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Self-Trapping State and Atomic Tunnelling Current of an Atomic Bose-Einstein Condensate Interacting with a Laser Field in a Double-Well Potential

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Abstract: We present a theoretical treatment of dynamics of an atomic Bose-Einstein condensation interacting with a single-mode quantized travelling-wave laser field in a double-well potential. When the atom-field system is initially in a coherent state, expressions for the energy exchange between atoms and photons are derived. It is revealed that atoms in the two wells can be in a self-trapping state when the tunnelling frequency satisfies two specific conditions, in which the resonant and far off-resonant cases are included. It is found that there is an alternating current with two different sinusoidal oscillations between the two wells, but no dc characteristic of the atomic tunnelling current occurs. It should be emphasized that when without the laser field, both the population difference and the atomic tunnelling current are only a single oscillation. But they will respectively become a superposition of two oscillations with different oscillatory frequencies in the presence of the laser field. For the two oscillations of the population difference, one always has an increment in the oscillatory frequency, the other can have an increment or a decrease under different cases. These conclusions are also suitable to those of the atomic tunnelling current. As a possible application, by measurement of the atomic tunnelling current between the two wells, the number of Bose-condensed atoms can be evaluated. By properly selecting the laser field, the expected atomic tunnelling current can be obtained too.

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Key words: self-trapping state, atomic tunnelling current, laser field

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