Plenary Talk PV II Tue 8:30 V53.01

Rydberg atoms on the move — •Jan Michael Rost — Max Planck Institute for the Physics of Complex Systems, Dresden

The combination of Rydberg excitation with very low kinetic energies in an ultracold gas is a new way to create low energy physics. While previously mostly realized through skillfully designed and fabricated quantum dots, well defined electronic low energy systems can be "imprinted" into ultracold gases through the interaction with laser light. This has allowed to realize and study low dimensional condensed matter quantum systems with optical lattices and has also lead to a strong interest of information science in cold Rydberg physics. In these applications the motion of the atoms is mostly an unavoidable perturbation due to "finite temperature".

Here, we will demonstrate that the motion of the atoms can be used to create electronic dynamics closely interwined with atomic motion putting ultracold Rydberg gases into the context of chemical and exciton physics. Indeed, ultralong range molecules exist [1] with unusual properties: They are bound by internal quantum reflection [2] and have a permanent dipole although they are homonuclear [3]. Furthermore, a quantum analogon of Newton's cradle, namely almost lossless excitonic transport of electronic entanglement in an ultracold electronic [4] gas promises future application in information science.

[1] V. Bendkowsky etal., Nature 458, 1005 (2009).
[2] V. Bendkowsky etal., Phys. Rev. Lett. 105, 163201 (2010).
[3] W. Li etal., Science 334, 1110 (2011).
[4] S. Wüster, etal., Phys. Rev. Lett. 105, 0534004 (2010).