

Abstract Submitted  
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**Multi-tone response of Nonlinear rf-SQUID metamaterials<sup>1</sup>**

DAIMENG ZHANG, MELISSA TREPANIER, Univ of Maryland-College Park, OLEG MUKHANOV, Hypres Inc., THOMAS ANTONSEN, EDWARD OTT, STEVEN ANLAGE, Univ of Maryland-College Park — We study the multi-tone response over a broad microwave frequency range of a nonlinear superconducting meta-atom and a metamaterial composed of Radio Frequency Superconducting QUantum Interference Devices (rf-SQUIDs). Nonlinearity in the SQUID metamaterial gives rise to large-range tunable resonance via dc/rf magnetic field and temperature [1] [2], it also results in signal mixing through intermodulation distortion (IMD). Our metamaterial responds to multi-frequency signals and generates strong higher order intermodulation signals in a certain range of applied rf power. However, our meta-atom and metamaterial show a reduced third-order IMD generation around the resonance, which is unusual for typical nonlinear systems. The numerical simulation predicts the same IMD gap feature as in experiment. A comprehensive analytical model is applied to explain the phenomena, and methods to enhance, or reduce, intermodulation levels are explored. [1] M. Trepanier, Daimeng Zhang, Oleg Mukhanov, Steven M. Anlage, Phys. Rev. X 3, 041029 (2013). [2] Daimeng Zhang, M. Trepanier, Oleg Mukhanov, Steven. M. Anlage, Anlage, arXiv:1504.08301 (2015).

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Daimeng Zhang  
Univ of Maryland-College Park

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