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Giant bandgap renormalization and excitonic effects in a monolayer transition metal dichalcogenide semiconductor AARON BRADLEY, MIGUEL M. UGEDA, SU-FEI SHI, Physics Dept. UC Berkeley, FELIPE H. DA JORNADA, Physics Dept. UC Berkeley; MSD LBNL, YI ZHANG, ALS LBNL; SLAC, DIANA Y. QIU, Physics Dept. UC Berkeley; MSD LBNL, WEI RUAN, Physics Dept. UC Berkeley; Physics Dept. Tsinghua Univ., SUNG-KWAN MO, ZAHID HUSSAIN, ALS LBNL, ZHI-XUN SHEN, SLAC; Geballe Lab. Adv. Mat. Stanford, FENG WANG, Physics Dept. UC Berkeley; MSD LBNL; Kavli Nanosciences Inst., STEVEN G. LOUIE, Physics Dept. UC Berkeley; MSD LBNL, MICHAEL F. CROMMIE, Physics Dept. UC Berkeley; MSD LBNL; Kavli Nanosciences Inst. — Reduced screening in 2D has been predicted to result in dramatically enhanced Coulomb interactions that should cause giant bandgap renormalization and exotic excitonic effects in single-layer TMD semiconductors. Here we present a direct experimental observation of extraordinarily high exciton binding energy and bandgap renormalization in a single-layer of a semiconducting MoSe2, grown on bilayer graphene, using high-resolution scanning tunneling spectroscopy and photoluminescence spectroscopy. We have measured both the quasiparticle electronic bandgap and the optical transitions, obtaining an exciton binding energy of 0.55 eV – a value orders of magnitude larger than in conventional 3D semiconductors. We have also studied the influence of external dielectric screening by repeating measurements on MoSe2/HOPG. These results are important for room-temperature optoelectronic devices involving 2D TMDs, as well as more complex layered heterostructures.

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