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Quantum Dynamics of a Single Trapped Ion Interacting with Standing Laser Pulses

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Abstract: A classically chaotic system consisting of a Paul trapped ion and a sequences of standing laser pulses is treated quantum-mechanically. Under the circumstance of time-dependence, we derive the transition probability from the ion's motional state n to n', and find, in the first-order approximation, the classically chaotic character disappears. Theoretical analysis and numerical calculations show that by regulating the phase parameter ϕ we can control the transition probability. When ϕ reaches some specific values, the transition from the state n to n' is forbidden and, for some laser periods, resonance occurs, which leads to the corresponding transitions between different motional states. The time-evolution of an initial motional state $|\psi_{z}\rangle$ just over one period is also studied in detail.

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