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Title:Multi-scale simulation for terahertz wave emission from the intrinsic Josephson junctions
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Abstract:A numerical method applicable to the analysis of the multi-scale electromagnetic (EM) excitations in intrinsic Josephson junctions (IJJs) is presented. Using this method, we investigate the EM wave emission from the IJJs observed in Bi<inf>2</inf>Sr<inf>2</inf>CaCu<inf>2</inf>O<inf>8</inf> mesas. The IJJs have three length scales that are greatly different in magnitude, i.e.the distance between superconducting layers (d ∼ 10⁻³νm), the Josephson length (λ<inf>J</inf> ∼ 1νm) and the c-axis penetration depth (λ<inf>c</inf> ∼ 10²νm). The EM field excited in the IJJs generally shows spatial variation of these three length scales at the same time. In our numerical method the coupled dynamical equations for the phase differences and the EM field can be solved simultaneously in all the scales in the whole space composed of the IJJs and the surrounding vacuum. We clarify that the spatial symmetry of the EM field excited at the resonance with the π-cavity-mode is different from that with the 2π-cavity-mode. The strong EM wave emission originating from the π-cavity-mode resonance takes place in the region where the uniform branch becomes unstable in the I-V characteristics. © 2011 IOP Publishing Ltd.