# Pump-driven optical Kerr rotation and hidden quantum entanglement in centrosymmetric bulk $WSe_2$

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**Abstract**: We report on the observation of an ultrafast pump-driven Kerr rotation in centrosymmetric bulk $WSe_2$. We rationalize these findings as result of the hidden entanglement among several qauntum degrees of freedom

Single-layer semiconducting transition-metal dichalcogenides (TMDs), lacking point inversion symmetry, provide an efficient platform for valleytronics, where the electronic, magnetic, valley and lattice degrees of freedom can be selectively manipulated by using polarized light. This task is however thought to be limited in parent bulk compounds where the point inversion symmetry is restored. Exploiting the underlying quantum physics in bulk materials is thus one of the biggest paradigmatic challenges.

Here we show that a sizable optical Kerr rotation can be efficiently generated in a wide energy range on ultrafast timescales in bulk $WSe_2$, by means of circularly-polarized light. We rationalize these findings as a result of the hidden spin/layer/valley quantum entanglement. The spectral analysis reveals clear features at the three characteristic frequencies corresponding to the A-, B- and C-exciton edges. The origin and the relative sign of all these features is shown to stem from the selective Pauli blocking of intralayer and interlayer optical transitions. The long lifetime of the broadband Kerr response ($\tau \sim 500$ fs) provides a strong indication that coupled photo-induced electron and hole densities survive in bulk compounds longer than previously expected. The present report demonstrates that a hidden quantum entanglement is operative also in bulk centrosymmetric layered materials, opening the way for an effective exploitation of bulk $WSe_2$ in optoelectronic applications.

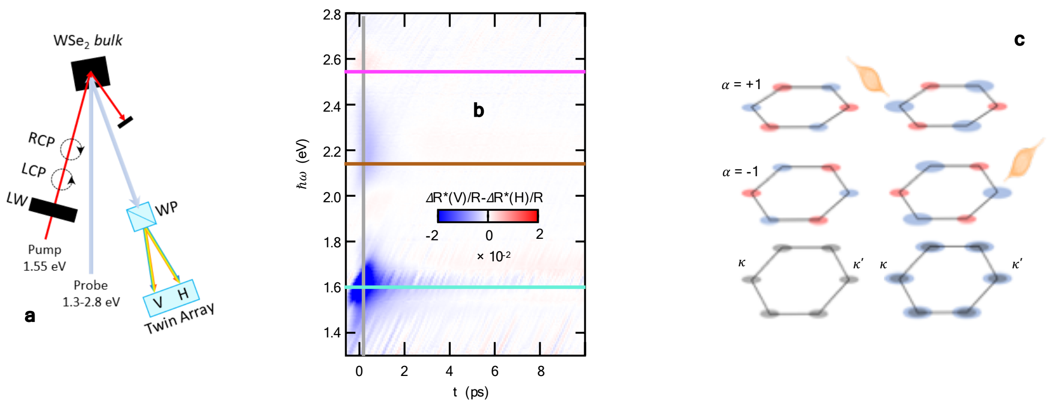


**Fig. 1** (a) Scheme of the experimental pump-probe setup. (b) Energy vs. time color map of the optical dichroism, which is proportional to the Kerr rotation angle. (c) Schematic representation of the different contributions of the Kerr optical rotation resolved for layer and valleys. The bottom line represents the total layer-averaged. Blue/red areas represent states resulting in a positive/negative Kerr angle, respectively, while grey areas stand for null Kerr rotation. Left panel shows the hidden order before pumping. circularly-polarized laser pumping in the right panel photo-excites charges at K in layer $\alpha = +1$, and at -K in layer $\alpha = -1$. In both cases it results in a finite Kerr rotation, still obeying point-inversion symmetry.

## Example References

[1] E. Cappelluti, H. Rostami, and F. Cilento, "Ultrafast light-driven optical rotation and hidden orders in bulk $WSe_2$", arXiv:2411.06561 (2024).