Analog quantum control of magnonic cat states on-a-chip by a superconducting qubit

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Interaction of magnons with microwave and optical photons is a recent rapidly developing fields [1]. In particular, it has been extended to quantum domain, and quantum properties of magnons have been demonstrated. All research on quantum magnonics so far has been concentrated on cavity architectures. Here, we propose to directly and quantum-coherently couple a superconducting transmon qubit to magnons — the quanta of the collective spin excitations, in a nearby magnetic particle, via a superconducting interference device (SQUID). We predict a resonant qubit-magnon exchange and a nonlinear radiation-pressure interaction that are both stronger than dissipation rates and tunable by an external flux bias. We additionally demonstrate a quantum control scheme that generates qubit-magnon entanglement and magnonic Schrödinger cat states with high fidelity [2].

[1] Babak Zare Rameshti, Silvia Viola Kusminskiy, James A. Haigh, Koji Usami, Dany Lachance-Quirion, Yasunobu Nakamura, Can-Ming Hu, Hong X. Tang, Gerrit E. W. Bauer, Yaroslav M. Blanter, arXiv:2106.09312

[2] Marios Kounalakis, Gerrit E. W. Bauer, and Yaroslav M. Blanter, arXiv:2203.11893