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Non-equilibrium superconductivity in light-stimulated YBa2Cu3Ox

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Using femtosecond mid-infrared pulses, we demonstrate that a photoinduced non-equilibrium superconducting state can be generated in underdoped YBa2Cu3Ox above Tc. Pumping nearly resonant to the Cu-O phonon mode at 15.8 micron along the c-axis (perpendicular to the Cu-O layers) establishes phase coherence throughout the pseudogap region of the phase diagram. The transient response at three doping levels (x = 6.5, 6.6, 7) was fully characterized using THz time-domain spectroscopy at temperatures ranging from below Tc to room temperature.

We measure the non-equilibrium superconducting state in two different ways: First, probing in-plane (along the a-axis) reveals a London-like inverse frequency dependence in the imaginary part of the conductivity which has a lifetime in the 20 ps range. Second, probing perpendicular to the Cu-O planes (along the c-axis) shows evidence of the so-called Josephson plasma resonance, which arises in the superconducting state of cuprates due to a tunneling current of Cooper pairs between the layers.

These results offer a new perspective on condensate formation in high temperature superconductors. The photoinduced non-equilibrium state will be discussed in the context of pre-formed pairs in the pseudogap phase.

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