Exciton-polaronic effects in two-dimensional semiconductors

Dmitry K. Efimkin[1] and Allan H. MacDonald[1]

[1] *The University of Texas at Austin, Austin, Texas 78712-1192, USA*
efimkindk@utexas.edu, and macd@physics.utexas.edu

ABSTRACT

Transition metal dichalcogenides (TMDC), being two-dimensional insulators with large gap and strong Coulomb interactions, represent a new very promising playground for excitonic effects. Their additional advantage is a possibility of control optics by gating. Recent absorption experiments at doped TMDC have reported a splitting of the excitonic feature into two separate peaks. The appearance of an additional peak is usually attributed to trions, representing a bound state of two electrons and hole, or vice versa in the case of hole doping.

Here we argue that in the density range, where "trion" peak is well resolved, three-body physics is actually unimportant and the appropriate picture is the one of excitons-polarons dressed by the Fermi sea of excess electrons or holes. Due to the dressing, excitons split into attractive and repulsive exciton-polaron branches, corresponding to "trion" and "exciton" peaks in the absorption. We have calculated the frequency and doping dependence of the optical conductivity and found that: (i) the splitting between peaks goes linearly with Fermi energy of the sea; (ii) the trion peak dominates the excitonic one with increasing of doping; (iii) the width of the trion peak is considerably smaller than that of the excitonic one. Our results are in very good qualitative agreement with recent experiments.