Optical absorption in twisted bilayer graphene

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Recent epitaxial growth technique realized twisted bilayer graphene in which two layers are stacked with a random rotation angle [1]. We theoretically investigate the optical absorption property of twisted bilayer graphenes with various stacking geometries, and demonstrate that the spectroscopic characteristics serve as a quite robust fingerprint to identify the rotation angle between two layers [2]. We find that the optical absorption spectrum consists of a series of characteristic peaks ranging from terahertz to ultraviolet frequencies, which are associated with the van Hove singularity in the superlattice band structure (Fig. 1). We calculated the optical conductivity in two different methods, the tight-binding model and the effective mass model based on the Dirac equation, and found that the effective model nicely reproduce the tight-binding results for small rotation angles, and also analytically explain the optical selection rule which is peculiar to twisted bilayer graphene. Our results not only give a convenient way to identify the geometry of twisted bilayer graphene but also provides useful information for opto-electronic application.

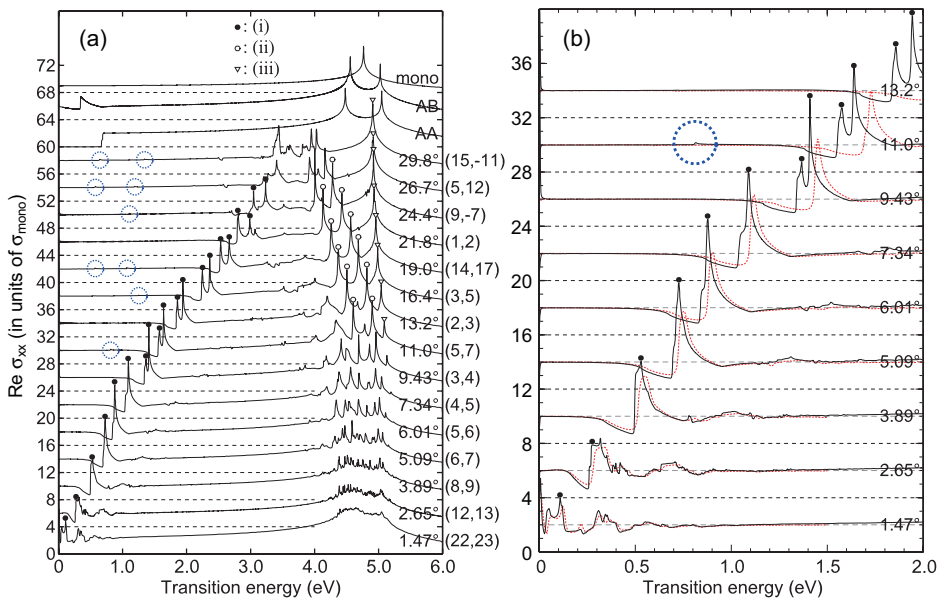

Figure 1: Dynamical conductivities of twisted bilayer graphenes with various rotation angles in (a) wide and (b) narrow frequency ranges. Peaks marked with symbols represent the excitations associated with three different types of van Hove singularity. Dashed (blue) circles indicate the tiny peaks which appears only when the actual lattice period L is larger than the Moiré period L_{M}.

[1] C. Berger *et al.*, Science **312**, 1191 (2006).
[2] P. Moon and M. Koshino, arXiv:1302.5218 (2013).