THz-Wave Emission from Inner I-V Branches of Intrinsic Josephson Junctions in $Bi_2Sr_2CaCu_2O_{8+\delta}$

M. Tsujimoto[a, b], T. Yamamoto[a], K. Delfanazari[a], R. Nakayama[a], N. Orita[a], T. Koike[a], K. Deguchi[a], T. Kashiwagi[a], H. Minami[a], and K. Kadowaki[a]

[a]Graduate School of Pure and Applied Sciences, University of Tsukuba, CREST-JST, WPI-MANA, Japan
[b]Research Fellow of the Japan Society for the Promotion of Science (JSPS), Tokyo, Japan

Intense and coherent terahertz electromagnetic wave (THz-wave) emission from intrinsic Josephson junctions (IJJ's) in single crystalline high-T_c superconductor $Bi_2Sr_2CaCu_2O_{8+\delta}$ was reported in 2007[1], where we have studied only the outermost I-V curve in multiple branching I-V structures. In order to further investigate the phenomenon, we traced the whole I-V branches by sweeping the source voltage and got into the inner I-V branch by increasing the current in the return branching region. By examining inner branches, the observed frequencies spread more widely than expected from the geometrical resonance condition. Although the widely spreading emission frequency may indicate the violation of the cavity resonance condition for the strong emission, the ac-Josephson effect is found to be still satisfied, in which the voltage v applied to an individual IJJ is proportional to the Josephson frequency f_J: $f_J = 2|e|v/h$, where e is the electron charge and h is Planck's constant. This emphasizes that the ac-Josephson effect plays a dominant role for the THz-wave emission.

[1]L. Ozyuzer *et al.*, Science **318**, 1291 (2007).