Coupling of a terahertz-cavity to a carbon nanotube quantum dot

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In this work we demonstrate the coupling of the optical mode of a terahertz split ring resonator to the electronic transition in a carbon nanotube-based quantum dot. Studying this kind of coupling lies at the basis of mesoscopic Quantum ElectroDynamics[1], the condensed-matter counterpart of cavity- and circuit-QED[2,3]. Up to now these investigations have focussed on the microwave range, but it comes natural to extend them to the THz, because the characteristic energies of CNT-based quantum dots naturally lie in the terahertz frequency range and offer a way to electronically access the coupled system.[4] Furthermore the terahertz frequency range is fundamental both scientifically and technologically, it being the natural bridge between optics and electronics.[5]

In the presented system, the electronic levels of the quantum dot get dressed by the cavity mode. Such dressing results in a clear signature in the transport, namely a region of suppressed conductance close to zero bias as large as the photon energy, reminiscent of the Frank-Condon blockade effect transposed to photons[6] For a certain parameter range, a level doublet is present additionally, possibly revealing strong coupling with a normalised Rabi splitting of about 10%.[7] These results pave the way towards quantum optics and mesoscopic QED in the THz frequency range. At the same time such system allows more complex fundamental condensed matter studies and is promising as a THz detector.

References

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