Magnetic Proximity Effects and Charge transfer in $MoSe_2$/CrSBr

C.S. de Brito[1,2], P. E. Faria Junior[3], T. S. Ghiasi[4], J. Ingla-Aynés[4], C. Rabahi[1], C. Cavalini[1], F. Dirnberger[5], S. Mañas-Valero[4,6] , K. Watanabe[7], T. Taniguchi[7], K. Zollner[3], J. Fabian[3], C. Schüller[2], H. S. J. van der Zant[4], and Y. Galvão Gobato[1]

[1]*Department of Physics, Federal University of São Carlos, São Carlos 13565-905, Brazil*
[2] *Institut für Experimentelle und Angewandte Physik, Universität Regensburg, D93040, Regensburg, Germany.*
[3]*Institute of Theoretical Physics, University of Regensburg, 93040 Regensburg, Germany*
[4]*Kavli Institute of Nanoscience, Delft University of Technology, Lorentzweg 1, 2628 CJ, Delft, The Netherlands.*
[5]*Institute of Applied Physics and Würzburg-Dresden Cluster of Excellence ct.qmat, Technische Universität Dresden, Germany*
[6]*Instituto de Ciencia Molecular (ICMol), Universitat de València, Catedrático José Beltrán 2, Paterna 46980, Spain*
[7]*Center for Materials Nanoarchitectonics, National Institute for Materials Science, 1-1 Namiki, Tsukuba 305-0044, Japan.*

yara@df.ufscar.br

Transition metal dichalcogenides (TMDs) are very attractive materials with strong spin-valley coupling and excitonic effects. Chromium-sulfide-bromide (CrSBr) is a promising van der Waals (vdW) magnetic material, undergoing a transition to an A-type antiferromagnetic state below the Neél temperature of $T_N \approx 132$ K. Moreover, vdW heterostructures composed of two-dimensional (2D) TMDs and magnetic materials such as CrSBr are an interesting platform to modify valley and excitonic properties of non-magnetic TMDs. In this work, we have investigated optical properties of $MoSe_2$/CrSBr heterostructures under different magnetic field orientations. Remarkably, we have observed a clear influence of the CrSBr magnetic order on the optical and magneto-optical properties of monolayer $MoSe_2$, such as an anomalous linear polarization dependence, anomalous changes of the exciton/trion energies, an unusual magnetic-field dependence of the photoluminescence (PL) intensities [1]. Under perpendicular magnetic fields, we also observe unusual valley g-factor values with clear signatures of an asymmetric magnetic proximity exchange interaction. Furthermore, our first principles calculations suggest that $MoSe_2$/CrSBr has a broken-gap (type-III) band alignment, which results in an efficient change transfer effect. The observed results are explained by asymmetric magnetic proximity, charge transfer, apossible contribution of exciton/trion magnon coupling/dielectric anomalies in CrSBr. Finally, our work suggests that vdW heterostructures with antiferromagnetic-nonmagnetic interfaces are interesting systems to modify the valley and excitonic properties of TMDs for possible applications in opto-spintronics [1].

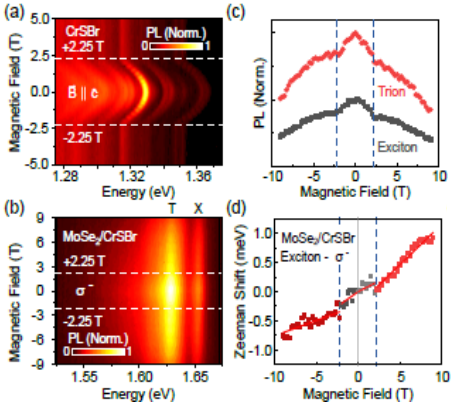

Fig.1; (a) and (b) Typical color-code map of circularly resolved PL intensity for CrSBr and $MoSe_2$ as a function of perpendicular magnetic field and 3.6 K. (c) and (d) Magnetic field dependence of $MoSe_2$ trion and exciton PL intensity and exciton Zeeman shift, respectively [1].

References

[1] C. S. de Brito et al., Nano Letters **23**, 11073 (2023).