Collective Effects in Dipole-Coupled Quantum Emitters

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Recent studies have shown that sub-wavelength sized rings of quantum emitters possess subradiant eigenmodes which mimic high-Q optical resonators. We add a continuously pumped atom as a gain medium in the ring's center creating a minimalistic coherent light source. The system behaves like a thresholdless laser, featuring a narrow linewidth well below the natural linewidth of the constituent atoms.[1]

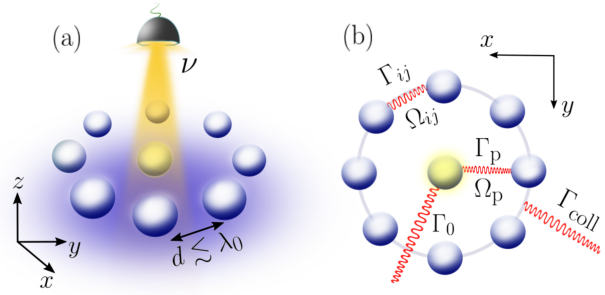

Fig. 1: (a) Illustration of a thresholdless nanoscale laser where the central emitter is incoherently pumped and the ring acts as the cavity. (b) Coherent and dissipative dipole-dipole couplings.

In another work we show that the strong inter-particle dipole coupling creates large energy shifts of the collective delocalized excitations, which generates a highly nonlinear response at the single and few photon level. This allows to implement a nanoscale non-classical light sources via weak coherent illumination.[2] Furthermore we show that by placing an extra resonant absorptive dipole at the ring center, such a structure can become a highly efficient single-photon absorber with tailorable frequency.[3]

References

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