Cavity quantum electrodynamics with rare-earth ions in solids

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Stellingen

behorend bij het proefschrift
"Cavity quantum electrodynamics with rare-earth ions in solids"

I. The Fano lineshape increases the slope responsivity maximally by a factor of 1.54 compared to a Lorentzian lineshape with the same quality factor of the resonance. This number is not as significant as many research articles claimed or implied (Chapter 2 of this thesis).

II. Spontaneous emission of dipole emitters can be enhanced by the modified vacuum density of states in an optical structure. Mathematically this enhancement can be decomposed into 1D, 2D, and 3D components, each of which can be calculated by the optical modes in the corresponding dimension (Chapter 4 of this thesis).

III. Rare-earth ions in amorphous materials suffer from decoherence induced by the tunnelling systems at low temperature, which cannot be completely suppressed even at millikelvin and limits practical applications of rare-earth-ion-doped glass for quantum information purposes (Chapter 5 of this thesis).

IV. Pure dephasing, which is generally considered as a detrimental effect for quantum correlation in an ensemble of atoms, can be favourable at certain initial states of atoms (Chapter 6 of this thesis).

V. It is misleading to use responsivity instead of sensitivity as a figure of merit for a sensor (A. C. Ruege and R. M. Reano, *Optics Express* **17**, 4295 (2009)).

VI. The fact that the assumed natural radiative decay lifetime of Er^{3+} in silicon nitride (7 ms) is different from the measured value in an unpatterned film at 3.1 K (3.4 ms) makes the estimated maximum Purcell factor (11–17) unconvincing (Y. Gong *et al.*, *Optics Express* **18**, 2601 (2010)).

VII. The nonlinear low-frequency (∼kHz) dielectric response of glasses at very low temperature might be also present at optical frequencies ($\sim 10^{14}$ Hz) (S. Rogge *et al.*, *Phys. Rev. B* **55**, 11256 (1997)).

VIII. For quantum information science, ensembles of rare-earth ions used as quantum memories are more promising than single rare-earth ions used as quantum bits (C. Clausen *et al.*, *Nature* **469**, 508 (2011) and E. Saglamyurek *et al.*, *ibid.*, 512 (2011)).

IX. Experimentalists should start with quick test experiments with minimal efforts to verify their ideas and to know the experimental requirements before they try to design fully optimized samples and setups.

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