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Exploring Ultrastrong Coupling Effects Using a Josephson Mixer
DANIJELA MARKOVI, Ecole Normale Suprieure — We use the Josephson Ring Modulator (JRM) to demonstrate new signatures of the ultrastrong coupling between two bosonic modes. The JRM implements a three wave mixer between two microwave modes a and b. When pumping the JRM at a red (blue) frequency $f_R^{(0)} = f_a - f_b$ ($f_B^{(0)} = f_a + f_b$), we realize frequency conversion between modes at a rate G_R (two mode squeezing at a rate G_B). The effective ultrastrong coupling is obtained when the JRM is pumped by these two tones simultaneously so that $G_B = G_R$ is larger than the relaxation rate of the modes a and b. We reach this regime by weakly coupling the modes of a Josephson mixer to measurement transmission lines compared to the rates $G_{B,R}$. By detuning the blue pump at a frequency $f_B = f_B^{(0)} + 2\delta$, two peaks appear in the spectral density of each mode output, separated by 2δ. A key signature of ultrastrong coupling corresponds to the splitting of each of these peaks in two other peaks whose separation is set by G_R. We present preliminary experimental results that demonstrate this behavior and reach the regime where a strong (20 dB) peak appears in the spectral density of each mode output at $G_R = G_B = \delta/2$. We should be able to demonstrate both two-mode and single mode squeezing.

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