Optically-enhanced superconductivity in high magnetic fields

D. Nicoletti[1], D. Fu[1], O. Mehio[1], S. Moore[1], A. Disa[1], G. D. Gu[2], A. Cavalleri[1,3]
[1]*Max Planck Institute for the Structure and Dynamics of Matter, Hamburg, Germany*
[2] *Brookhaven National Laboratories, Upton, NY, United States*
[3]*Department of Physics, Clarendon Laboratory, University of Oxford, Oxford, UK*

Email: daniele.nicoletti@mpsd.mpg.de

In the high-T_C cuprate $La_{2-x}Ba_xCuO_4$, superconducting interlayer coupling is highly quenched at equilibrium by the presence of charge- and spin-order (the so-called *stripes*), for compositions close to x = 1/8 [1]. Excitation with near-infrared (1.5 eV) laser pulses polarized perpendicular to the superconducting planes (along the *c* axis) has been shown to transiently revive this coupling, as evidenced by a blue-shift of the Josephson Plasma Resonance (JPR) in the terahertz reflectivity [2]. This effect is particularly strong in $La_{1.885}Ba_{0.115}CuO_4$, for which a 3D superconducting response can be optically induced above T_C = 13 K, all the way up to the spin-ordering temperature $T_{SO} \simeq$ 40 K [2].
Here we investigate how such optically enhanced (induced) superconducting state reacts to the presence of a strong magnetic field (up to 7 Tesla), applied along the *c* axis. A 7 T field in this geometry is known to stabilize stripe order at equilibrium [3] and to effectively decouple the superconducting planes, thus depleting the interlayer superfluid stiffness [4].
Our experiment reveals that the transient superconductor behaves very differently from the equilibrium one, showing enhanced coherence in presence of magnetic field, as well as a longer lifetime [5]. This is evidenced, for example, by the dynamical evolution of the frequency-dependent energy loss function in Figure, which shows for all time delays a stronger and sharper JPR peak in the measurement taken at 7 T with respect to that at zero field [5].
The observations reported here suggest that transient superconductivity in $La_{2-x}Ba_xCuO_4$ may not be just a consequence of optical melting of stripes and could instead be originated by some excited state of in-plane superconducting stripes (the so-called *pair-density-waves*). As for the stripes, such new entity would be in competition with equilibrium 3D superconductivity and get stabilized by an external magnetic field. Additional effort is needed, however, in order to fully understand how the magnetic field directly affects the photo-physics of this material and concurs in enhancing its superconducting coherence.

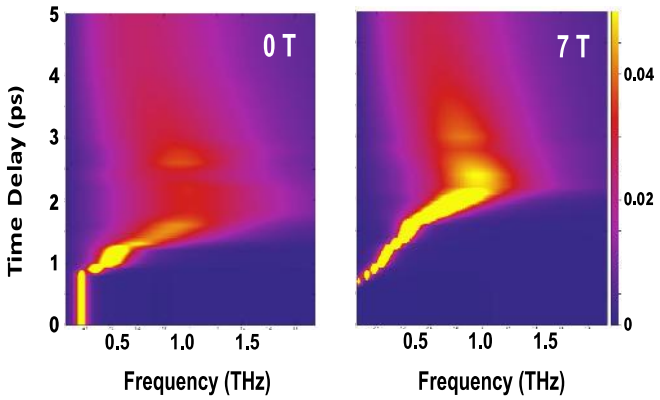

Figure. Frequency and time-delay-dependent energy loss function of photo-stimulated $La_{1.885}Ba_{0.115}CuO_4$, measured at T = 5 K in absence (left) and in presence (right) of a 7 T magnetic field oriented along the *c* axis.

References

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