Ultrafast Response of Dark States in TMD Heterostructures Photocurrent

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We study the photocurrent response of TMD heterostructures $MoS_2/MoSe_2$ with 150 femtosecond time resolution. In order to study the dynamics of transport at the interface of the heterostructure, we tune one pulse to MoS_2 resonance and the second, time-delayed pulse, to that of $MoSe_2$. We find stark asymmetry between negative and positive delays. We attribute this asymmetry to the formation of interlayer excitons. Using a simple model of charge carriers decaying in optically dark states we successfully describe both time-resolved reflectivity and photocurrent response of heterostructures. Extracted formation time of interlayer excitons is similar to that observed in ARPES and TR-THz at room temperature. Strong response to interlayer excitons shows the potential of our technique in detecting other dark states promising for information storing and processing.

Figures

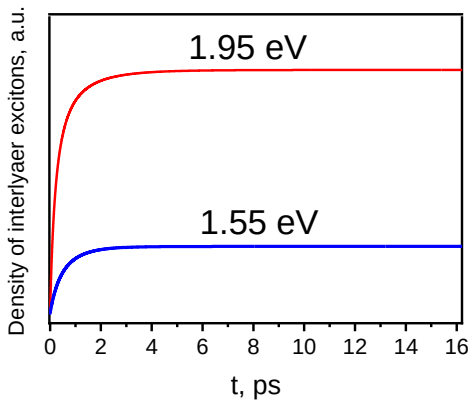

Figure 1: Density of interlayer excitons after pulsed excitation in optical resonance with MoS_2 (red) and $MoSe_2$ (Blue) monolayers extracted from proposed model for time resolved photocurrent and reflectivity responses.