Superconducting Metamaterials

P. Jung[1], S. Butz[1], N. Maleeva[1,2], A. Averkin[2], N. Abramov[2], K. Shulga[2,3],
V. P. Koshelets[2,4], L. V. Filippenko[2,4], V. Chichkov[2], A. Karpov[2], S. V. Shitov[2,4],
V. V. Ryazanov[2,3], and A. V. Ustinov[1,2,3]

[1]Karlsruhe Institute of Technology (KIT), Germany
[2]National University of Science and Technology (MISiS), Moscow, Russia
[3]Russian Quantum Center (RQC), Moscow, Russia
[4]Kotel'nikov Institute of Radio Engineering and Electronics (IREE), Moscow, Russia

E-mail: Alexey Ustinov

Abstract — Metamaterials are artificial engineered media that enable tailored interactions with electromagnetic waves. The design flexibility of superconducting thin-film resonators and Josephson circuits allows for utilizing small structures down to the nanoscal while maintaining low loss properties, very strong and well-controlled nonlinearity, and frequency tunability in the microwave and mm-wave frequency ranges. An interesting spin-off here is going to be quantum metamaterials comprised of arrays of superconducting qubits.

Keywords (Index Terms) — Metamaterials, meta-atoms, Josephson junctions, SQUIDs, qubits, superconducting resonators, cloaking.