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Performance of an on-chip superconducting circulator for quantum microwave systems[1] BENJAMIN CHAPMAN, ERIC ROSENTHAL, BRADLEY MOORES, JILA, University of Colorado at Boulder, JOSEPH KERCKHOFF, HRL, J. A. B. MATES, G. C. HILTON, L. R. VALE, J. N. ULLOM, National Institute of Standards and Technology, Boulder, KEVIN LALUMERE, ALEXANDRE BLAIS, University of Sherbrooke, K. W. LEHNERT, JILA, University of Colorado at Boulder, National Institute of Standards and Technology, Boulder — Microwave circulators enforce a single propagation direction for signals in an electrical network. Unfortunately, commercial circulators are bulky, lossy, and cannot be integrated close to superconducting circuits because they require strong (˜kOe) magnetic fields produced by permanent magnets. Here we report on the performance of an on-chip, active circulator for superconducting microwave circuits, which uses no permanent magnets. Non-reciprocity is achieved by actively modulating reactive elements around 100 MHz, giving roughly a factor of 50 in the separation between signal and control frequencies, which facilitates filtering. The circulator's active components are dynamically tunable inductors constructed with arrays of dc-SQUIDs in series. Array inductance is tuned by varying the magnetic flux through the SQUIDs with fields weaker than 1 Oe. Although the instantaneous bandwidth of the device is narrow, the operation frequency is tunable between 4 and 8 GHz. This presentation will describe the device's theory of operation and compare its measured performance to design goals.

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Benjamin Chapman
Univ of Colorado - Boulder

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