Exploiting the Photonic Non-linearity of Free Space Subwavelength Arrays of Atoms

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Ordered ensembles of atoms, such as atomic arrays, exhibit distinctive features from their disordered counterpart. In particular, while collective modes in disordered ensembles show a linear optical response, collective subradiant excitations of subwavelength arrays are endowed with an intrinsic non-linearity [1]. Such non-linearity has both a coherent and a dissipative component: two excitations propagating in the array scatter off each other leading to formation of correlations and to emission into free space modes. We show how to take advantage of such non-linearity to coherently prepare a single excitation in a subradiant (dark) collective state of a one dimensional array as well as to perform an entangling operation on dark states of parallel arrays. We discuss the main source of errors represented by disorder introduced by atomic center-of-mass fluctuations, and we propose a practical way to mitigate its effects [2].

References

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