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Radiation Due to Josephson Oscillations in Layered Superconductors.[1]

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The power of direct tunable radiation into free space induced by Josephson oscillations in intrinsic Josephson junctions of highly anisotropic layered superconductors is derived. The super-radiation regime in a current biased crystal is considered when no dc magnetic field is applied. It is assumed that crystal is cut in the form of thin plate parallel to the ac-plane with the thickness of several microns along the b-axis and length of several hundreds microns along the a-axis. At large number of intrinsic junctions oscillations in such BSCCO crystal are synchronized providing high radiation power proportional to squared number of junctions and high efficiency up to 1/3 in the THz frequency range. The radiation correction to the current-voltage characteristic in this regime depends only on crystal shape. When the ac-edge of such a crystal is irradiated by external electromagnetic wave, radiation from both ac-edges of the crystal is enhanced (stimulated radiation) at higher-current part of the Shapiro step. The main part of extra radiation is in the direction opposite to incident wave. This effect of stimulated radiation may be used for amplification of electromagnetic waves. BSCCO crystal with modulated critical current and length several tens microns along the b-axis also provides high THz-radiation power from the ac-edges at discrete Josephson frequencies corresponding to the crystal thickness along the b- axis. Enhancement of radiation power in this case is due to Fiske resonances and super-radiation regime. The powerfuI almost standing electromagnetic wave is excited inside the crystal in the resonance. This wave is homogeneous across the layers meaning that the oscillations are synchronized in all junctions in the stack. In this situation the synchronization of radiation in different junctions is enforced by both super-radiation regime and similar critical current profile in all junctions of the crystal.

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