Coherent microwave comb generation by Josephson effect

Alessandro Crippa
A. Greco, X. Ballu, F. Giazotto

NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, I-56127, Pisa, Italy

alessandro.crippa@cnr.it

Frequency combs represent an exceptionally precise measurement tool owing to the coherence of their spectral lines, as recognized by the Nobel Prize in Physics 2005. While miniaturizing optical frequency comb sources poses significant challenges [1], superconducting circuits provide a promising on-chip platform for low-dissipation comb emitters able to cover frequency ranges from gigahertz to terahertz. Here, I shall discuss coherent microwave frequency comb generation by leveraging the well-known ac Josephson effect in a double-junction superconducting quantum interference device (dc SQUID, Fig. 1) [2]. Under a properly time-dependent magnetic drive, the device generates a train of voltage pulses equally spaced in time, which correspond to a comb with tens of harmonics in the frequency domain. The absence of a cavity imposes no limitations on the generated spectrum bandwidth and does not hinder the coherence of the emitted modes, which exceeds seconds (Fig. 2). The SQUID micrometer-scale footprint, combined with the low dissipation intrinsic of superconducting systems, enable efficient integration into today's cryogenic electronics with applications for many solid-state quantum technologies.

Figures

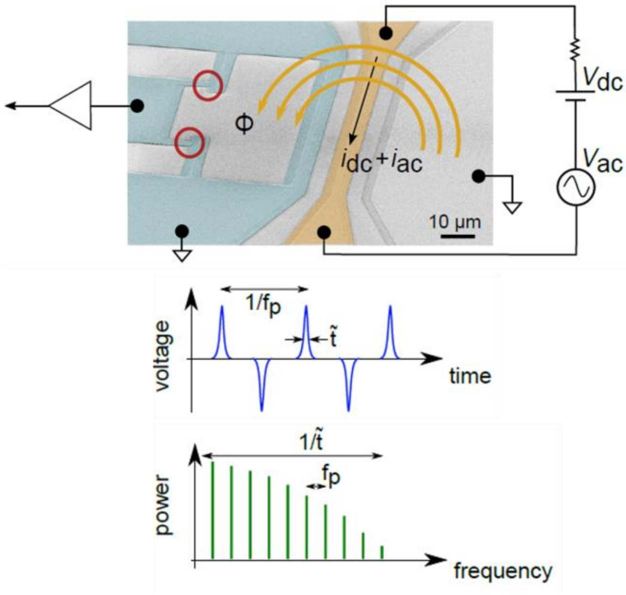

Figure 1: Device layout and working principle of the comb source, which generates a train of evenly spaced voltage pulses.

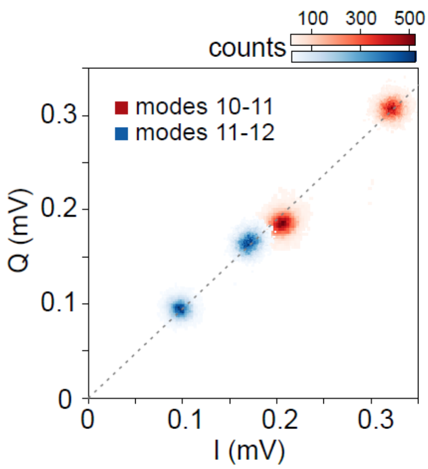

Figure 2: IQ histograms of two mode pairs, showing a mutual coherence over 10 seconds.

References

[1] N. Picqué and T. W. Hansch, Nature Photonics 13, 146 (2019)198
[2] A. Greco, X. Ballu, F. Giazotto, and A. Crippa (preprint soon available)