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Theory of dynamical screening of excitons in monolayer transition-metal dichalcogenides[1]

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Exciton optical transitions in transition-metal dichalcogenides offer unique opportunities to study rich many-body physics. Recent experiments in monolayer WSe_2 and WS_2 have shown that, while the low-temperature absorption and photoluminescence from neutral excitons and three-body complexes is suppressed in the presence of elevated electron densities or strong photoexcitation, new dominant peaks emerge in the low-energy side of the spectrum. I present a theory that elucidates the nature of these optical transitions showing the role of the intervalley Coulomb interaction and ensuing valley plasmons. Considering their signature in the self-energy of electrons from the top spin-split conduction valleys leads to the emergence of a correlation-induced virtual state in the band gap. This phenomenon sheds light on the origin of the luminescence in monolayer WSe_2 and WS_2 in the presence of pronounced many-body interactions. I will also present numerical results of the absorption spectrum calculated from the two-particle Dyson Equation of the pair Green's function. Inclusion of dynamical screening in the potential is imperative to correctly describe the physics of excitons in gated structures.

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