

Petahertz charge dynamics in an organic superconductor

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Recent advances of ultrafast laser technologies and quantum materials open non-perturbative manipulations of correlated electron systems [1-3]. Thus, a strong light-field enables us to expect realization of a new class of photoinduced nonlinear charge motions which are different from the conventional regime. Here, we would like to discuss stimulated emission driven by coherently synchronized charge motion and second harmonic generation (SHG) induced by no scattering light-currents in a centrosymmetric organic superconductor κ -(ET)₂Cu[N(CN)₂]₂Br.

i) A nonlinear charge oscillation driven by a nearly single-cycle strong electric field of >10 MV cm⁻¹ is observed as a stimulated emission. The charge oscillation is different from a linear response and ascribed to a polar charge oscillation with a period of ~ 6 fs. This nonlinear polar charge oscillation is enhanced by critical fluctuations near a superconducting transition temperature and a critical end-point of first-order Mott transitions. Its observation on an ultrafast timescale of ~ 10 fs clarifies that Coulomb repulsion plays an essential role in the superconductivity of organic superconductors[4].

ii) SHG is observed in centrosymmetric organic superconductor κ -(ET)₂Cu[N(CN)₂]₂Br by using a single-cycle 6 femtosecond near infrared pulse, which is in contrast to the perturbation theory where even harmonics are forbidden in centrosymmetric systems. The SHG shows a CEP sensitive nature and an enhancement near the superconducting temperature. The result and its quantum many-body analysis indicate that a polarized current is induced by non-dissipative acceleration of charge, which is amplified by superconducting fluctuations [5].

These studies have been performed in collaboration with Y. Kawakami, H. Itoh, T. Amano, S. Ishihara (Tohoku Univ.), T. Sasaki (IMR, Tohoku Univ.), Y. Nakamura, H. Kishida (Nagoya Univ.), G. Kawaguchi, H.M. Yamamoto (IMS), K. Yonemitsu (Chuo Univ.).

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