A hybrid ferromagnetic transmon qubit: the ferro-trasmon

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Magnetic Josephson junctions (MJJs) provide an intriguing playground to explore the interplay between superconductivity and ferromagnetism [1]. A series of fascinating experiments have revealed striking phenomena at the Superconductor/Ferromagnet (S/F) interface, e.g., 0-π phase transition and the generation of spin-triplet correlations, thus paving the way for advances in a wide range of applications from spintronics to superconducting digital electronics [2]. For what concerns the use of MJJs in quantum architectures, because of their intrinsic high dissipation resulting from the metallic nature of standard ferromagnetic barriers, they have been mainly suggested as π -phase shifters [3]. Advances in realizing MJJs by coupling ferromagnetic layers with insulating barriers [4]and by exploiting intrinsic insulating ferromagnetic materials [5]have allowed to engineer MJJs with very low damping, even accessing the macroscopic tunneling quantum regime [6]. The integration of MJJs as active components in quantum circuits has thus gained attention. In Ref. [7], we have proposed a proof-of-concept of a hybrid ferromagnetic transmon qubit, namely the ferro-transmon. The main idea of the ferro-trasmon consists in the use of tunnel MJJs that allows an alternative control of the qubit frequency by means of magnetic field pulses with a significant potential impact on the scalability of superconducting quantum circuits. In this talk, we will present the recent advances in realizing a tunnel MJJs compatible with the circuit outlined above, with a special focus on its dissipation [8]and magnetic properties [9]. Additionally, we will highlight the design, simulations, and preliminary experimental characterization of superconducting lines to provide in-plane magnetic fields, a fundamental step towards the experimental validation of the ferro-transmon design [10].

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