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Microwave characterization of Josephson junctions arrays for Coulomb blockade VLADIMIR MANUCHARYAN, MICHAEL METCALFE, R. VIJAY, ETIENNE BOAKNIN, MICHEL DEVORET, Yale Applied Physics — Coulomb Blockade of a single Josephson junction leads to oscillations in time of the voltage across the junction when a DC electrical current is applied. Because the frequency f of these so-called Bloch oscillations is related to the current I only through the charge $2e$ of a Cooper pair, $f = I/2e$, the phenomenon can be utilized to build a primary standard of electrical current. However, to reach the regime of Coulomb blockade, the current must be applied to the junction through the leads with electromagnetic impedance exceeding the quantum of resistance for Cooper pairs (6.5 kΩ) at frequencies $\omega_c \approx \hbar/E_c$, E_c being the charging energy of the junction. For typical parameters ω_c lies in the microwave domain, where electromagnetic impedances tend to be of the order of the free space impedance (377 Ω). This fundamental mismatch in the impedance turns the realization of a current standard based on Bloch oscillations into a very challenging problem. Our proposal is to use kinetic impedance of a superconductor, namely, the Josephson inductance. We have fabricated arrays of large Josephson junctions which are superconducting at DC and characterized them at microwave frequencies. Our results indicate that these arrays are capable of beating the impedance quantum and we are setting up an experiment on electrical current metrology.

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