Probing ultrafast Spin and Electron Dynamics in Momentum, Space, and Time

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Competing interactions of spin with charge and lattice, determined by the spin-orbit interaction, yield rich phase diagrams of states in novel correlated electron materials. In such materials, magnetically ordered phases are very often in direct competition with other ordered phases, such as a spin- or charge-ordered phase. Unfortunately, the dominant interaction responsible for the formation of a particular phase is often difficult to determine in thermal equilibrium, so that a fundamental understanding of the underlying competing interactions is out of reach using static measurements. Time-resolved spectroscopy techniques have the potential to overcome these limitations by temporally driving the material system out of equilibrium. The subsequent relaxation pathways are then determined by the spin-charge lattice interactions, which can be studied using various photoemission techniques. In this talk I will show how recent developments in ultrafast light sources and photoemission detector technology have paved the way for a completely new generation of time- and spin-resolved photoemission experiments. With this tool at hand, we can directly observe the temporal evolution of excited carriers (see Figure 1) and spins in energy, momentum space and time, providing an unprecedented insight into the fundamental energy and (angular) momentum dissipation mechanisms even in complex condensed matter [1,2].

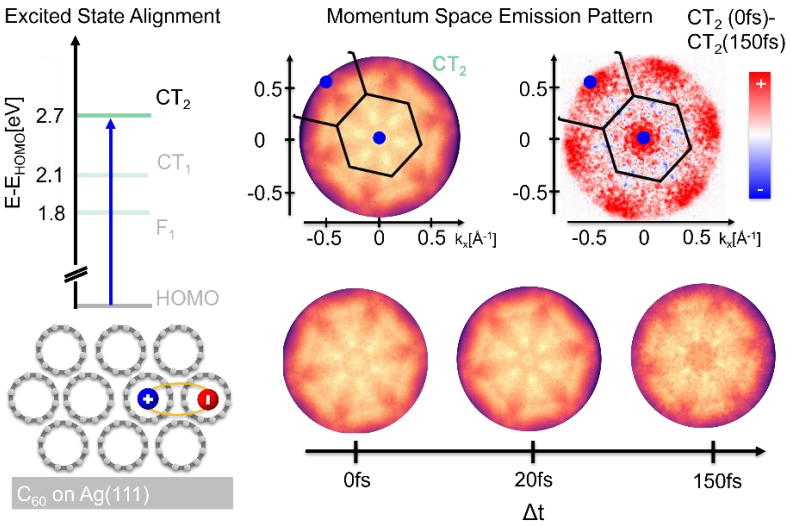

Figure 1: Time- and momentum-resolved photoemission with femtosecond extreme ultraviolet (fs-XUV) radiation makes it possible to follow the exciton dynamics in the excited state energy region of a C60 film.

References

[1] S. Emmerich et al, J. Phys. Chem. C, **124**, 43, 23579 (2020).
[2] B. Stadtmüller, J. Phys. Condens. Matter, **33**,353001 (2021)