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Acoustic Models for Atomtronic Circuits[1] TYLER NEELY, GUILLAUME GAUTHIER, University of Queensland, STUART S. SZIGETI, The Australian National University, MATTHEW T. REEVES, MARK BAKER, THOMAS A. BELL, HALINA RUBINSZTEIN-DUNLOP, MATTHEW J. DAVIS, University of Queensland — Atomtronics emerged more than 10 years ago as a framework for enhancing and developing applications of cold- atom technology, such as quantum sensors. Similar to what electrical circuit theory provides to electronics, atomtronics requires simple yet quantitative models that describe fundamental circuit elements. Such models should be able to predict the behavior of relatively simple circuit elements, analogous to capacitors, resistors, and inductors. We study a ^{87}Rb BEC superfluid confined to a highly configurable optical trap that produces a "dumbbell" atomtronic circuit, with two reservoirs connected by a tunable channel. We first examine the behavior of the circuit in response to a small initial chemical potential bias. We demonstrate experimentally and numerically that an approach based on classical acoustic circuit theory, rather than electrical circuit theory, can quantitatively predict the behavior of the circuit. We also study the responses to larger initial chemical potential biases, and compare these with phase-slip models of dissipation. Our work suggests that empirical models of turbulent dynamics in the system, as have been used in classical acoustics, will be needed to fully understand the behavior of atomtronic circuits in these regime.

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