Investigation of excitonic Fano resonances in graphene using optical spectroscopy

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Using transmission and reflection spectroscopy we examine the optical response of free-standing and supported graphene from the visible to the UV regime.

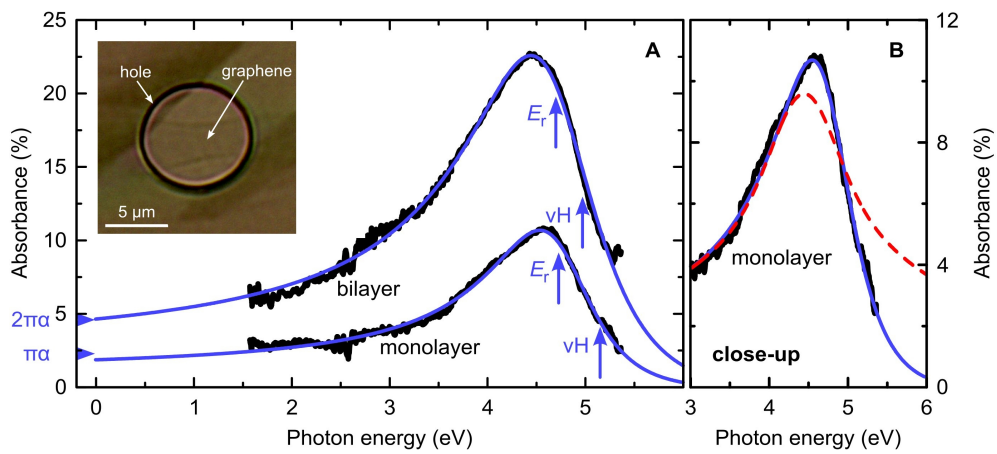
The absorbance spectrum of free-standing graphene is dominated by an asymmetric peak in the UV at 4.7 eV (see Figure A). While the tight-binding model describes most of graphene's physical properties, it predicts a symmetric line shape of the absorbance peak and thus cannot be brought into agreement with our measurement (see Figure B). However, taking into account an excitonic state at the saddle point M in the band structure, a Fano model can be used which excellently fits our measured data and also reproduces the constant absorption of πα at low photon energies [1].

Additionally, the influence of the environment on the excitonic Fano resonance is studied. We compare the optical response of free-standing and supported graphene and investigate the dependence on the ambient conditions. Finally, we present an outlook on future projects.

References

[1] D.-H. Chae, T. Utikal, S. Weisenburger, H. Giessen, K. v. Klitzing, M. Lippitz and J. Smet, Nano Letters **11** (2011), 1379-1382.

Figures



(A) Absorbance (= 1 - transmittance) spectra of free-standing monolayer and bilayer graphene (black thick lines) are well described by a Fano model (blue thin lines). The difference between the resonance energy Er of the discrete state and the saddle point energy (van Hove singularity, vH) determines the exciton binding energy.
Inset: optical microscope image of a measured graphene layer, taken in transmission mode.
(B) Close-up of the monolayer spectrum (black thick line) with the Fano fit (blue thin line) compared to a model neglecting electron-hole correlations (red dashed line).