Non-equilibrium Transitions in Sub/Second Harmonic Generation: Quantum Theory

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ABSTRACT

This article provides a condensed summary and replication of numerical results from a prior theoretical investigation by Drummond *et al.* [1] on a non-linear optical system with a mode coupled to its second harmonic. Within this study, a quantum statistical analysis of coherently driven sub/second harmonic generation within an optical resonator is described. Quantum fluctuations are analyzed through a Fokker-Planck equation employing a generalized Glauber-Sudarshan P-representation. Specifically, the analysis focuses on the fluctuation behavior proximate to instability points as predicted by semiclassical theory. Remarkably, the spectrum of the sub-harmonic field exhibits critical narrowing in close proximity to the threshold, indicative of a second-order phase transition. Additionally, at higher driving field intensities, the sub-harmonic spectrum separate into two distinct peaks. Furthermore, the second harmonic light spectrum demonstrates a similar separation below the threshold for hard mode oscillations. Notably, under certain conditions, the photon statistics of the emitted light may reveal photon antibunching phenomena. This understanding and manipulation of anti-bunched light are crucial for advancing various applications in quantum technology, including secure communication, computing, metrology, and imaging.

Introduction

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References

1. Drummond, P., McNeil, K. & Walls, D. Non-equilibrium transitions in sub/second harmonic generation. *Opt. Acta: Int. J. Opt.* **28**, 211–225 (1981).