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Superadiabatic stimulated Raman passage via synthetic Aharonov-Bohm phases

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We present an implementation of a superadiabatic protocol proposed by Demirplack and Rice and by Sir Michael Berry in a superconducting circuit consisting of a transmon device operated as a qutrit (three-level system). The adiabatic process studied is STIRAP (stimulated Raman adiabatic passage), which in our system is realized by coupling the two transitions by Gaussian microwave pulsed with an appropriate timing [1]. Then, a control Hamiltonian in the subspace of the ground state and the second excited state is created by using a two-photon pulse. The three pulses produce an analog of the Aharonov-Bohm effect in the "internal space" of the qutrit: this results in a synthetic gauge-invariant phase, which can be tuned externally. The control Hamiltonian can be tailored to cancel the nonadiabatic terms, thus achieving superadiabatic transfer of population [2]. In addition, I will show another related experiment in which the transfer is realized by a non-Abelian gate [3].

References:
[1] K.S. Kumar, A. Vepsalainen, S. Danilin, G. S. Paraoanu, Stimulated Raman adiabatic passage in a three-level superconducting circuit. Nature Communications 7, 10628 (2016)
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[3] S. Danilin, A. Vepsäläinen, G. S. Paraoanu, Experimental state control by fast non-Abelian holonomic gates with a superconducting qutrit. Phys. Scr. 93 055101 (2018)

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