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Intrinsic line shape of electromagnetic radiation from a stack of intrinsic Josephson junctions synchronized by an internal cavity resonance[1]

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Stacks of intrinsic Josephson-junctions are realized in mesas fabricated out of layered superconducting single crystals, such as $Bi_2Sr_2CaCu_2O_8$ (BSCCO). Synchronization of phase oscillations in different junctions can be facilitated by the coupling to the internal cavity mode leading to powerful and coherent electromagnetic radiation in the terahertz frequency range. An important characteristic of this radiation is the shape of the emission line. A finite line width appears due to different noise sources leading to phase diffusion. We investigated the intrinsic line shape caused by the thermal noise for a mesa fabricated on the top of a BSCCO single crystal. In the ideal case of fully synchronized stack the finite line width is coming from two main contributions, the quasiparticle-current noise inside the mesa and the fluctuating radiation in the base crystal. We compute both contributions and conclude that for realistic mesa's parameters the second mechanism typically dominates. The role of the cavity quality factor in the emission line spectrum is clarified. Analytical results were verified by numerical simulations. In real mesa structures part of the stack may not be synchronized and chaotic dynamics of unsynchronized junctions may determine the real line width.

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