Cooperative optical non-linearity in a blockaded rydberg ensemble

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Abstrak

This thesis describes the first demonstration of a cooperative optical non-linearity based on Rydberg excitation. Whereas in conventional non-linear optics the non-linearity arises directly from the interaction between light and matter, in a cooperative process it is mediated by dipole-dipole interactions between light-induced excitations. For excitation to high Rydberg states where the electron is only weakly bound, the dipole-dipole interactions are extremely large and long range, enabling an enormous enhancement of the non-linear effect. Consequently, cooperative non-linear optics using Rydberg excitations opens a new era for quantum optics enabling large single photon non-linearity to be accessible in free space for the first time. The thesis describes the theoretical underpinnings of the non- linear effect, the pioneering experimental results and implications for experiments in the single photon regime.