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Rydberg gases as thermostats for ultracold neutral plasmas

THOMAS PATTARD, Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, D-01187 Dresden, Germany

Ultracold neutral plasmas produced by photoionization of laser-cooled neutral atoms are very appealing for a number of different reasons. One of them is the prospect of creating, in a table-top experiment, a strongly coupled two-component plasma where the electrostatic potential energy greatly exceeds the thermal kinetic energy of the plasma particles. In this talk, I will discuss two examples of the potential of Rydberg gases for manipulating the electronic *and* ionic temperature of ultracold plasmas. In the first part, I will show that the addition of Rydberg atoms to a plasma permits controlling the electronic temperature to a significant extent. Depending on the level of excitation of the atoms and the timing of their creation, both cooling and heating of the plasma electrons can be achieved. In the second part, I will discuss the effect of a "dipole blockade", i.e.the interaction-induced suppression of Rydberg excitations in a gas, as a means of creating spatial correlations in the initial state (i.e. before the plasma is created by photoionization) in order to suppress the disorder-induced heating of the ions. This blockade effect, which has recently been demonstrated in a number of experiments, is of significant current interest beyond its application for the creation of strongly coupled plasmas, e.g. in certain proposed schemes for quantum information processing. In the talk, I will introduce a microscopic theoretical approach for the simulation of the Rydberg excitation dynamics in a dense gas of interacting atoms. It allows for a detailed investigation of the excitation process, including its statistical properties and spatial correlation properties.