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Superconducting metamaterial resonators: analysis of mode structure HAOZHI WANG, MATTHEW HUTCHINGS, SAGAR INDRAJEET, FRANCISCO ROUXINOL, MATTHEW LAHAYE, B.L.T. PLOURDE, Syracuse University, BRUNO G. TAKETANI, FRANK K. WILHELM, Saarland University, ALEXANDER ZHURAVEL, B. Verkin Institute for Low Temperature Physics Engineering, National Academy of Sciences of Ukraine, ALEXEY USTINOV, Karlsruhe Institute of Technology and Russian Quantum Center, National University of Science and Technology MISIS — Metamaterial transmission line resonators fabricated from superconducting thin films exhibit novel mode spectra that can be used for multi-mode experiments with superconducting qubits. For certain configurations of the circuit elements, these structures have a dispersion relation that is a falling function of wavenumber, leading to a high density of narrow modes in the typical frequency range of transmon qubits. We present Laser Scanning Microscope images of the microwave current distribution while driving the various metamaterial resonances and we compare these with numerical simulations of the microwave behavior of these structures, including the effects of stray reactances in the circuit elements. We demonstrate that the wavelength of the metamaterial modes in fact grows with increasing frequency, characteristic of a left-handed system.

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