Collosal field-induced energy shift of high-energy excitons in 2D van der Waals magnetic semiconductor CrSBr

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The isolation of monolayers from layered materials paved the way for exploring new phenomena occuring in two dimensions. In particular, in recent years there has been a considerable focus on layered materials exhibiting magnetic ordering, either ferro- or antiferromagnetic.

A prominent example of such materials is chromium sulfide bromide – CrSBr, which is particularly interesting due to the combination of semiconducting and magnetic properties. This semiconductor exhibits strongly anisotropic direct-band gap excitations in the near-infrared energy range [1]. Showcasing the intriguing coupling of electronic and magnetic properties, the energy of an exciton was shown to be affected by the magnetic interlayer ordering.

The standard exciton states with energy around 1.32 eV have been thoroughly examined for their prominent tunability in magnetic field of around 15 meV. In this work we present a study of higher-bands exciton states[2] in the same material. With identical anisotropy and qualitatively analogous field dependence, the reported states offer over 7 times wider span of field-tunable exciton energies. We present a phenomenological model of magnetic field-assisted coupling between two higher energy states, providing some insights into the surprisingly large energy shift observed when applying a magnetic field.

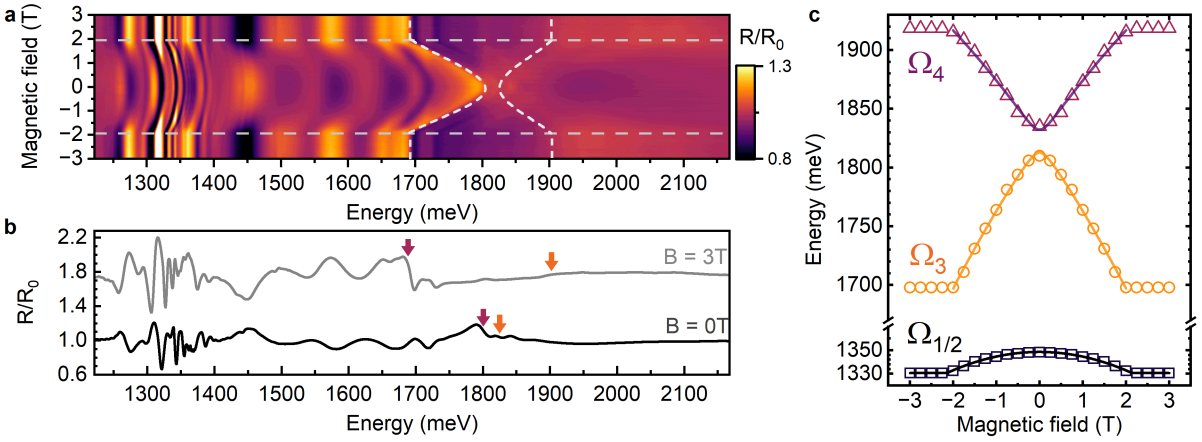

Fig. 1. **a**, Magnetoreflectance map normalized to the substrate reflectance R_0, in a wide range of energy showcasing the absorptions of both the fundamental (1.3 eV), and the higher-bands (1.8 eV) exciton states. **b**, Comparison of the reflectance profiles in magnetic fields of 0T and 3T with two chosen higher-bands states highlighted with arrows. **c**, Extracted energies of earlier denoted states with our phenomenological model for all the states as a function of the magnetic field.

References

[1] N.P. Wilson *et al.*, Nat. Mater. **20**, 1657–1662 (2021).
[2] W. M. Linhart *et al.*, J. Mater. Chem. C **11**, 8423-8430 (2023).