Mechanical coupling of microwave and optical photons

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Abstract

Quantum electromagnetic phenomenon are of both theoretical and practical interest. Quantum phenomenon are more readily observable at high energies where individual photons are well localized. New methods of coherent coupling between optical and microwave systems hold the promise of extending quantum techniques into the microwave regime.

1 Introduction

Coupling between optical and microwave modes creates a new set of experimental techniques to explore the principles of quantum dynamics. The coherent transfer of quantum states may be exploited in applications including quantum-enhanced sensing and quantum computing. Several similar mechanisms for optical/microwave coupling have been reported recently [1, 2].
We will start by reviewing some of the proposed methods for microwave/optical coupling. We then sketch the analytical exploration of the nanomechanical resonator from [2] to demonstrate some important aspects of the approach. A general discussion of applications is followed by a discussion of aspects of quantum illumination applied to radar systems.

2 Optical/Microwave Coupling Methods

Piezoelectric optomechanical crystal.
Mechanical resonator.

3 Analysis of the Mechanical Resonator

Hamiltonian.
Linearized quantum Langevin equations.
Correlation between systems and log-negativity.

4 Applications of coherent optical/microwave coupling

Quanum computing.
Quantum illumination.

5 Discussion of microwave quantum illumination

References

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[2] Sh. Barzanjeh D. Vitali P. Tombesi G.J. Milburn. "Entangling optical and microwave cavity modes by means of a nanomechanical resonator". In: *Annalen der Physik* 322.10 (1905), pp. 891–921. DOI: http://dx.doi.org/10.1002/andp.19053221004.