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Two-qubit gates with superconducting fluxonium circuits.[1] KONSTANTIN NESTEROV, YINQI CHEN, ZHENYI QI, University of Wisconsin - Madison, IVAN PECHENEZHSKIY, LONG NGUYEN, YEN-HSIANG LIN, AARON SOMOROFF, RAYMOND MENCIA, VLADIMIR MANUCHARYAN, University of Maryland, MAXIM VAVILOV, University of Wisconsin - Madison — The superconducting fluxonium circuit is an artificial atom with a strongly anharmonic spectrum and with selection rules that are not typical for mainstream superconducting qubits. In the "sweet spot", its lowest energy transition has a small frequency and can have a very long coherence time [1], while its next transition has an order of magnitude higher frequency and a large transition matrix element. Therefore, similar to conventional atomic systems, the fluxonium offers a unique advantage of the possibility to use different transitions for memory storage and gate control. In this talk, we discuss various ways to make entangling gates between fluxoniums in the two-qubit system. In one example, a controlled-Z gate is activated by driving a transition leading out of the computational subspace while two qubits are kept at fixed frequencies at their sweet spots [2]. One more possible gate is mediated through a common resonator mode. [1] Long B. Nguyen, Yen-Hsiang Ling, Aaron Somoroff, Raymond Mencia, Nicholas Grabon, Vladimir E. Manucharyan, arXiv:1810.11006 (2018). [2] Konstantin N. Nesterov, Ivan V. Pechenezhskiy, Chen Wang, Vladimir E. Manucharyan, and Maxim G. Vavilov, Phys. Rev. A **98**, 030301 (2018).

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