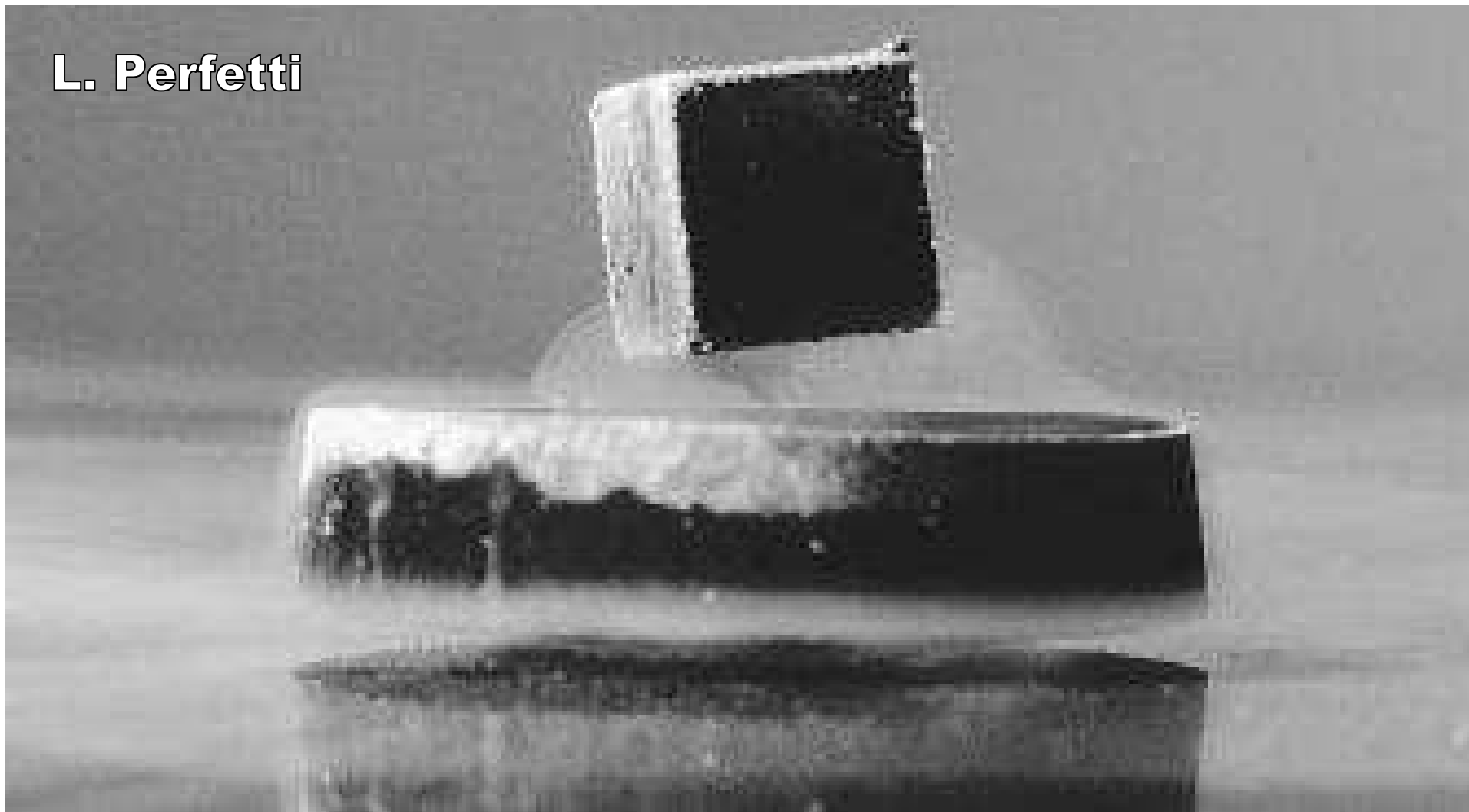
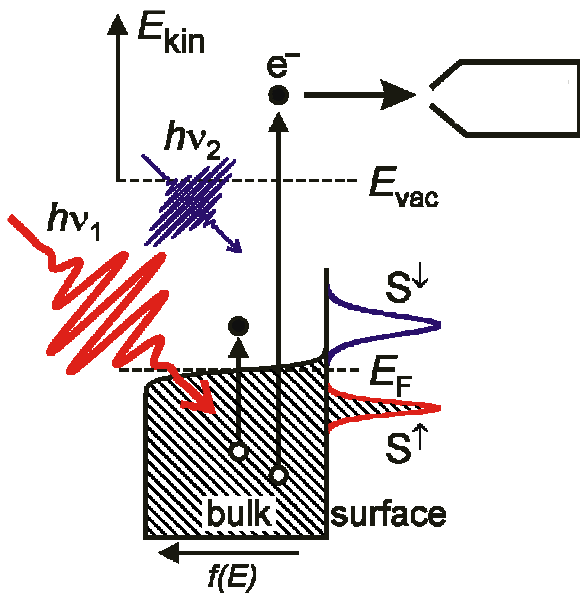
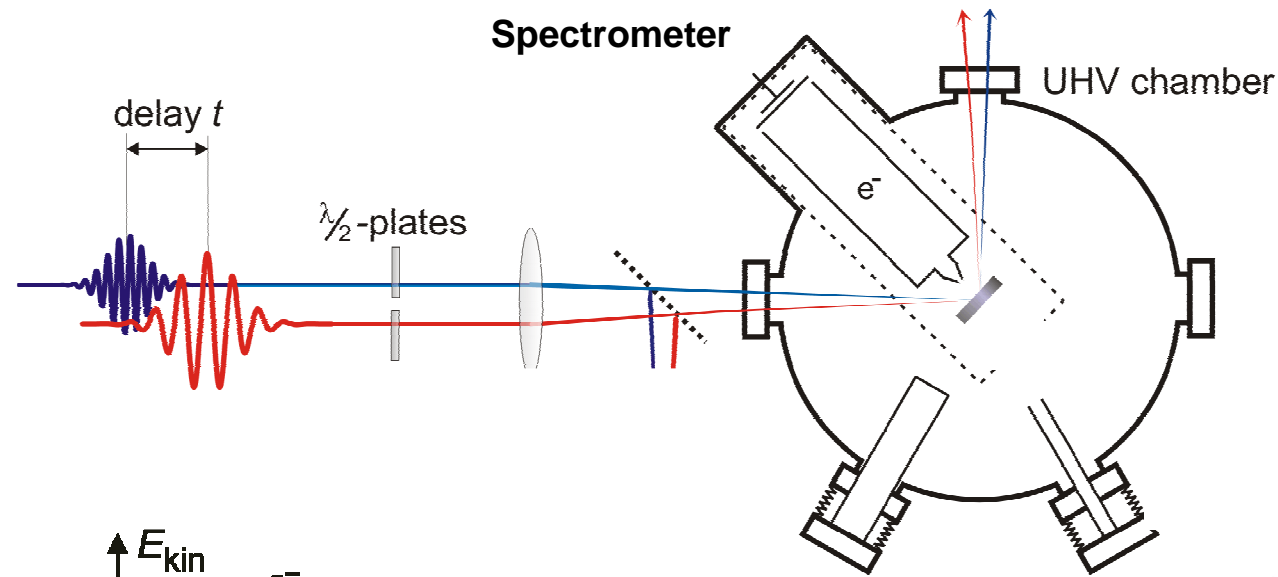


TR-ARPES on high correlated materials

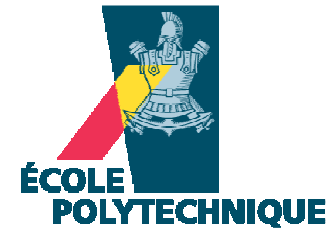
L. Perfetti



Time-resolved photoemission with fs-pulses



FemtoARPES



Light Source

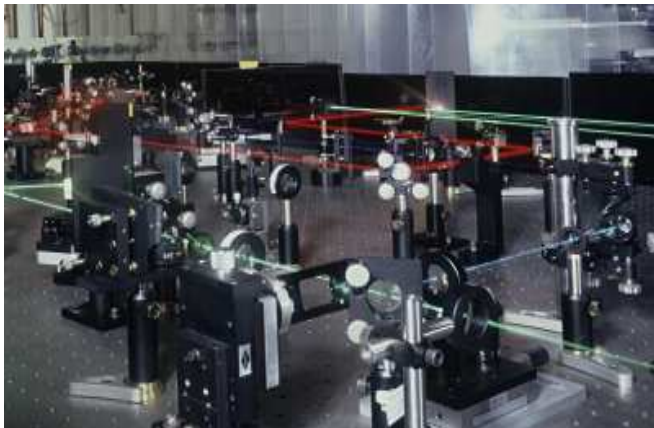
Pulses shorter than 100 fs

Repetition rate higher than 10 KHz

Pulse intensity of 10^9 photons

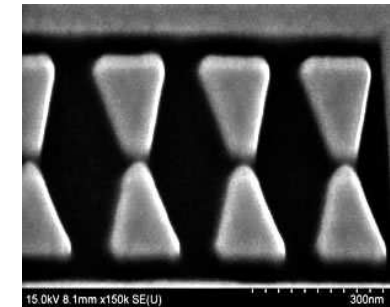
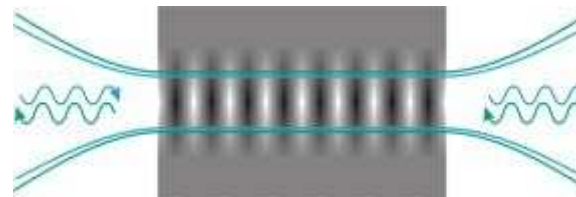
Photon energy higher than 6 eV

High pulse stability

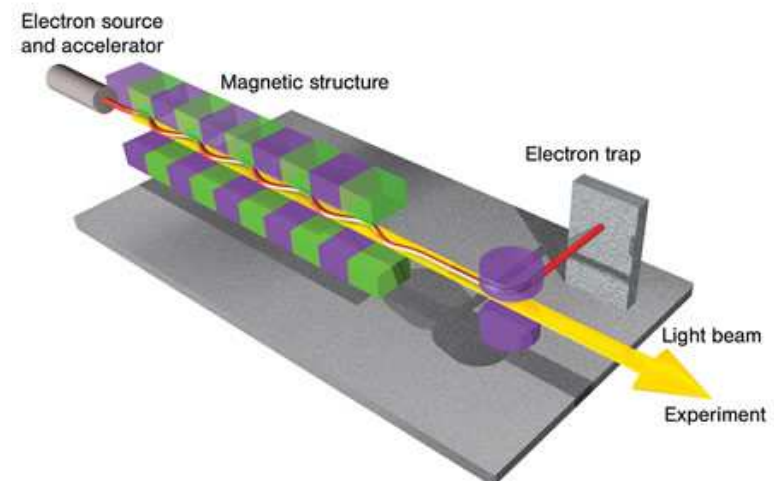


Future developments

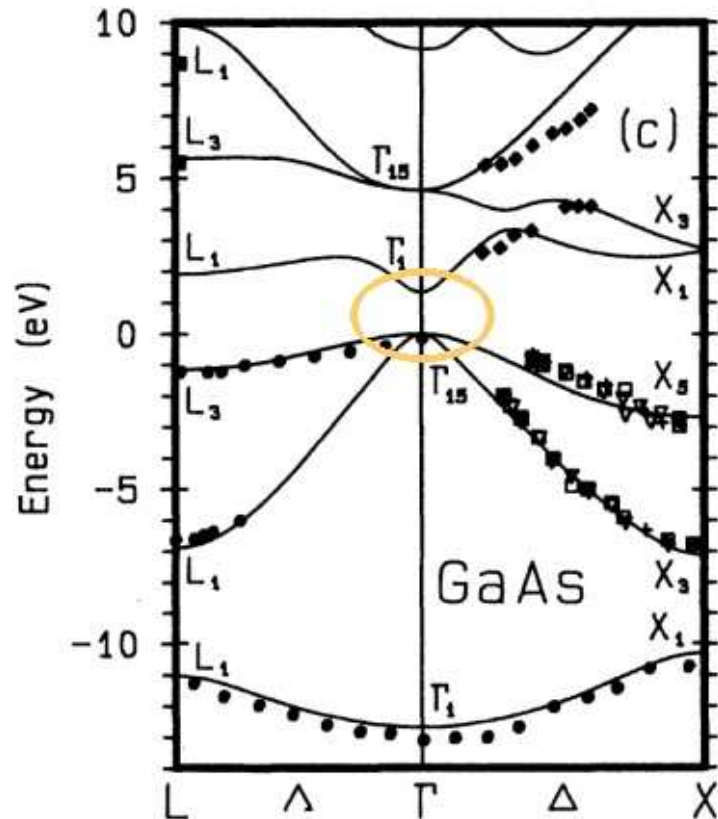
High Harmonics Generation



Free electrons Laser



Time resolved photoemission on high correlated materials

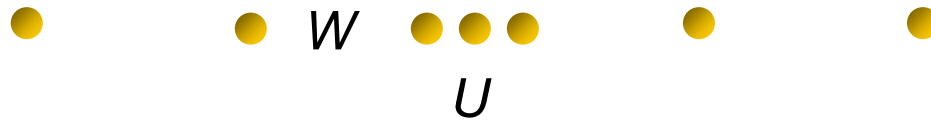
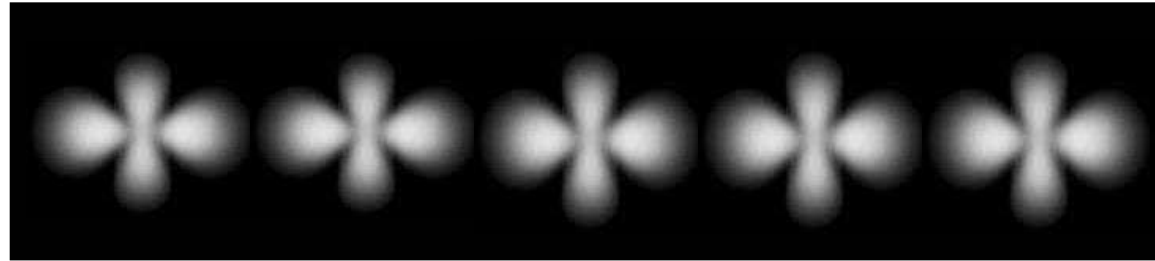


Observation of the electronic states out of equilibrium

Correlated materials have entangled interactions

Different dynamics of the electrons and lattice

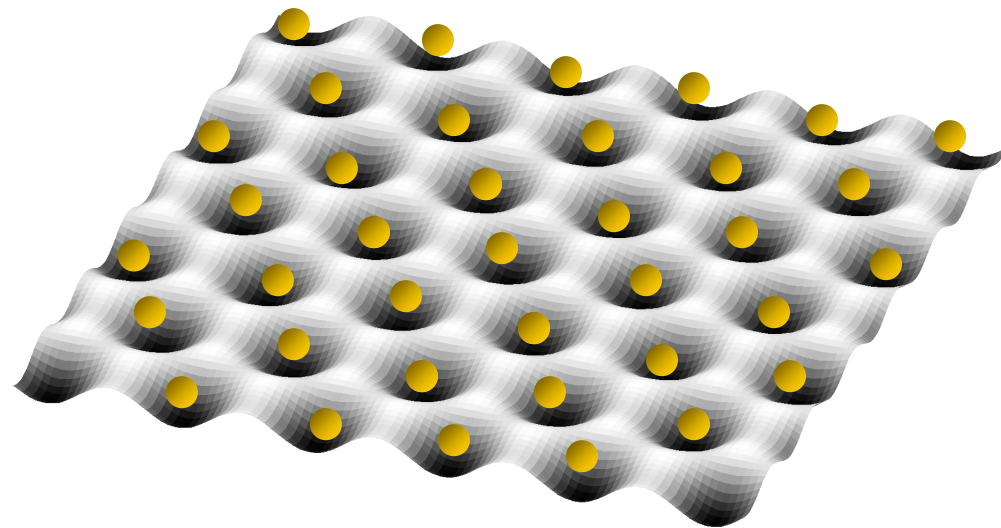
A purely electronic phenomenon: the Mott transition

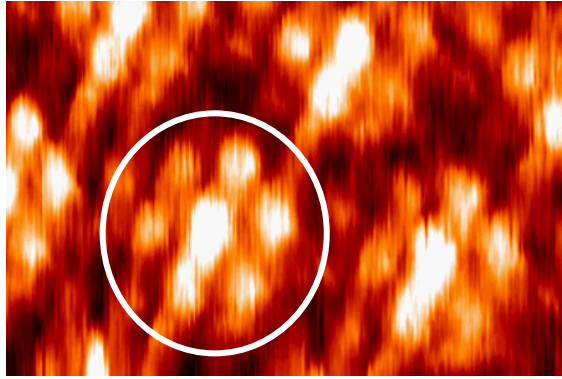


W bandwidth
 U Coulomb repulsion

$$U/W > 1$$

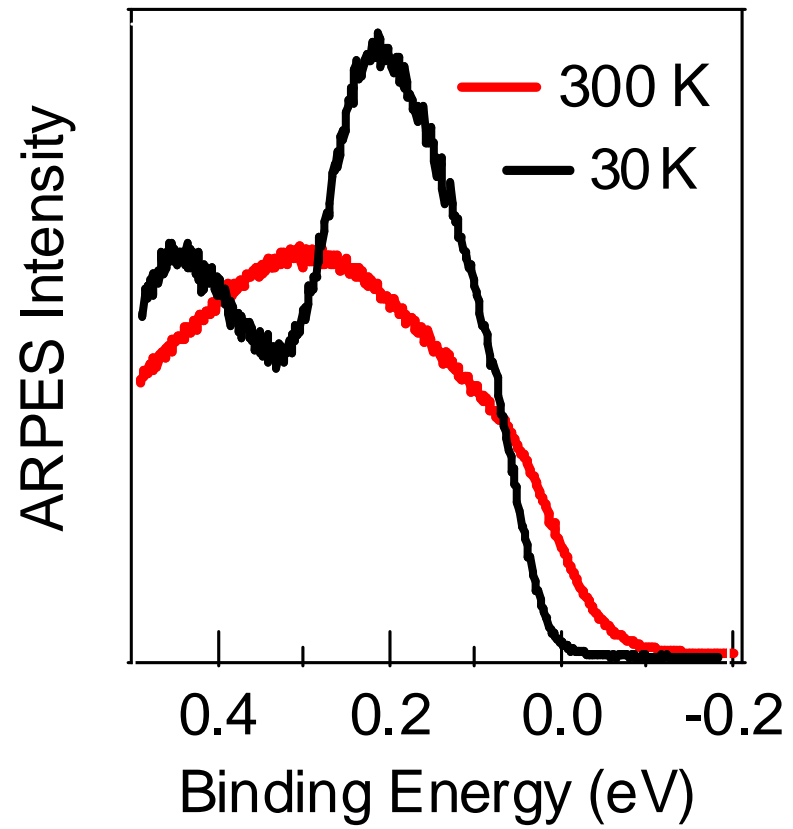
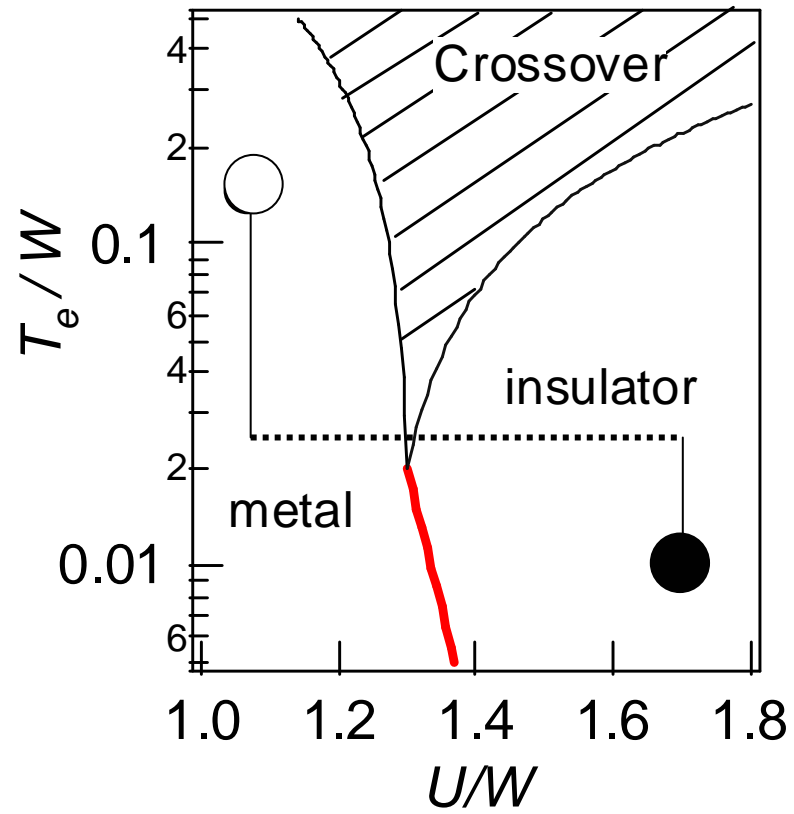
Mott transition

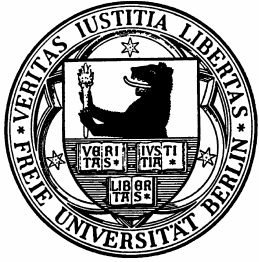




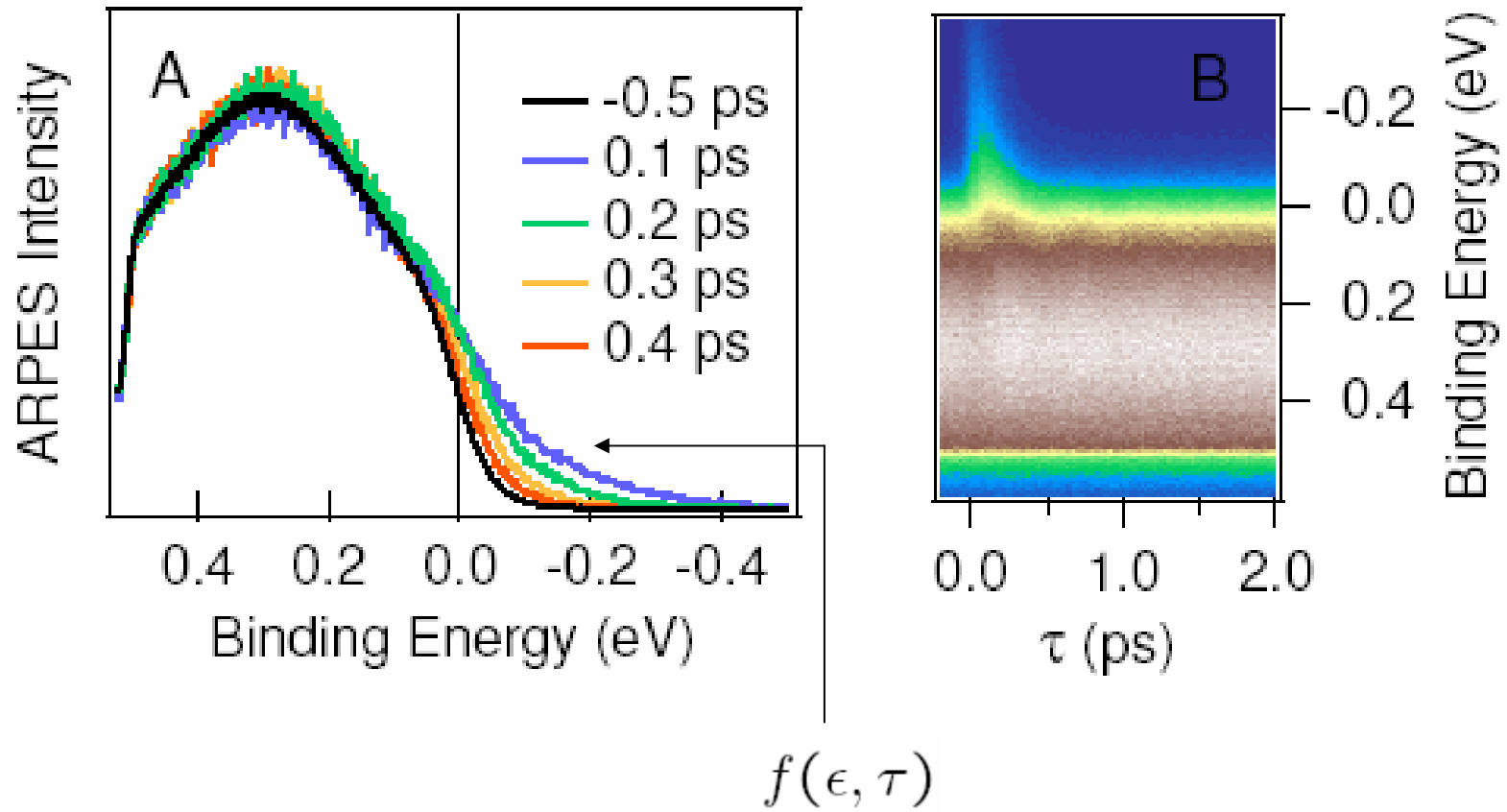
1T-TaS₂

Bandwidth controlled
Metal-insulator transition





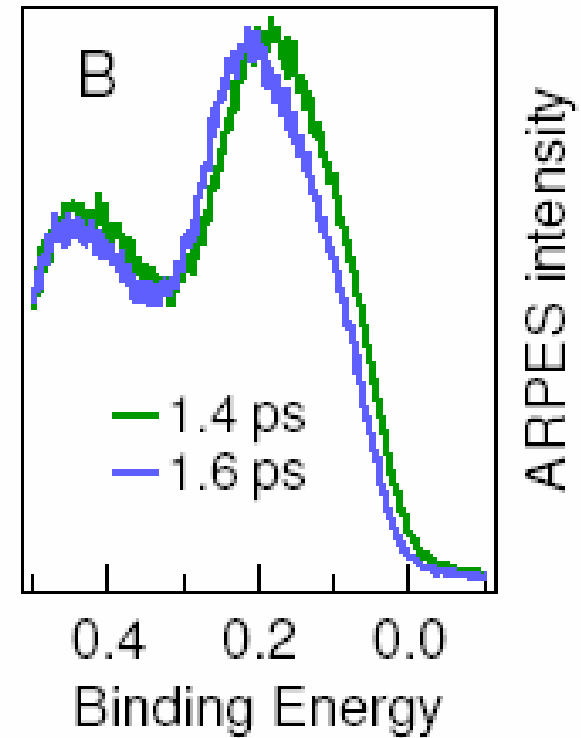
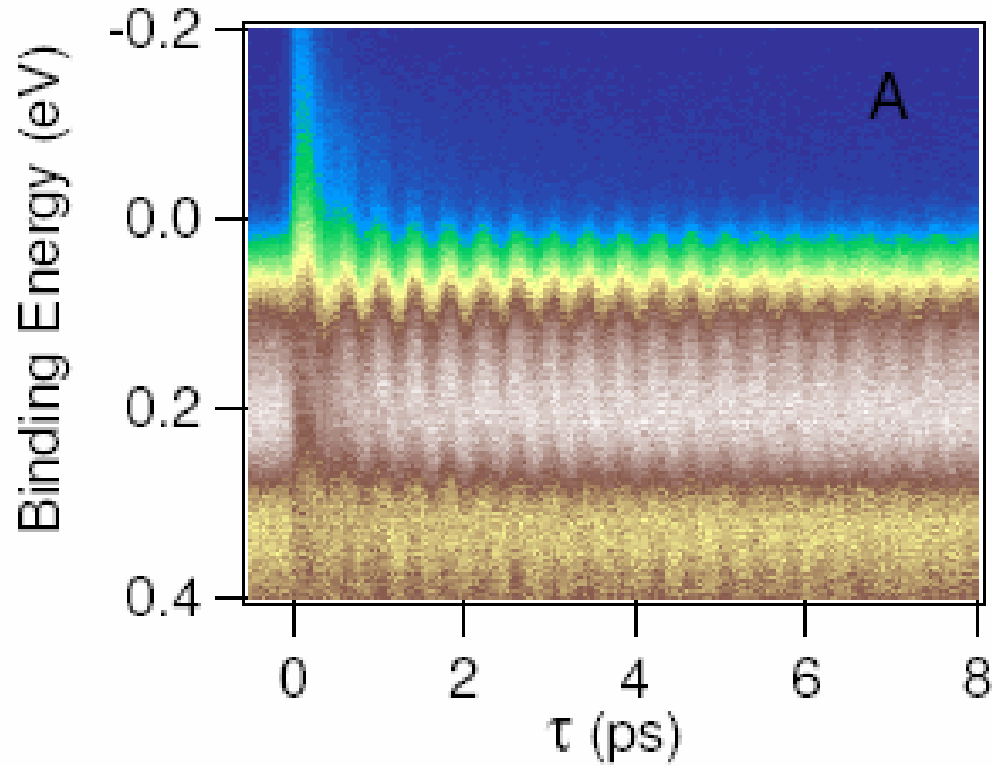
Metallic phase $T_f = 300$ K



Electrons reach ~ 1100 K and cool down in ~ 150 fs

Weak oscillations of the spectral function

$A(\epsilon, \tau)$ $f(\epsilon, \tau)$ Mott phase $T_f = 30$ K

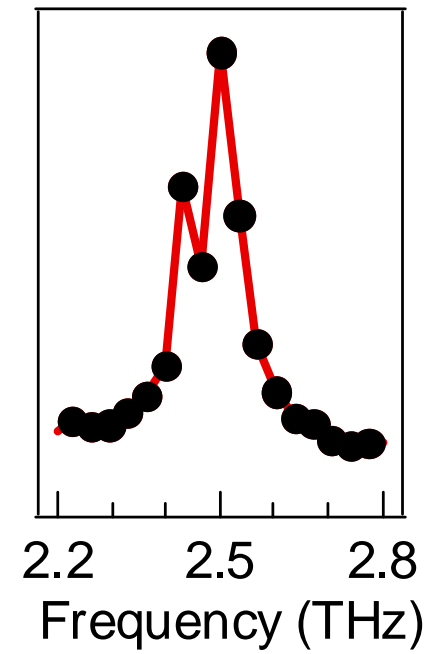
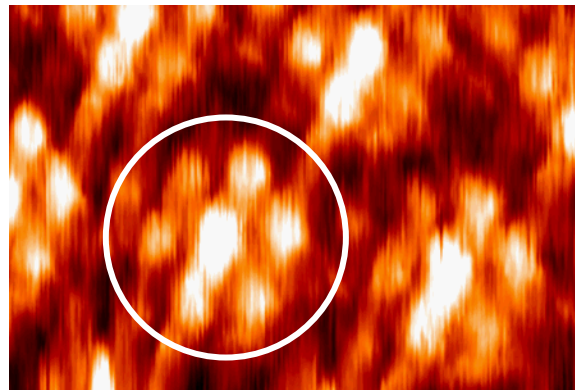
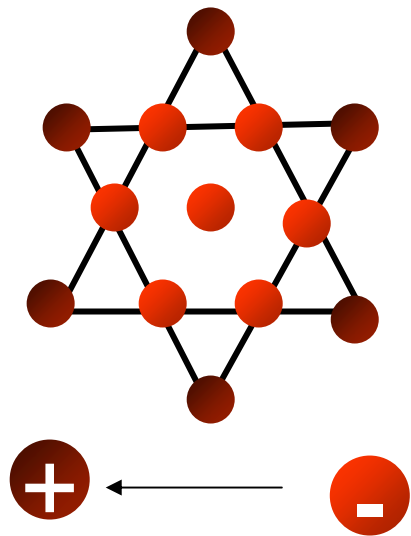
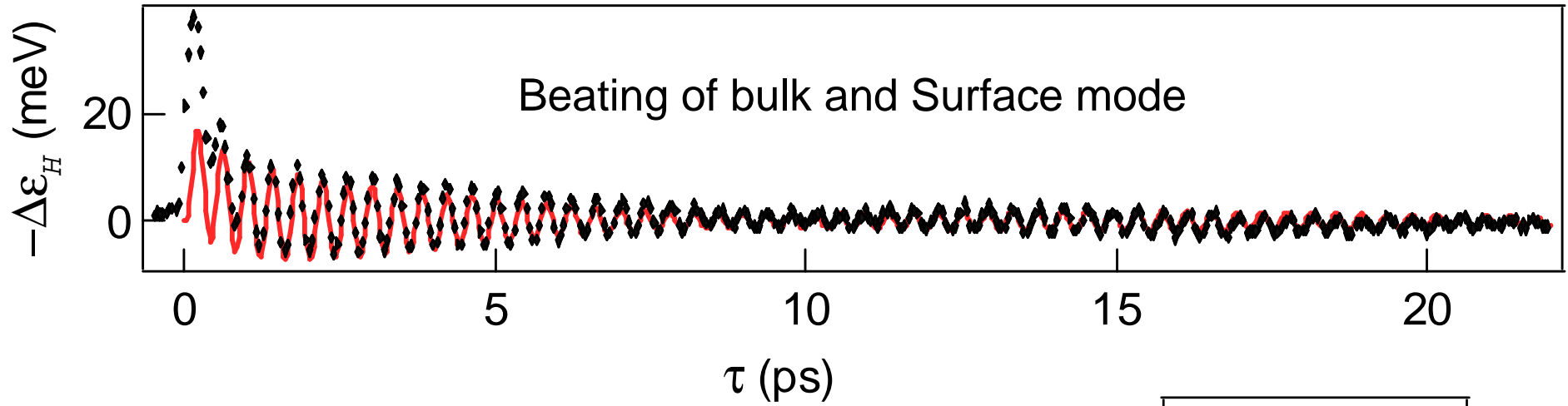


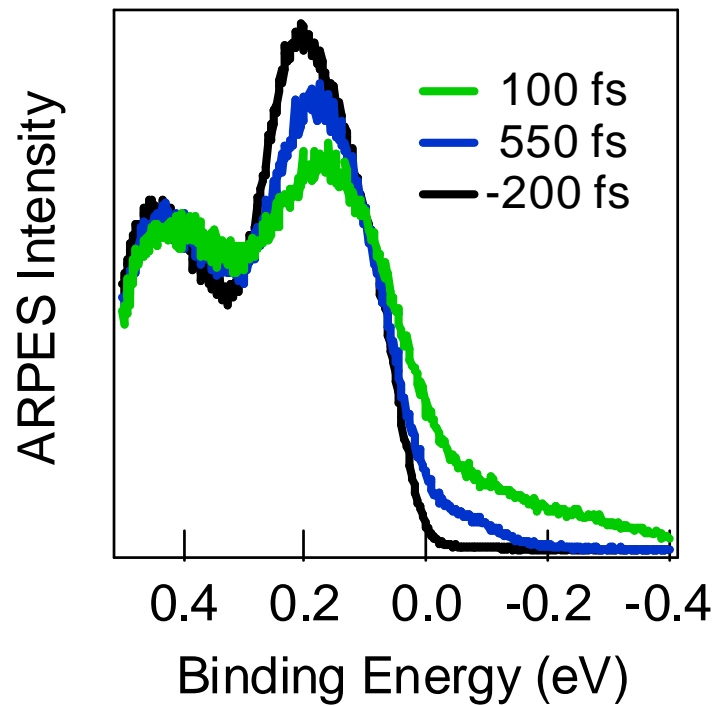
Large oscillations lasting longer than 10 ps

Rigid spectral shift of 18 meV

Mott phase stable after $t > 1$ ps

Coherent excitation of the CDW amplitude



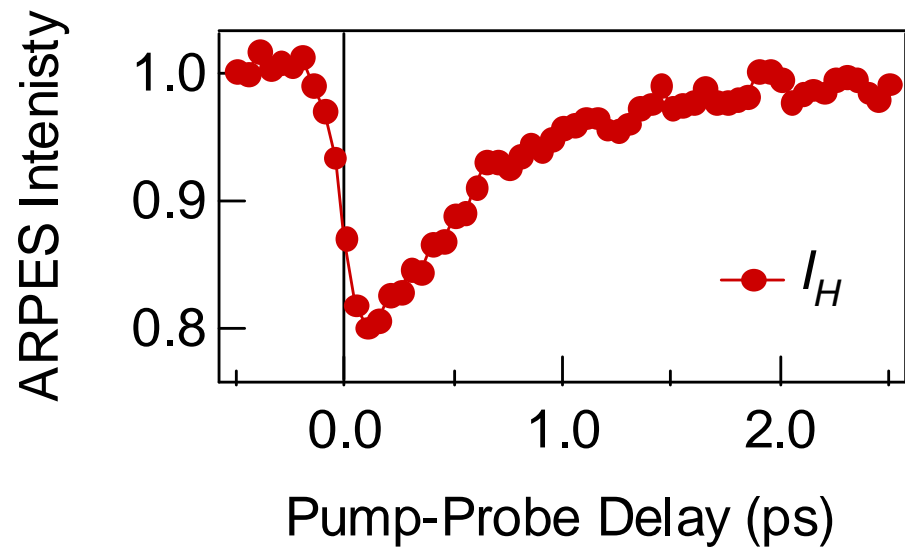


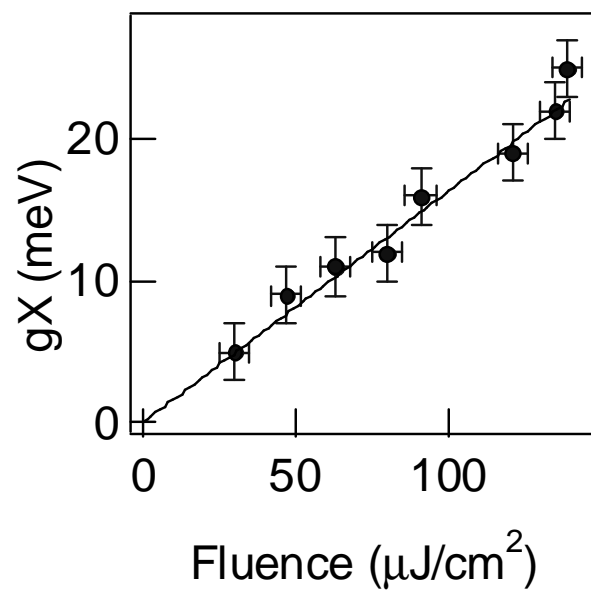
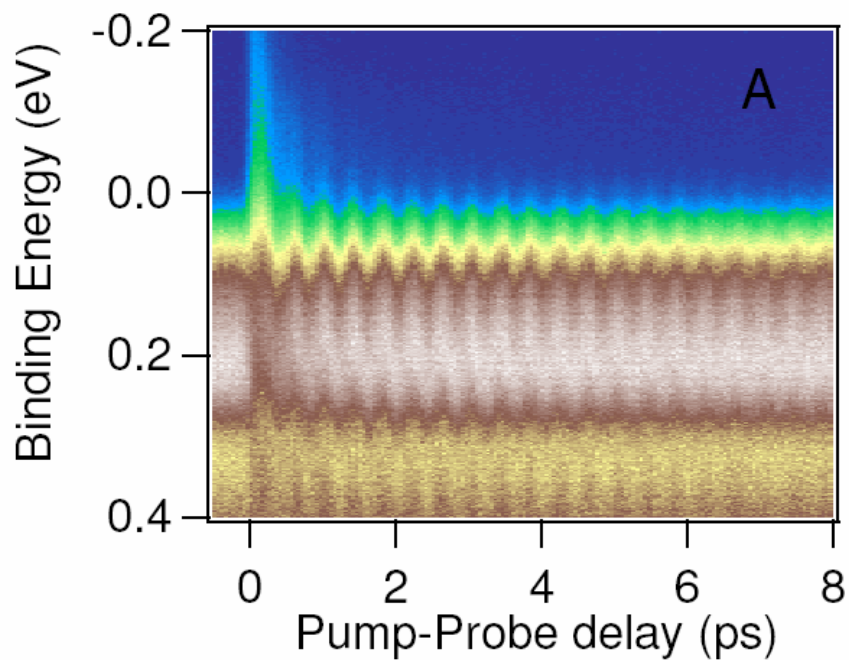
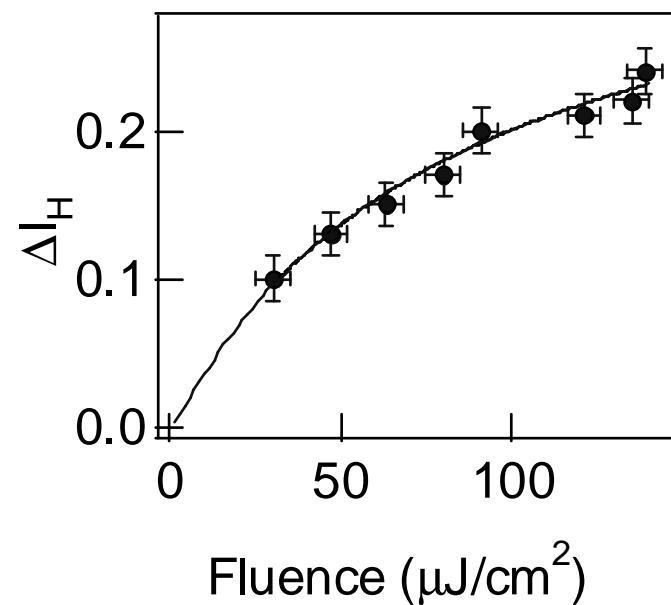
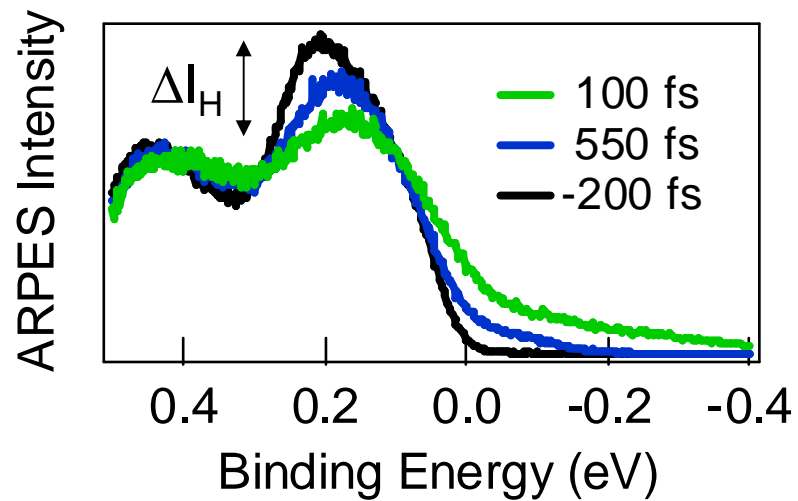
Breakdown of the MOTT phase

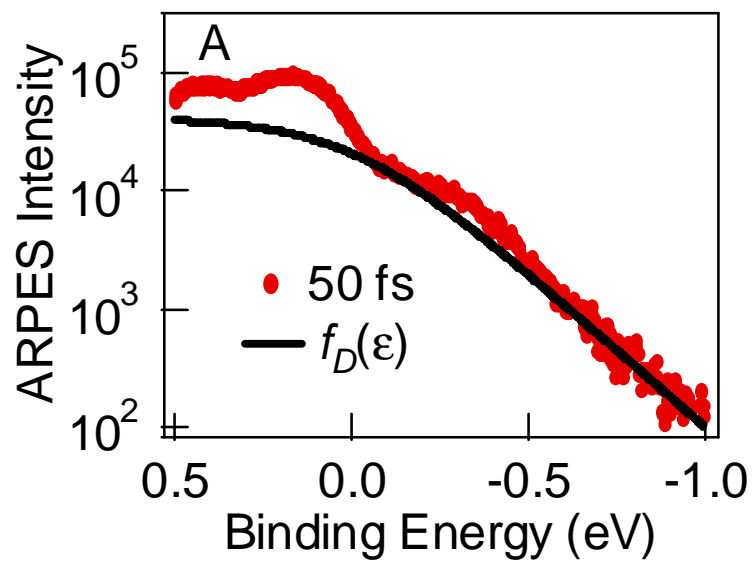
Transfer of spectral weight from the Hubbard peak to the Fermi level

The intensity of the of the Hubbard peak

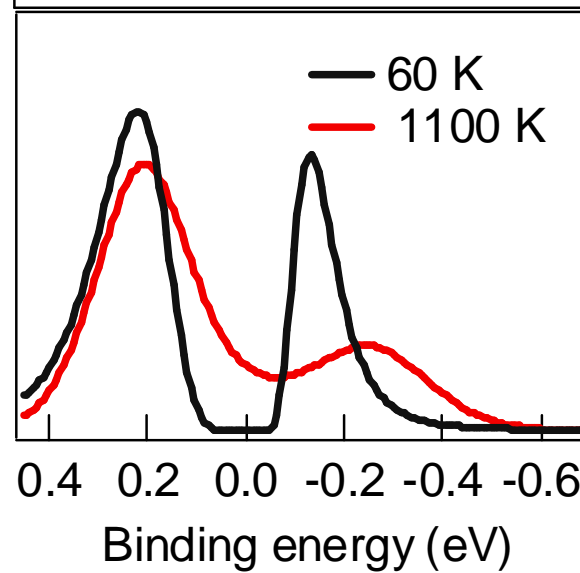
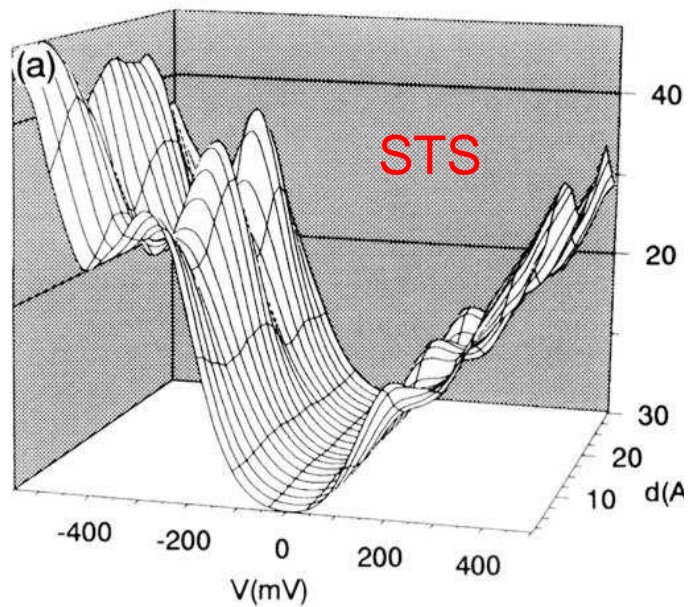
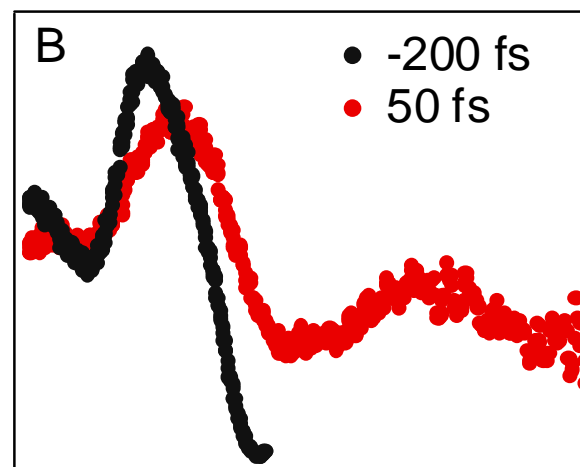
Instantaneous collapse recovery in 680 fs





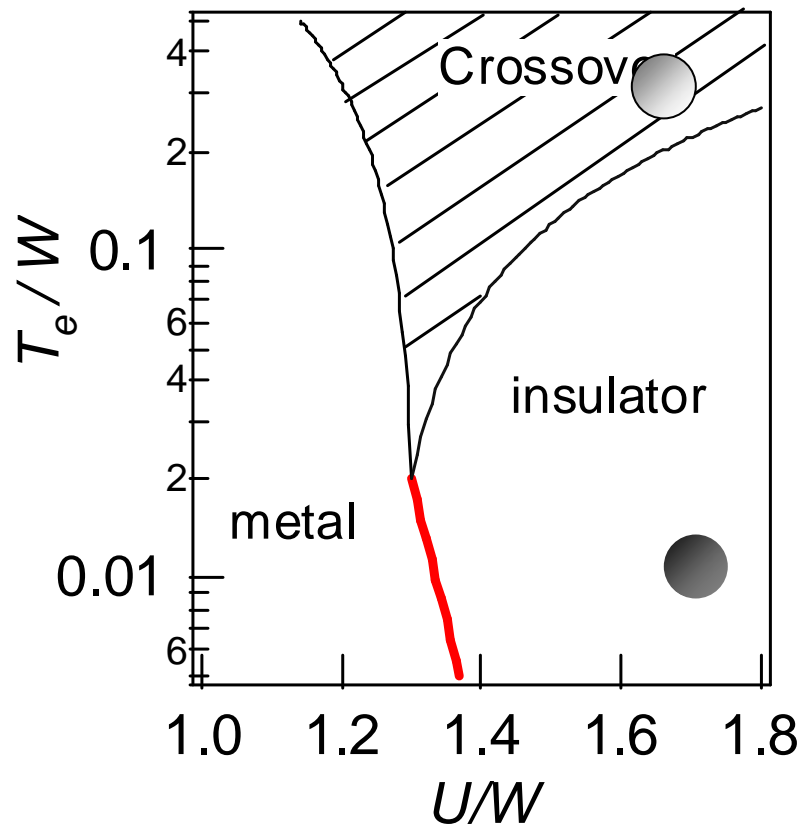


Lower and upper Hubbard bands

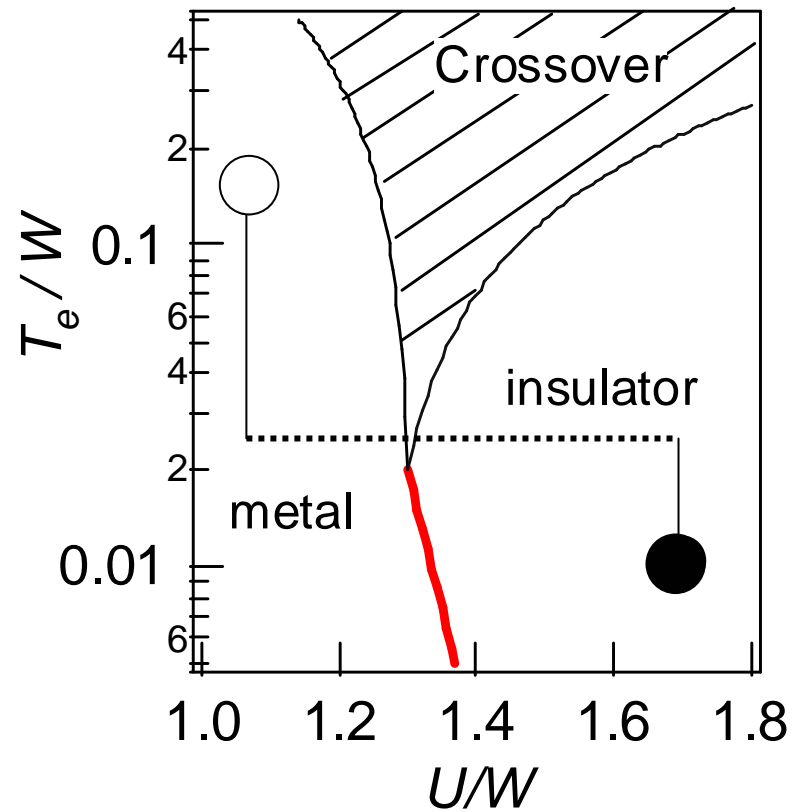


The phase transition

photoinduced



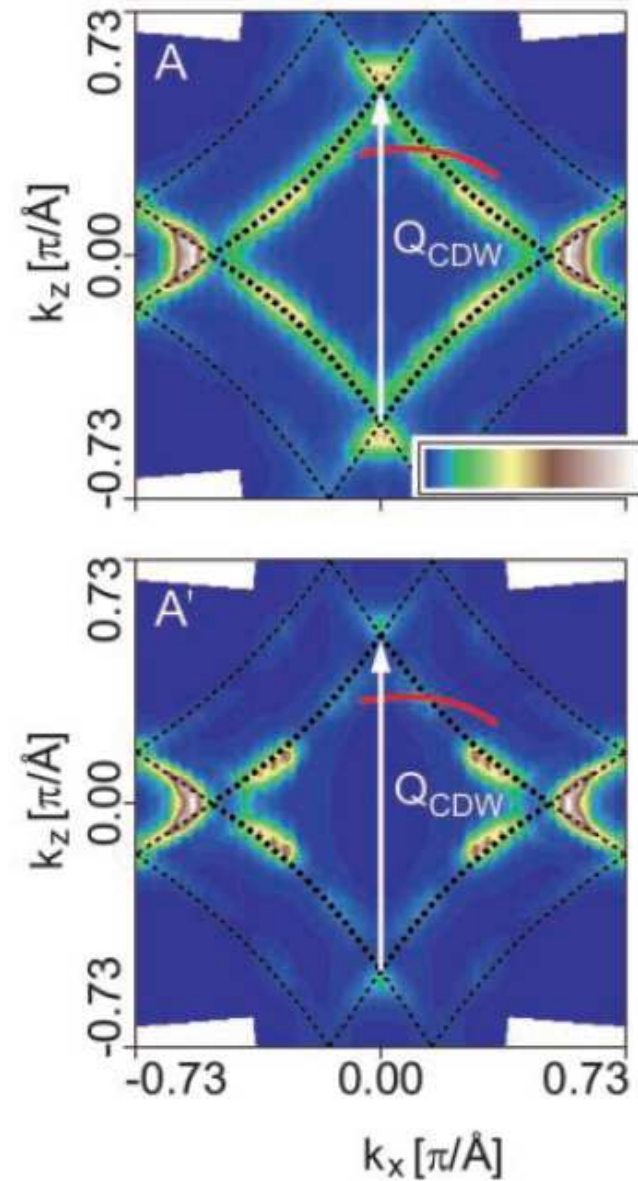
Thermally induced

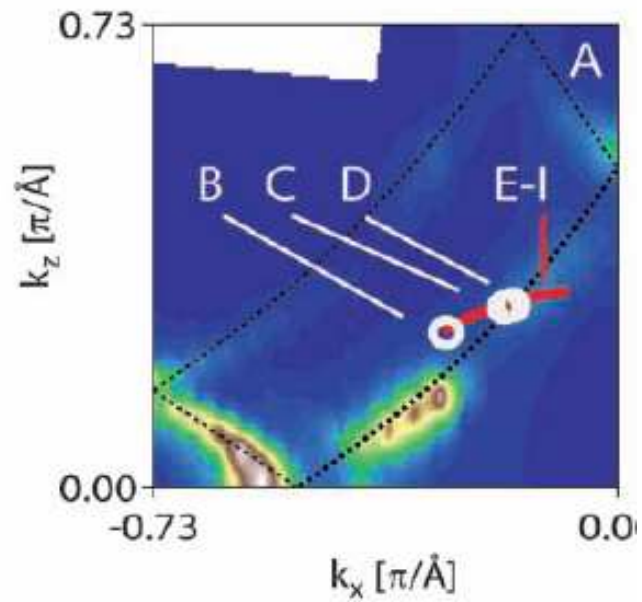


Charge Density Wave
compound TbTe_3

Partial disruption of the FS
due to a periodic lattice
distortion

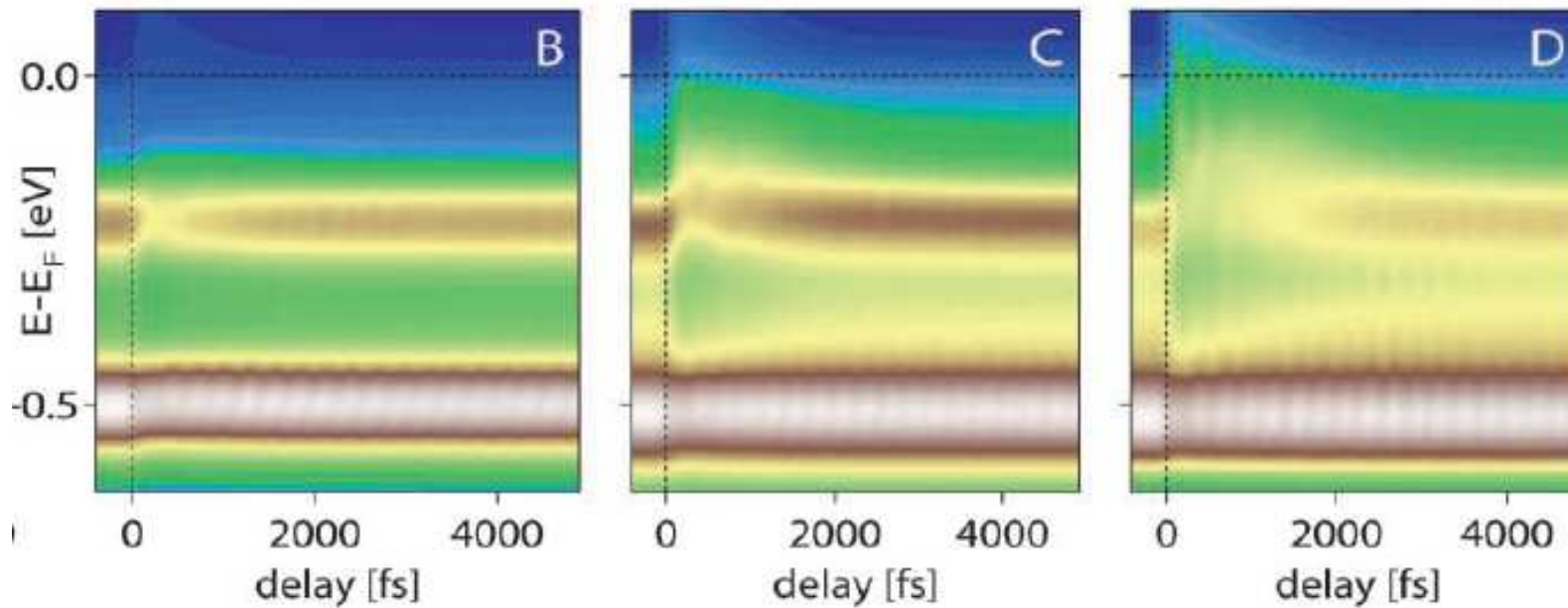
The electron phonon coupling
Induce the opening of an
electronic gap

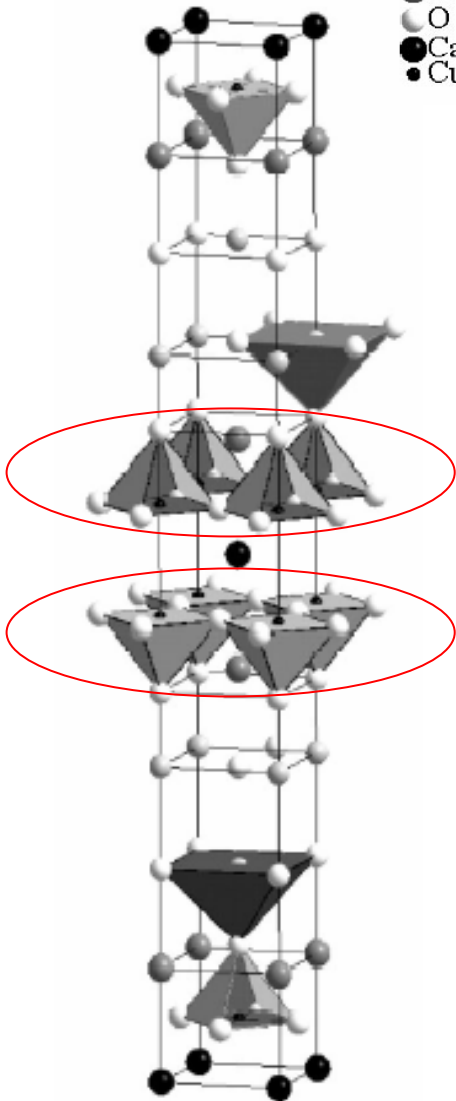
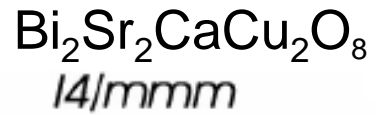




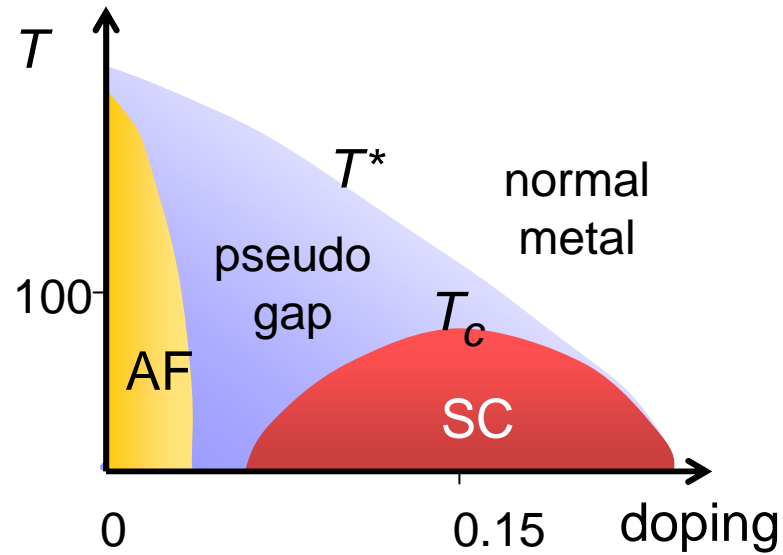
Large oscillations of electronic states
in the gapped region of the FS

Collapse and revival of the CDW gap





Phase diagram

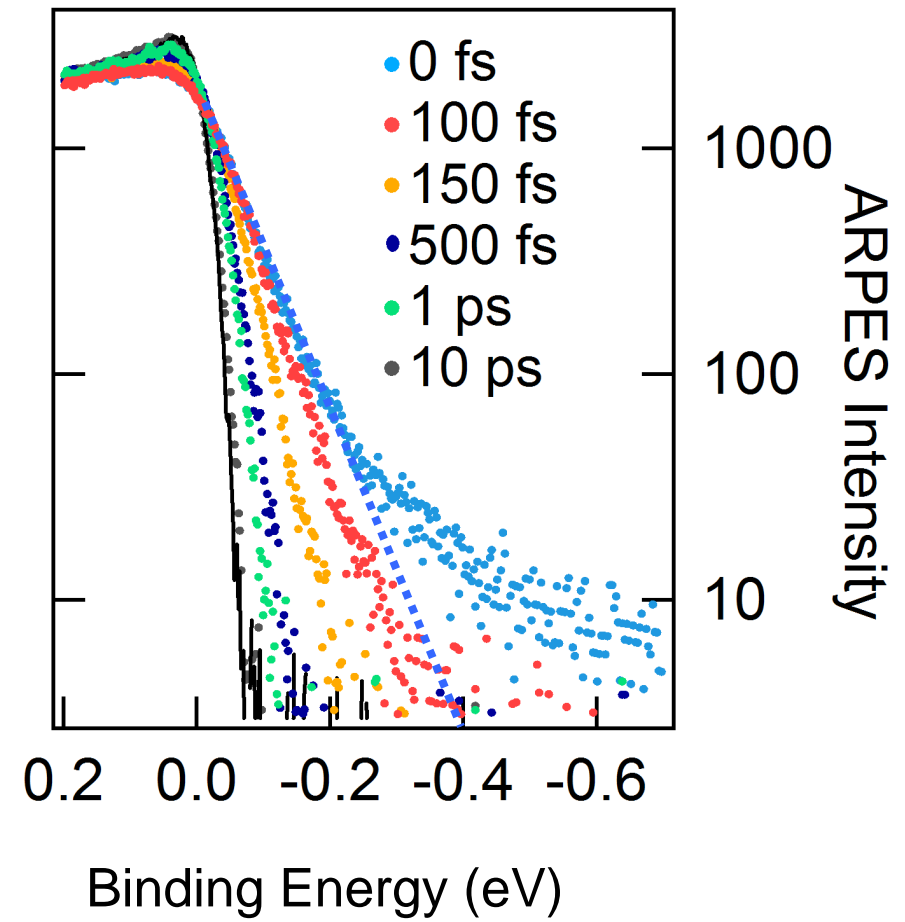
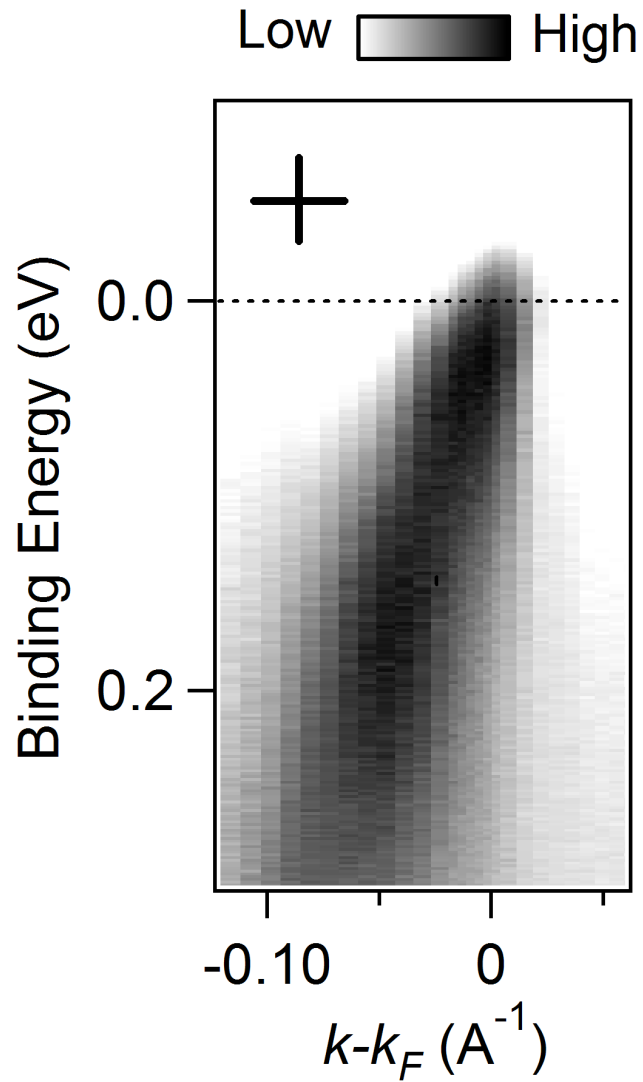


Superconductivity due to cooper pairs

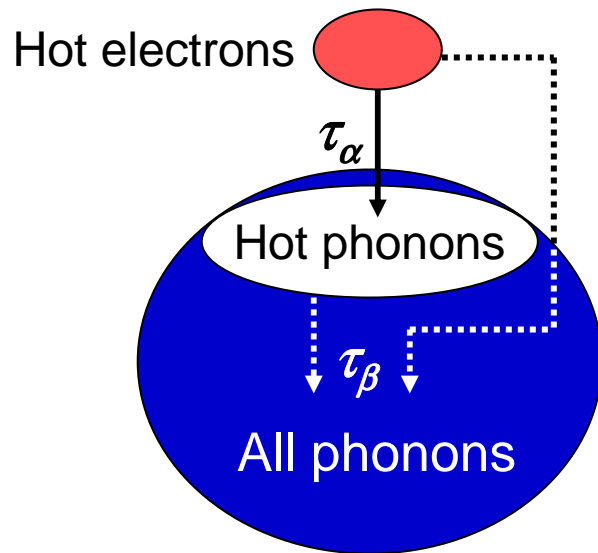
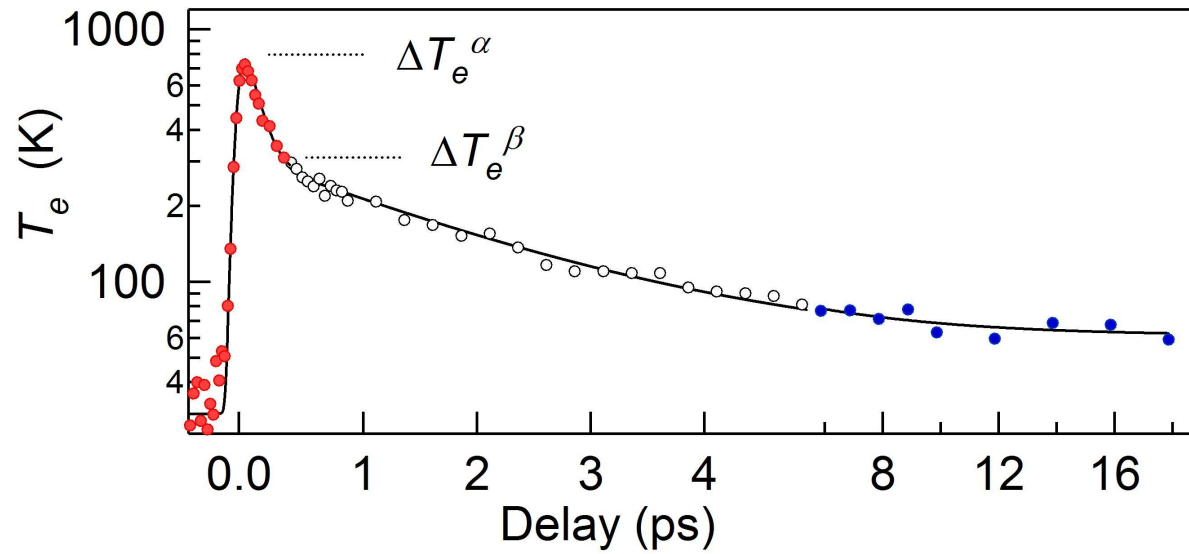
Which is the pairing glue of the pairs:
Phonons or spin fluctuations?

Novel methods to investigate el-ph coupling

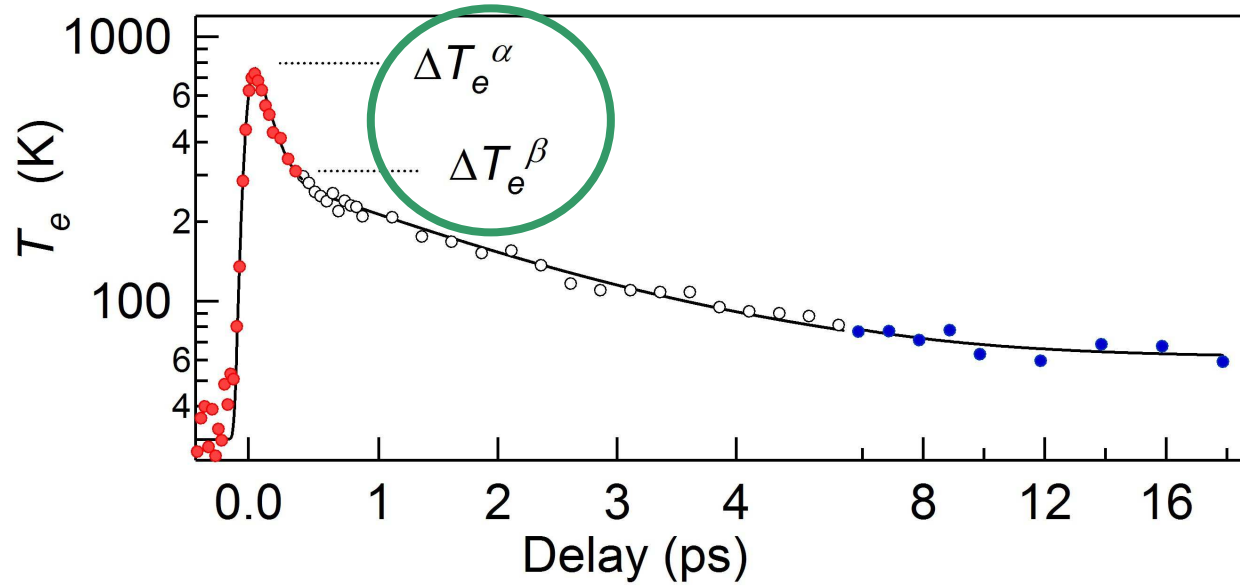
Ultrafast electronic thermalization



Generation of hot phonons during the electrons cooling

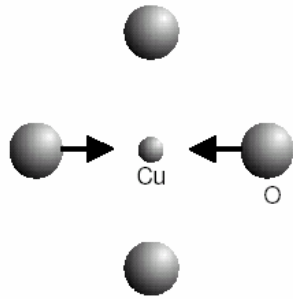


Properties of the electron-phonon interaction



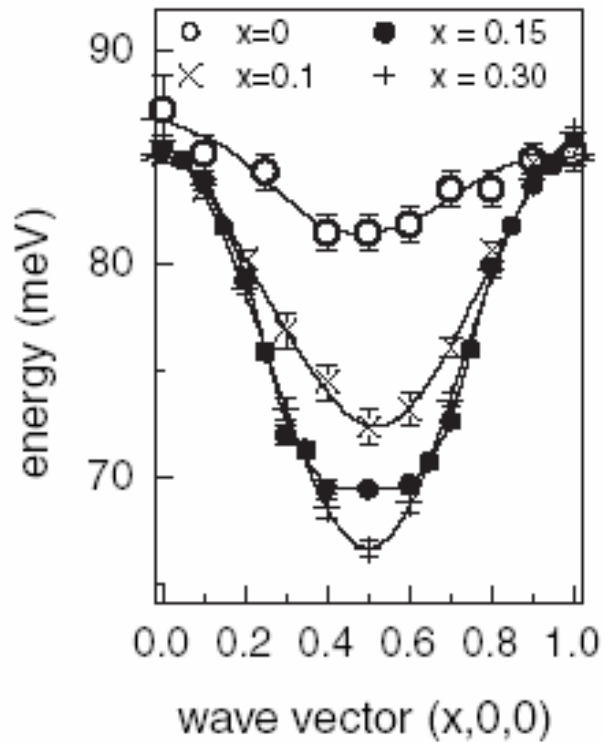
T_l	f	$\lambda\Omega^2$ (meV ²)	τ_β (ps)
30 ± 10	$0.13 - 0.25$	$300 - 380$	2 ± 0.1
300 ± 10	$0.18 - 0.25$	$340 - 380$	0.9 ± 0.1

$\Omega > 40$ meV \Rightarrow $\lambda < 0.25$

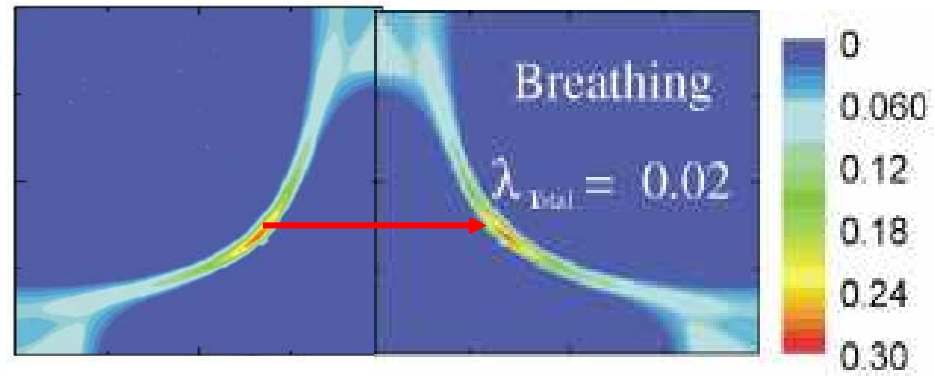


Half Breathing mode in $\text{La}_{2-x}\text{Sr}_x\text{CuO}_4$

L. Pintschovius Phys. Status Solidi (b) **242**, 30



Strong anisotropy of the electron-phonon coupling



T. P. Devereaux et. al. PRL **93**, 117004

Conclusions

Photoinduced breakdown of a Mott insulator is due the elevated electronic temperature

Coherent lattice motion induces rigid oscillations of the electronic states

Bi2212: anisotropic and weak electron-phonon coupling

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