Hybrid Quantum Systems Composed of Superconducting Qubits, Nanomechanics, and Transmission Line Metamaterials

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Hybrid quantum interconnects and processor components are likely to play an important role in future scalable quantum communication and computation networks. In this talk, I will outline several nascent ideas for a new type of hybrid system, composed of mechanical elements, superconducting metamaterials, and superconducting qubits, which could be applicable to quantum transduction and memory functions. Before introducing these new ideas, I will start with a summary of recent incipient work at Syracuse that has inspired them. My summary will include a brief overview of efforts in the LaHaye group to investigate interactions between a superconducting transmon qubit and UHF nanomechanical element[1]; as well, I will highlight work conducted concomitantly and independently by the Plourde group to study the mode structure[2] and cQED interactions of a superconducting metamaterial transmission line. The talk will then conclude with an overview of related ideas to utilize qubit-coupled nanoresonator architectures as platforms for quantum simulation[3,4].

[1] F. Rouxinol, Y. Hao, F. Brito, A.O. Caldeira, E.K. Irish, M.D. LaHaye. Nanotechnology 27, 36 (2016).

[2] H. Wang, A.P. Zhuravel, S. Indrajeet, Bruno G. Taketani, M.D. Hutchings, Y. Hao, F. Rouxinol, F.K. Wilhelm, M. LaHaye, A.V. Ustinov, B.L.T. Plourde. arXiv:1812.02579 (Dec. 06, 2018).

[3] J. Lozada-Vera, A. Carrillo, O. P. de Sá Neto, J. Khatibi Moqadam, M. D. LaHaye, M. C. de Oliveira. EPJ Quantum Technology 3, 1 (2016).

[4] F. Tacchino, A. Chiesa, M. D. LaHaye, S. Carretta, and D. Gerace. Phys. Rev. B 97, 214302 (2018).