{L}^2$ basis set. Nevertheless, this method does so far only provide the *total* auto-ionization rate. In this work, the *partial* auto-ionization rates for doubly excited states into different single continuum channels are calculated for the first time within the framework of the Complex Rotation Method. These calculations are obtained for 2D-helium, that mimics the realistic helium atom very well [1].

[1] J. Madroñero, P. Schlagheck, L. Hilico, B. Gremaud, D. Delande, and A. Buchleitner, Europhysics Letters **70**, 183 (2005)