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1D atom localization via probe absorption spectrum in a four-level cascade-type atomic system

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Abstract We present a simple scheme of atom localization in a subwavelength domain via manipulation of probe absorption spectrum in a four-level atomic system. Due to the joint quantum interference induced by the standing-wave and radio-frequency driving fields, the localization peak position and number as well as the conditional position probability can be controlled by properly adjusting the system parameters. The proposed scheme may provide a promising way to achieve high-precision and high-resolution 1D atom localization.

Keywords Atom localization · Probe absorption spectrum · Four-level atomic system

1 Introduction

During the past few years, the precision position measurement of an atom has been the subject of many recent studies because of its potential wide applications in trapping of neutral atoms, laser cooling (Phillips 1998), and atom nano-lithography (Johnson et al. 1998). Earlier schemes include the measurement of the phase shift of the field inside the cavity (Quadt et al. 1995), the atomic dipole (Kunze et al. 1994), and the entanglement between atom's position and its internal state (Kunze et al. 1997). It is well known that quantum coherence and interference have led to the observation of many useful effects, such as electromagnetically induced transparency (Harris 1997; Scully and Zubairry 1997; Wu and Yang 2005), four-wave mixing (Wu et al. 2003), Kerr nonlinearity (Niu et al. 2005), optical soliton (Wu and Deng 2004; Wu 2005), and so on. Based on atomic coherence and quantum interference, many schemes have been proposed for one-dimensional (Paspalakis and Knight 2001; Kapale and Zubairy 2006; Liu et al. 2006; Xu and Hu 2007; Wang and Jiang 2010) and two-dimensional

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