Out-of-equilibrium Raman spectroscopy of graphene and related 2D heterostructures

T. Scopigno[1,2]
[1]"Sapienza" University of Rome, Physics Department, Femtoscopy Labs, 00185 Rome - Italy
[2]Istituto Italiano di Tecnologia, Graphene Labs, 16163 Genova - Italy.
Tullio.scopigno@uniroma1.it

At the Femtoscopy labs, we work at the development of time-resolved Raman micro-spectroscopies aiming at the enhancement of spectral and temporal resolutions, to address ultrafast dynamics in biomaterials and condensed matter. Here I will present recent results on the out of equilibrium interaction of lattice vibrations with charge carriers in 2D materials. Specifically, the way ultrafast photoexcitation transiently enhances the electron-phonon interaction in Gr by smearing the Dirac cone [1] and how it induces interlayer *energy transfer* in TMD-Gr heterostructures on the picosecond timescale [2], revealing an intermediate process with respect to the generation of a net charge underlying the slower electric signals detected in optoelectronic applications.

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References

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[2] C. Ferrante, G. Di Battista, L. E. Parra Lopez, G. Batignani, E. Lorchat, A. Virga, S. Berciaud and T. Scopigno, "Picosecond energy transfer in a transition metal dichalcogenide-graphene heterostructure revealed by transient Raman spectroscopy" *Proceedings of the National Academy of Science*, 119, e2119726119, (2022)

Figures

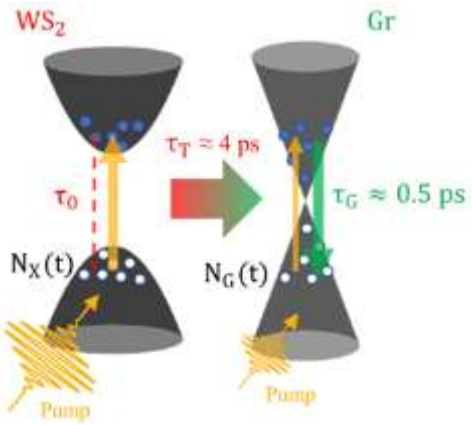

Figure 1: *Modeling energy transfer in a WS_2–Gr heterostructure. The pump pulse can generate an exciton population in WS_2 or populate the electronic states of Gr with e–h pairs. These latter decay with a timescale τ_G. In contrast, the excitons in bare WS_2 have a long lifetime τ_0. Exciton decay is strongly accelerated in WS_2 –Gr due to energy transfer to Gr with a characteristic time τ_T*