Coherent conversion between 7.5-8.7 GHz and 21.5-25 GHz photons with a two-mode flux-tunable Josephson dipole

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Abstract

Large detuning between a transmon and its readout resonator has been shown to dramatically reduce the occurrence of nonlinear transitions that can bring the qubit out of the computational space [1]. For a standard Al transmon in the 5-7 GHz frequency range, a high-frequency readout resonator can be designed to have 20 GHz of detuning from the qubit. However, commonly used readout electronics and superconducting parametric amplifiers operate in the 7-10 GHz band. In this talk, we experimentally demonstrate the operation of a two-mode flux-tunable Josephson dipole as a coherent frequency converter. The dipole has a low-frequency mode which can be tuned in the 7.2-9.5 GHz band and a high-frequency mode which correlatively tunes in the 21-28 GHz band. By pumping the dipole at the frequency difference between the two modes at different external fluxes, exploiting the strong three-wave-mixing coupling between them, we demonstrate coherent conversion between 7.5-8.7 GHz and 21.5-25 GHz photons. Our converter paves the way for sensing high-frequency superconducting circuits with lower-frequency, standard readout chains.

References

[1] P. D. Kurilovich, T. Connolly, et al. "*High-frequency readout free from transmon multi-excitation resonances*", arXiv:2501.09161