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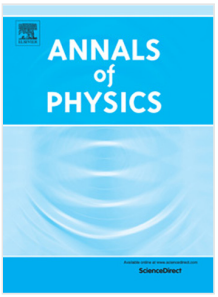

Duality between a dark state and a quasi-dark state

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Duality between A Dark State And A Quasi-Dark State

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Abstract

We study a physical system coupled with two one-mode Bose fields. The physical system is a two-level system or a harmonic oscillator. We prove that each dark and quasi-dark state appears under a proper condition, and then, we derive a duality between the dark state and the quasi-dark state. This duality induces the switch between the dark state and the quasi-dark state.

Keywords: two-level system, dark state, quasi-dark state, duality
42.50.Gy, 42.50.Ct, 03.65.Ge

1. Introduction

Dark states [1] are a significant phenomenon of coherent trapping in quantum optics. The dark state supplies us with important technologies, such as electromagnetically-induced transparency (EIT) [2] and cavity-induced transparency (CIT) [3] for the development of both quantum information and quantum computing. The EIT technologies have been realized even in a solid medium [4, 5]. In addition, EIT using an artificial atom has been proposed in circuit QED [6, 7, 8]. These increase our expectations of possibilities in quantum information and quantum computing. In particular, one of them is for quantum memory [5, 9]. Moreover, as for quantum memory, superconducting qubits coupled with nitrogen-vacancy centers in diamond have been studied extensively [10, 11, 12, 13, 14, 15, 16, 17], and a dark state for such a superconducting qubit has recently been observed in the experiment by Zhu *et al.* [18]. Namely, they show experimental evidence for the existence of an excited state which includes no photon, and therefore, it cannot emit any photon. This is their dark state. Here we pay particular attention to the following. A dark state usually appears for a coherent superposition of a three-level atom in the so-called Λ-configuration coupled with a one-mode