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**Transparency and Coherence in rf SQUID Metamaterials**[1]
STEVEN ANLAGE, MELISSA TREPANIER, DAIMENG ZHANG, University of Maryland — We have developed active metamaterials capable of quickly tuning their electrical and magnetic responses over a wide frequency range [1]. These metamaterials are based on superconducting elements to form low loss, physically and electrically small, highly tunable structures for fundamental studies of extraordinarily nonlinear media. The meta-atoms are rf superconducting quantum interference devices (SQUIDs) that incorporate the Josephson effect. RF SQUIDs have an inductance which is strongly tunable with dc and rf magnetic fields and currents. The rf SQUID metamaterial is a richly nonlinear effective medium introducing qualitatively new macroscopic quantum phenomena into the metamaterials community, namely magnetic flux quantization and the Josephson effect. The coherent oscillation of the meta-atoms is strongly sensitive to the environment and measurement conditions, and we have developed several strategies to improve the coherence experimentally by exploiting ideas from nonlinear dynamics [2]. The metamaterials also display a unique form of transparency whose development can be manipulated through multiple parametric dependences [3]. We discuss these qualitatively new metamaterial phenomena. [1] Melissa Trepanier, *et al.*, Phys. Rev. X 3, 041029 (2013). [2] Melissa Trepanier, *et al.*, in preparation. [3] Daimeng Zhang, *et al.*, Phys. Rev. X (in press). arXiv:1504.08301

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