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Dipole-dipole interaction between cold Rydberg atoms in RF fields

H.B. VAN LINDEN VAN DEN HEUVELL, Van der Waals-Zeeman Institute, University of Amsterdam

Already for some time, dipole-dipole interaction between cold Rydberg atoms is promising as application in quantum information. This promise drives the research on this interaction. In this context we report two aspects:

1) Coherence. When a quantum-mechanical state energetically shifts under the influence of some external perturbation, the effect of a periodic perturbation will show up as side bands. When this shift is linear (e.g. a dipole in an electric field) the population of this side band is described by Bessel-functions. Here we treat the situation that the shift of the state is quadratic under an external perturbation (a polarizable state in an electric field). Now not only the population of the sidebands is a (known but complicated) function of the perturbation, but also the energy of the state and its sidebands is no longer constant. Both the energy and the population of the sidebands are probed by introduction a second state, which is insensitive for the perturbation and that is weakly couple to the first state. This weak coupling is dipole-dipole interaction between two Rydberg atoms. This coupling leads to an avoided crossing between the externally perturbed and the unperturbed states. This particular realization allows for an alternative interpretation of the population of sidebands, in particular of the minima, in terms of Stückelberg oscillations. These oscillations are measured in the sidebands of the resonant interaction between Rb 49s and 41d states with 49p and 42p states and are used to obtain information about the coherent nature of the interaction.

2) Surfaces. In addition we report on the effect of a conducting surface nearby a Rydberg atoms. This issue is particularly relevant in case the conducting surface is an atom chip. The Rydberg atoms are probed by means of electromagnetically induced transparency (EIT) induced in Rb 5s-5p-Rydberg ladder schemes.