CEA – Saclay, 91191 Gif-sur-Yvette Cedex

Service de Physique de l'Etat Condensé - UMR 3680

SÉMINAIRE

Mercredi 21 février 2018 à 11h15

Orme des Merisiers SPEC, Salle Itzykson, Bât.774

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A unified theory for quasiparticle interference in two-dimensional materials

Quasiparticle interference (QPI) measured by low-temperature scanning tunneling spectroscopy (STS) accompanied by a Fourier transform analysis (FT-STS) provides unique insight into the effect of atomic defects on carrier scattering inside and between valleys in two-dimensional (2D) materials. Here I present a general T-matrix based framework for the calculation of FT-STS spectra which in combination with atomistic DFT calculations of the defect scattering potential allows for detailed FT-STS modeling of "realistic" defects such as, e.g., atomic vacancies, adatoms and substitutional atoms [1].

In monolayer transition metal dichalcogenides (TDMs; MX2), atomic vacancies are commonly believed to be a source of pronounced intervalley scattering, thereby presenting a serious obstacle for applications exploiting their unique valley-contrasting properties. However, as I here show, the symmetry of the defect site gives rise to selection rules which may protect against intervalley scattering. In the conduction-band FT-STS spectra this manifests itself by a K ↔ K' intervalley peak which is missing for X vacancies, while appearing clearly for M vacancies. These findings put the recent observations of absent K ↔ K' intervalley peaks in QPI experiments [2,3] in a new perspective.

In graphene, the chiral nature of the states leaves clear fingerprints in the FT-STS spectra [4,5]. For example, the q=2kF ring due to backscattering is strongly suprressed near the Dirac point where trigonal warping is small -- this in spite of the fact that atomic defects often break the A,B sublattice symmetry thus allowing for backscattering. The explanation for this apparent paradox emerges straight forwardly from our unified theory.

[1] K. Kaasbjerg et al., Phys. Rev. B, 96, 241411(R) (2017).
[2] H. Liu et al., Nature Commun. 6, 8180 (2015).
[3] M. Yankowitz et al., Phys. Rev. Lett. 115, 136803 (2015).
[4] P. Mallet et al., Phys. Rev. B 86, 045444 (2012).
[5] D. Dombrowski et al., Phys. Rev. Lett. 118, 116401 (2017).

A coffee break will be served at 11h00. The seminar will be given in English.

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