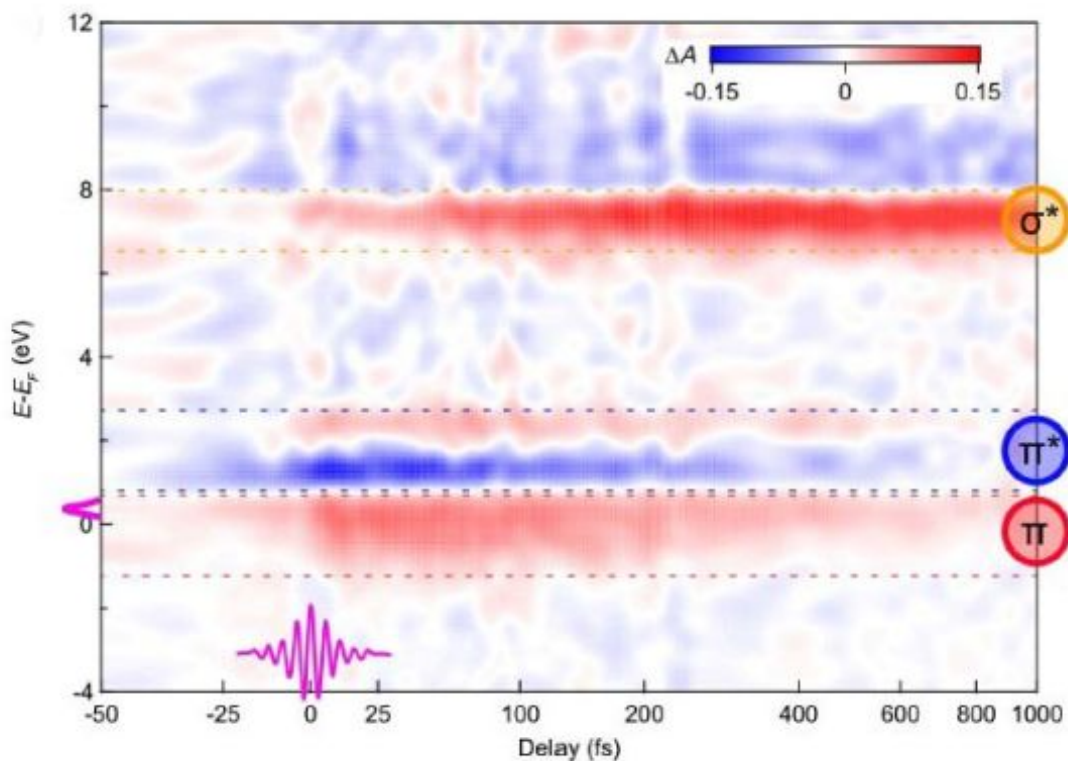




Real-time imaging of the flow of energy inside a material between light, charge carriers and lattice

Attosecond core-level x-ray spectroscopy reveals the energy conversion between light, charge carriers and lattice in graphite.

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A new methodology which employs attosecond core-level x-ray spectroscopy was shown to reveal the energy conversion pathways between photons, charge carriers (electrons and holes), and the atomic lattice of a material in real time. The challenge to overcome was the correlated and time-overlapping dynamic signatures of the various material sub-systems.

In a recent study published in *Physical Review X*, the group of **ICREA Prof. at ICFO Jens Biegert** with collaborators from **Universität Kassel, Fritz Haber Institute of the Max Planck Society, Universität Göttingen, Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie, Max-Planck-Institut für Mikrostrukturphysik, and Institut Neel** t **Université Grenoble Alpes (CNRS)** developed and applied attosecond soft X-ray absorption

fine-structure (XAFS) spectroscopy to reveal the coherent excitation and dephasing of all material sub-systems in graphite. X-ray absorption fine-structure spectroscopy is a powerful technique that provides electronic as well as structural and chemical information of materials with atomic resolution. attoXAFS revealed the complete flow of excitation across the photon-carrier-lattice system and resolved outstanding questions pertaining to the scattering mechanisms for both carrier types, and it settled the role of dephasing via strongly coupled optical phonons.

The results of the study prove and confirm the usefulness of core-level XANES with attosecond temporal resolution to achieve an unprecedented view on the temporal evolution of the photon-carrier-phonon system with surprising new results even for a seemingly well-studied system like graphite. It will be exciting to apply the method to questions in light-harvesting, organic electronic and energy storage systems, or even non-equilibrium multi-body physics such as phases transitions and superconductivity.