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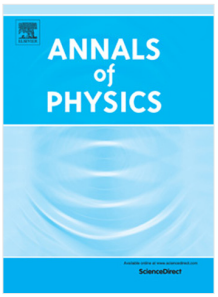

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Aixi Chen, Liujuan Zhang, Li Deng

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Controllable diffraction pattern in semiconductor quantum well based on quantum coherence

Aixi Chen[a,b,c*], Liujuan Zhang[b], Li Deng[a]

[a] *Department of Physics,Zhejiang SCI-TECH University, Hangzhou,310018, China*

[b] *Department of Applied Physics, East China Jiaotong University, Nanchang,330013, China*

[c] *Institute for Quantum Computing, University of Waterloo, Ontario N2L 3G1, Canada*

Abstract：In this paper, we study properties of diffraction of a weak probe field interacting with a symmetric semiconductor quantum well that is coherently manipulated by a standing wave. Based on the theory of quantum coherent and of light diffraction, we can obtain distribution of the diffraction spectra of the probe field. We consider the influences of Kerr nonlinear effect on the diffraction pattern, and studies show the distribution of diffraction pattern can be controlled through choosing appropriate physical parameters of system. Kerr nonlinear effect can enhance the brightness of central pattern and improve the transmission efficiency of the incident beam. A controllable diffraction pattern has potential applications in some areas, such as design of quantum diffractive optical elements, grating imaging system, precision measurement and so on.

Keywords: diffraction pattern; quantum coherent; semiconductor quantum well

1. Introduction

The studies of transmission of radiation field in media is an old and young topic. The reflection, refraction, and absorption and dispersion of radiation field have been well known for people long ago. Recent decades, along with the development of technology of quantum coherent, the theory about interaction of light with matter have become more abundant, and some novel phenomena of quantum coherent have been reported, such as coherent population trapped (CPT) [1], laser without inversion (LWI) [2], electromagnetically induced transparency (EIT) [3，4], and so forth. When the frequency of a weak incident field is the same as the transition frequency between two levels of atom, that is, the resonant condition is satisfied, radiation field is almost absorbed by the media. However, skillfully choosing the structure of levels and adding a strong coherent field, the media can become transparent for the weak incident field even resonantly interacting with the media, which is called EIT. The essence of EIT is that constructive interference and destructive interference for the weak probe field can be manipulated by the strong coherent field. The appearance of EIT has been widely extended. Based on the technology of EIT, researchers proposed the theory about transmission of slow light [5,6], four-wave mixed (FWM) [7,8], and preparation of entangled state [9,10] in atomic systems. Similar phenomena are showed in the semiconductor quantum structure [11-15]. furthermore, under the coupling of coherent standing wave, a three-level atomic medium can be devised as a grating [16], and the diffraction pattern and diffractive efficiency are analyzed and calculated.

In our previous work [17], we investigated phase grating based on phonon induced in quantum dot system in the case of the exciton-phonon interaction. Semiconductor quantum structure, such as

*Corresponding author： *E-mail address:aixichen@zstu.edu.cn*