

Ultrafast Dynamics in bilayer MoS₂

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The recent development of ultrafast time-resolved photoemission experiments has led to novel findings concerning non-equilibrium electron dynamics. Of particular interest are the 2D semiconducting transition metal dichalcogenides (TMDCs) that can be seen as graphene analogues with strong spin-orbit interactions and a large direct band gap. Here, the ultrafast dynamics in the electronic structure of bilayer MoS₂ on Ag(111) are investigated using time and angle resolved photoemission spectroscopy (TR-ARPES) following an optical excitation with tunable pump pulse polarisation.

The ultrafast dynamics within this material show a strong conduction band excitation, localised at the K point, and a delocalised hole distribution along the valence band, which suggests a strong coupling to the substrate. Additionally, we find that the nature of the light polarisation dependence for the excitation between the valence and conduction bands is different from the single layer case on the basis of valley-selection rules [1]. In bilayer MoS₂, the coupling between layers leads to a strong linear anisotropy in the conduction band, while the holes in the valence band show no polarization dependence. Our experimental results are compared to the transition probabilities of a two-layer $\mathbf{k}\cdot\mathbf{p}$ model for TMDCs near the K-point [2] using an arbitrary polarization excitation. This could provide new insight into the interlayer coupling and inter-valley dynamics at play in bilayer TMDCs.

References:

[1] Di Xiao, et al., *Phys. Rev. Lett.* **108**, 196802 (2012)

[2] Gong, Zhirui, et al., *Nature Comm.* **4**, 2053 (2013).