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Interaction and Correlation Effects in Quasi Two-dimensional Materials[1]

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Experimental and theoretical studies of atomically thin quasi two-dimensional materials (typically related to some parent van der Waals layered crystals) and their nanostructures have revealed that these systems can exhibit highly unusual behaviors. In this talk, we discuss some theoretical studies of the electronic, transport and optical properties of such systems. We present results on graphene and graphene nanostructures as well as other quasi-2D systems such as monolayer and few-layer transition metal dichalcogenides (e.g., MoS_2, $MoSe_2$, WS_2, and WSe_2) and metal monochalcogenides (such as GaSe and FeSe). Owing to their reduced dimensionality, these systems present opportunities for unusual manifestation of concepts and phenomena that may not be so prominent or have not been seen in bulk materials. Symmetry and many-body interaction effects often play a critical role in shaping qualitatively and quantitatively their properties. Several quantum phenomena are discussed, including novel and dominant exciton effects, tunable magnetism, electron supercollimation by disorder, unusual plasmon behaviors, and possible enhanced superconductivity in some of these systems. We investigate their physical origins and compare theoretical predictions with experimental data.

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