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Universal set of single-qubit gates based on geometric phase of electron spin in a quantum dot VLADIMIR MALINOVSKY, SERGEY RUDIN, Army Research Laboratory, 2800 Powder Mill Road, Adelphi, MD 20783 — The electron spin in a single quantum dot is one of the perspective realizations of a qubit for the implementation of a quantum computer. During last decade several control schemes to perform single gate operations on a single quantum dot spin have been reported. We propose a scheme that allows performing ultrafast arbitrary unitary operations on a single qubit. We demonstrate how to use the geometric phase, which the Bloch vector gains along the cyclic path, to prepare an arbitrary state of a single qubit. It is shown that, the geometrical phase is fully controllable by the relative phase between the external fields. Using the analytic expression of the evolution operator for the electron spin in a quantum dot, we propose a scheme to design a universal set of single-qubit gates based solely on the geometrical phase that the qubit state acquires after a cyclic evolution in the parameter space. The scheme is utilizing ultrafast linearly-chirped pulses providing adiabatic excitation of the qubit states and the geometric phase is fully controlled by the relative phase between pulses.

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