

# Electronic excitations in solids and nanostructures: GW, GW-BSE, and beyond

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In this talk, we discuss some recent progress in the use of the GW approach and its extensions to electronic excitations and related spectroscopic properties of materials and nanostructures. Inclusion of electron-hole interactions allows further *ab initio* study of optical properties. Several topics are discussed. We present results on excitonic effects in the optical spectra of graphene, in the form of a strong resonant exciton, and show how the prominent exciton features are altered by carrier doping and quasiparticle lifetime. We describe how calculations of electronic multiplet splittings are possible within the GW approximation. Finally, we show that the *ab initio* GW approximation overestimates the quasiparticle-satellite separation significantly in photoemission spectra and falsely predicts a plasmaron excitation. By including significant vertex corrections via the *ab initio* GW+cumulant approach, we demonstrate that the plasmon satellites may be accurately computed, explaining recent angle-resolved photoemission measurements, e.g., on graphene. Comparisons with experiments for all three cases are presented.