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Two-photon adiabatic passage for excitation of Rydberg states[1]
SVETLANA MALINOVSKAYA, GENGYUAN LIU, Stevens Institute of Technology, ELENA KUZNETSOVA, ITAMP, Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA — We study the excitation of the Rb atom to a Rydberg state in the blockaded regime and the excitation of two Rb atoms to Rydberg states in the regime of a weak blockade. For a single atom excitation, we describe a technique to realize two-photon adiabatic passage involving $5S_{1/2}$, $5P_{1/2,3/2}$ and the Rydberg state modeled by a three level ladder system. The technique is based on using a pair of linearly chirped pulses, initially detuned off the one-photon resonance and satisfying the two-photon resonance condition at the time of peak pulse intensity. Secondly, we consider the excitation of two atoms to Rydberg states in the presence of dipole-dipole interaction between them. We find that an efficient excitation to the two-atom Rydberg state can be realized with two-photon adiabatic passage using chirped pulses with equal Rabi frequencies and chirp rates. High transfer efficiency can be achieved for pulse Rabi frequencies $\Omega_{p,S} \geq V_{int}$, where $\Omega_{p,S}$ is the Rabi frequency of the pump and Stokes pulses and V_{int} is the Rydberg-Rydberg interaction strength. The use of chirped pulses for performing two-photon transitions has a benefit of passing through the two-photon resonances whose frequencies are known only to a certain level of approximation.

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