The evolution of the g-factor of Rydberg excitons in monolayer WSe_2

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We report the observation of radiative recombination from Rydberg excitons in a two-dimensional semiconductor, monolayer WSe_2, encapsulated in hexagonal boron nitride. Excitonic emission up to the 4s excited state is directly observed in photoluminescence spectroscopy in an out-of-plane magnetic field up to 31 Tesla. We confirm the progressively larger exciton size for higher energy excited states through diamagnetic shift measurements. This also enables us to estimate the 1s exciton binding energy to be about 170 meV, which is significantly smaller than previous reports. The Zeeman shift of the 1s to 3s states, from both luminescence and absorption measurements, exhibits a monotonic increase of g-factor, reflecting nontrivial magnetic-dipole-moment differences between ground and excited exciton states. This systematic evolution of magnetic dipole moments is theoretically explained from the spreading of the Rydberg states in momentum space.

References

[1] S.-Y. Chen, Z. Lu, T. Goldstein, J. Tong, A. Chaves, J. Kunstmann, L. S. R. Cavalcante, T. Woźniak, G. Seifert, D. R. Reichman, T. Taniguchi, K. Watanabe, D. Smirnov, J. Yan, (2019), submitted.

Figures

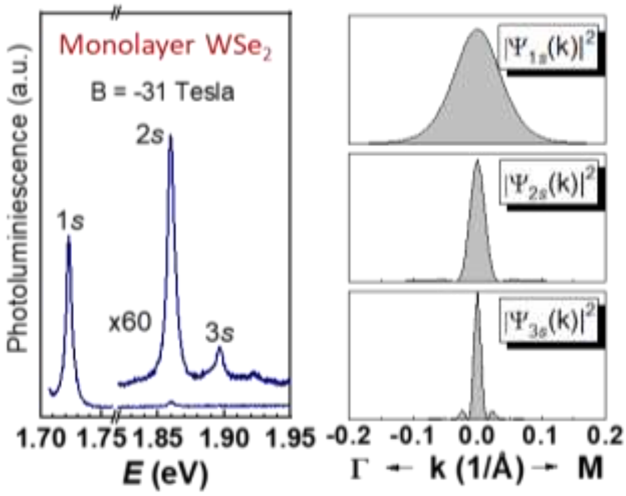

Figure 1: (left) Photoluminescence spectrum of WSe_2 at a magnetic field of -31 Tesla. Emission from 1s, 2s and 3s excitons is observed. (right) The spread of the exciton wave functions in momentum space can explain the increase of the g-factor from 2.15, for the 1s exciton, to 2.53, for the 3s exciton.