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# Unusual charge carrier pairing across van der Waals interfaces


A pair of charge carriers across the interface of van der Waals (vdW) heterostructure can form a bound quantum state. In this talk, we will discuss several such examples realized in vdW interfaces between graphene layers and other 2-dimensional materials. In the first part of the presentation, we will discuss an experimental demonstration of magnetoexciton condensation. Employing two layers of graphene separated by an atomically thin insulator, we realize a superfluid condensation of magnetic-field-induced excitons across the double layers of graphene probed by Coulomb drag [1,2]. In the second example, we will discuss observing interlayer exciton formation in semiconducting transition metal dichalcogenide (TMDC) layers. Unlike conventional semiconductor heterostructures, charge transport in of the devices is found to critically depend on the interlayer charge transport, electron-hole recombination process mediated by tunneling across the interface [2]. Finally, we will discuss the recent development of unconventional superconductivity appeared in twisted double graphene bilayers with small twisting angles. We observed that a ferromagnetic correlated insulating state appears by controlling the flatness of the bilayer graphene band using the perpendicular electric field applied by the gate. Upon doping this ferromagnetic insulator, we obtain the superconductivity, whose transition temperature can be controlled by electric fields. Remarkably, we find that increasing in-plane magnetic field increases superconducting transition temperature, suggesting unconventional superconductivity with spin-polarized cooper pairs [3].


### References


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