

Exciton-exciton interaction beyond the hydrogenic picture in a MoSe₂ monolayer in the strong light-matter coupling regime

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In transition metal dichalcogenides layers of atomic scale thickness, the electron-hole Coulomb interaction potential is strongly influenced by the sharp discontinuity of the dielectric function across the layer plane. This feature results in peculiar non-hydrogenic excitonic states, in which exciton-mediated optical nonlinearities are predicted to be enhanced as compared to their hydrogenic counterpart. To demonstrate this enhancement, our experimental collaborators performed optical transmission spectroscopy of a MoSe₂ monolayer placed in the strong coupling regime with the mode of an optical microcavity, and we analyzed the results quantitatively with a nonlinear input-output theory. We found an enhancement of both the exciton-exciton interaction and of the excitonic fermionic saturation with respect to realistic values expected in the hydrogenic picture. Such results demonstrate that unconventional excitons in MoSe₂ are highly favourable for the implementation of large exciton-mediated optical nonlinearities, potentially working up to room temperature.

REFERENCES

[1] Stepanov et al, Arxiv 2007.00431 (Accepted in PRL)

FIGURES

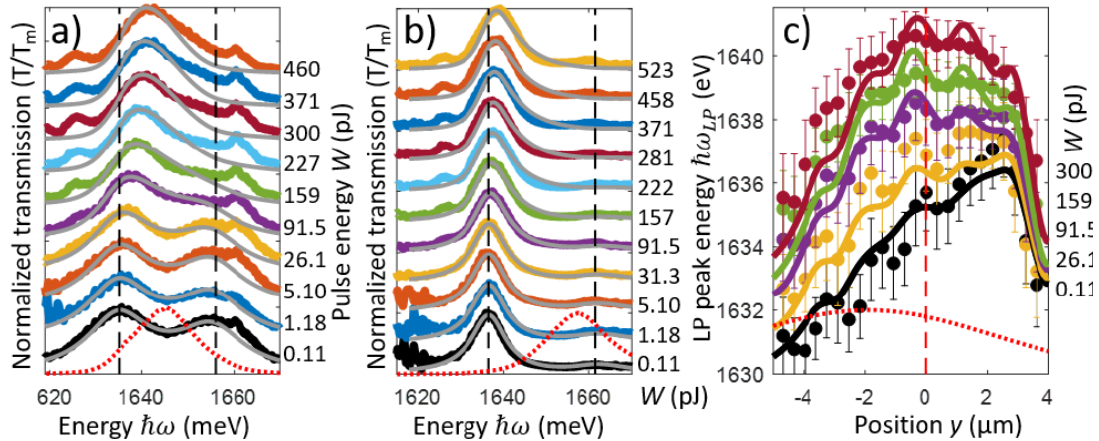


Figure 1: Nonlinear transmission spectroscopy. Measured normalized transmission spectra $T(\omega)/\text{Max}(T)$ at $T=127\text{K}$ (a) and $T=105\text{K}$ (b). The spectra are stacked from the lowest used pulse energy, W (bottom) to the highest (top). The pulse energy, W , used for each spectrum is indicated on the right axis. The laser pulse spectrum is shown in (a, b) as a red dotted line. The dashed vertical black lines in (a, b) highlight the polaritonic resonances in the linear regime. The theoretical fits are shown as solid gray lines. (c) Spatially resolved lower-polariton transmission peak energy measured at $T=127\text{K}$, across the excitation spot diameter, for increasing W (same colour code as in (a)). The spatial laser intensity profile is shown as a red dotted line. The spectra in (a) have been measured at $y=0$ (dashed vertical line).