Anisotropic electron dynamics and electron-phonon coupling in Fe-pnictides

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The recently discovered class of Fe-based high-T_c superconductors (SC) and their parent compounds represent an interesting correlated electron system facilitating the study of effects like intra- and interband scattering and electron-phonon coupling. A powerful method to investigate such effects is femtosecond (fs) time- and angle-resolved photoemission spectroscopy (trARPES).

Here, we present trARPES experiments of the parent compound $EuFe_2As_2$ and the doped $BaFe_{1.85}Co_{0.15}As_2$ high-T_c SC. We observe a strongly momentum dependent dynamics of states around the hole-pocket at the Γ-point of the Brillouin zone (BZ) where occupied states become depopulated by excited holes, whereas electrons are filling empty states within the hole-pocket. The timescales of electron and hole dynamics differ by almost an order of magnitude which cannot be explained solely by intraband scattering processes. Thus, additional interband scattering channels between the center and the boundary of the BZ have to be considered, which require momentum transfer and might lead to the excitation of zone boundary phonons.

In addition, a periodic modulation of the trARPES intensity near the Fermi level is observed. Analysis of these oscillations reveals three coherently excited phonon modes at frequencies of 5.6, 3.3 and 2.6 THz, that couple to the electronic system and modulate the chemical potential. Comparison to Raman data identifies the mode at 5.6 THz as the A_{1g} mode. The other two modes cannot be assigned to Raman active modes and might originate from zone boundary phonons.

The analysis of the excited electron distribution allows to estimate the average electron-phonon coupling parameter λ, which is an important property related to superconductivity. The small value of $\lambda < 0.5$ resulting from our experiments suggest a limited importance of e-ph coupling to superconductivity in Fe-pnictides.