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Cooperative optical non-linearity using Rydberg atoms

CHARLES ADAMS, Durham University

Strong dipole-dipole interactions between Rydberg atoms result in an energy level spacing that is anharmonic in the photon number (analogous to the strong coupling regime in cavity QED). This anharmonicity scales with the strength of the interactions and hence the interatomic spacing. This gives rise to a cooperative optical response where the state of each atom modifies the behaviour of its nearest neighbours in a significant way. Consequently the optical response becomes a non-linear function of both the incident optical field and the atomic density. We report on the experimental observation of this cooperative optical non-linearity [1] and discuss potential applications to single photon gates.

[1] J. D. Pritchard *et al.* arXiv0911:3523