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Excitons and Valley Dynamics in MoS_2, $MoSe_2$ and WSe_2 monolayers[1]

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We have investigated the optical and valley properties for both neutral and charged excitons in transition metal dichalcogenide monolayers (ML): MoS_2, $MoSe_2$ and WSe_2. In WSe_2 MLs, we have combined linear and non-linear optical spectroscopy (one and two-photon PLE, Second Harmonic Generation spectroscopy) to uncover the excited states of the neutral exciton. The clear identification of s and p exciton excited states combined with first principle calculations allows us to determine an exciton binding energy of the order of 600 meV. The deviation of the excited exciton spectrum from the standard Rydberg series will be discussed. Moreover we show that exciton valley coherence can be achieved following resonant one or two photon excitation [1]. The neutral and charged exciton dynamics have been measured by time-resolved photoluminescence and pump-probe Kerr rotation dynamics [2,3]. The neutral exciton valley polarization decays within about 6 ps, as a result of the intervalley coupling due the strong electron-hole Coulomb exchange interaction in bright excitons. The temperature dependence is well explained by the developed theory, taking into account the long-range exchange interaction [4]. In contrast the valley polarization decay time for the charged exciton is much longer ($\sim$ 1ns) [5]. Finally we will compare the exciton dynamics in WSe_2 mono and bi-layers [6]

[1] G. Wang et al, arXiv:1404.0056 (2014)
[2] D. Lagarde et al, PRL 112, 047401 (2014)
[3] C.R. Zhu et al, PRB 90, 161302(R) (2014)
[4] M. Glazov et al, PRB 89, 201302(R) (2014)
[5] G. Wang et al, PRB 90, 075413 (2014)
[6] G. Wang et al, APL 105, 182105 (2014)

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