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论文

三能级原子与少周期脉冲串作用中的相干布居捕获

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摘要:

研究了少周期脉冲串作用下三能级原子中的布居转移和相干布居捕获现象.在非旋波近似的情况下求解了密度矩阵方程.研究结果表明在等时间间隔的锁相脉冲作用下,系统能级的布居逐步转移并积累,系统基态相干也逐步积累.在满足脉冲重复频率为基态能级频差的整数分之一倍时,三能级系统和频率梳中两梳齿频率成分作用形成相干布居捕获现象,原子暗态布居值达到最大,介质对脉冲透明.在适当选取少周期脉冲参量的情况下,在0.5个ns的时间内三能级系统相干性演化到最大后到达稳态,相干布居捕获发生.与脉宽为100个fs的多周期脉冲相比,少周期脉冲串在介质中建立相干布居捕获的时间缩短两个数量级.由于频率梳中与三能级系统发生作用的梳频成份有相同的频移,相干布居捕获的条件双光子共振仍然满足.因而,当两基态能级频率差较大时,如果选取少周期脉冲载波频率为系统能级1至2和1至3的传输频率之和的一半$\omega=(\omega_1+\omega_2)/2$,室温下原子热运动的引起的多普勒频移并不会破坏相干布居捕获.

关键词: 相干布居捕获 少周期脉冲 频率梳 量子相干 非旋波近似

Coherent Population Trapping of a Three-level Atom Interacting with Few Cycle Pulse Train

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Abstract:

The poulation transfer and coherent population trapping of a three-level atom interacting with few cycle pulse train are studied. The density matrix equation in interation picture is numerical solved without rotating wave approximation. The research indicates that if a three-level atom interacts with a few cycle pulse train, the population transfer of level and the coherence of ground state will be gradual accumulated. When the repetition frequency of pulses is integer points of the ground-state splitting, the three atom interacts with pulse train can be seen as the atom interacts with two tenoning frequency of the frequency comb. So the system will be in the dark state and reach coherent population trapping. If the parameters of few-cycle pulse are appropriately selected, the coherence of three-level system will evolute into stable value in 0.5 nanosecond. The coherent population trapping in the three-level is generated. Comparing with the pulse that the pulse width is 100 femtoseconds, the build-up time of coherent population trapping by few cycle pulse train is shortened two orders of magnitude. When the ground-state splitting is wided enough and the carrier frequency of pulse is $\omega=(\omega_1+\omega_2)/2$, where, are the atomic transition frequency, the doppler frequency shift that is aroused by the movement of atom won't destroy the coherent population trapping of atom. The reason is that all tenoning frequencies of the frequency comb have the same frequency shift, so the condition of coherent population trapping is still meeted.

Keywords: Coherent population trapping Few cycle pulse train Frequency comb Quantum coherence Without rotating wave approximation

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