DAMOP08-2008-000016

Abstract for an Invited Paper
for the DAMOP08 Meeting of
the American Physical Society

One-dimensional Rydberg gas in a Magneto-Electric Trap[1]

PETER SCHMELCHER, University of Heidelberg

We investigate the possibility to trap and align ultracold Rydberg atoms in the regime where both the (coupled) center of mass and electronic motion of the Rydberg atom are of quantum nature. First we explore the properties of Rydberg atoms in a magnetic Ioffe-Pritchard trap being commonly used in ultracold atomic physics experiments. A computational scheme projecting on a single n-manifold and incorporating an adiabatic separation of the electronic and ultracold center of mass motion is developed. An analysis of the resulting adiabatic potential energy surfaces for the center of mass motion demonstrates the possibility of trapping for a class of large angular momentum electronic states. In a second step we study the quantum properties of Rydberg atoms in a magnetic Ioffe-Pritchard trap which is superimposed by a homogeneous electric field. Trapped Rydberg atoms can be created here in long-lived electronic states exhibiting a permanent electric dipole moment of several hundred Debye. The resulting dipole-dipole interaction in conjunction with the radial confinement is demonstrated to give rise to an effectively one-dimensional ultracold quantum Rydberg gas with a macroscopic interparticle distance. We derive analytical expressions for the electric dipole moment and the required linear density of Rydberg atoms.

References: I. Lesanovsky and P. Schmelcher, Phys.Rev.Lett. **95**, 053001 (2005)
B. Hezel, I. Lesanovsky and P. Schmelcher, Phys.Rev.Lett. **97**, 223001 (2006)
M. Mayle, B. Hezel, I. Lesanovsky and P. Schmelcher, Phys.Rev.Lett. **99**, 113005 (2007)

[1]Financial support by the Deutsche Forschungsgemeinschaft is gratefully acknowledged.