EXCITONIC FINGERPRINT OF ATOMICALLY THIN 2D MATERIALS

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As truly two-dimensional materials with a weak dielectric screening, monolayer transition metal dichalcogenides (TMDs) show a remarkably strong Coulomb interaction giving rise to the formation of tightly bound excitons. In addition to the optically accessible bright excitonic states, there is also a variety of optically forbidden states including excitons exhibiting a non-zero angular momentum or a non-zero center-of-mass momentum.

Here, we present the excitonic fingerprint in optical absorption and differential transmission spectra based on a microscopic approach that combines the Wannier equation with TMD Bloch equations. We show the appearance of a pronounced Rydberg-like series of excitonic transitions with binding energies in the range of 0.5 eV [1]. We investigate the microscopic origin of their homogeneous linewidth including radiative and phonon-assisted non-radiative relaxation channels [2, 3]. We predict a significant disorder-induced coupling of bright and dark excitonic states offering a strategy to circumvent optical selection rules and make dark states visible in optical spectra [4]. Finally, we study exciton valley dynamics including Coulomb-driven intervalley coupling mechanisms between the high symmetry K and K' points [5].

Keywords: 2D materials; dark and bright excitons

References

[1] G. Berghaeuser and E. Malic, Phys. Rev. B 89 (2014), 125309.
[2] G. Moody, C. Dass, K. Hao, C. Chen, L. Li, A. Singh, K. Tran, G. Clark, X. Xu, G. Bergaeuser, E. Malic, A. Knorr, and X. Li, Nature Commun. 6, (2015) 8315.
[3] M. Selig, G. Berghaeuser, A. Raja, P. Nagler, C. Schüller, T. Heinz, T. Korn, A. Chernikov, E. Malic, A. Knorr, arXiv:1605.03359.
[4] G. Berhaeuser, A. Knorr, and E. Malic, arXiv:1605.07014.
[5] R. Schmidt, G. Berghaeuser, R. Schneider, M. Selig, P. Tonndorf. E. Malic, A. Knorr, S. Michaelis de Vasconcellos, and R. Bratschitsch, Nano letters 16 (2016) 2945.