Tuneable dark magneto-exciton-polaritons in CrSBr coupled to bound states in the continuum from a WS2 nanophotonic grating

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Transition metal dichalcogenides (TMDCs) have most commonly been sought after due to their unique exciton properties in the monolayer regime [1]. More recently, however, due to their naturally high refractive index and near-zero absorption at photon energies below the band-edge, along with ever-advancing fabrication and etching techniques, TMDCs have been frequently employed as a method of exploring the nanophotonic and topological playgrounds via etching of photonic crystals and lattices into large-area bulk TMDC flakes, raising a wide-ranging research topic with abundant exotic physical phenomena and photonic applications [2-3]. Here we utilize a WS2 photonic grating to produce an optical bound state in the continuum (BIC) [4]. By coupling the photonic modes to the magneto-exciton of chromium sulphur bromide (CrSBr), we achieve a tuneable BIC polariton, with a Rabi splitting of 92 meV, inheriting an anisotropic B-field dependence from CrSBr, and vortex-like properties from the WS2 grating BIC. Combining these properties leads to B-field dependent non-linearity with stronger polariton-polariton interactions observed in the spin-aligned ferromagnetic regime at high fields, while limited interactions are observed in the low field antiferromagnetic regime.

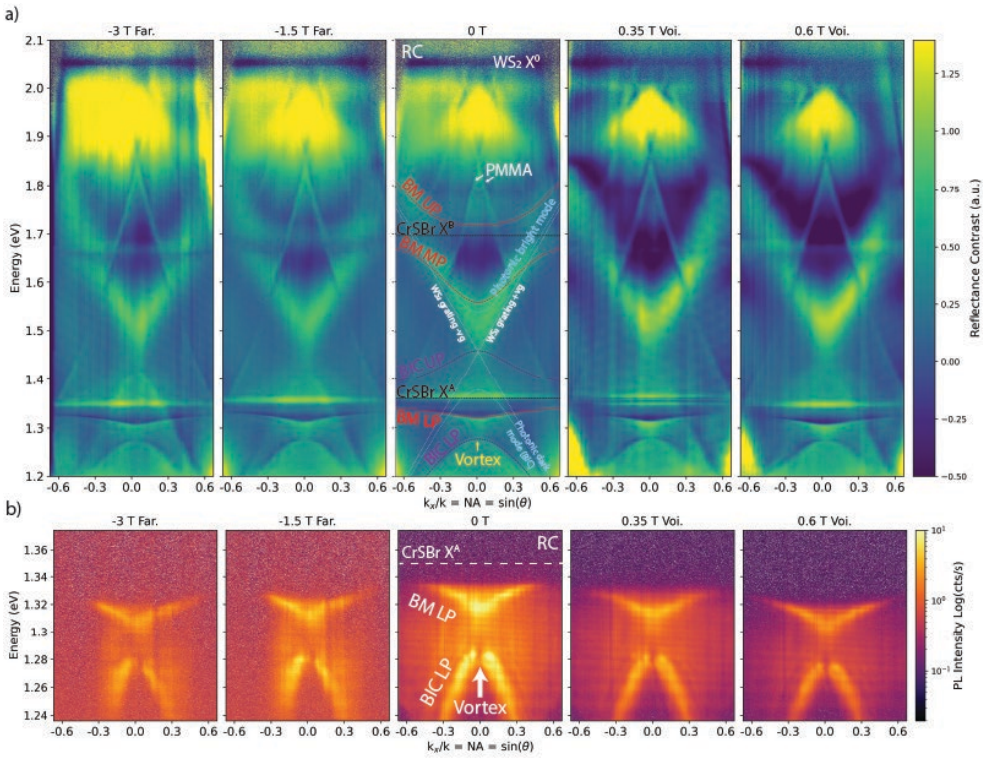

Figure 1: B-field dependent angle resolved reflectance contrast taken at (left to right) -3 T Faraday, -1.5 T Faraday, 0 T, +0.35 T Voigt, and 0.6 T Voigt. The bright and dark (BIC) photonic modes (light blue dashed curves) form as a result of a coupling between the forward ($+v_g$) and backward ($-v_g$) WS_2 grating modes (white dashed lines). These photonic modes strongly couple to the CrSBr magneto-excitons (black dashed lines) to form polaritonic states. Bright upper, middle, and lower polaritons (BM UP, BM MP, and BM LP, respectively) are highlighted with red dashed curves, while the dark BIC upper and lower polaritons (BIC UP and BIC LP, respectively) are highlighted by purple dashed curve fit. b) B-field dependent angle resolved photoluminescence taken at (left to right) -3 T Faraday, -1.5 T Faraday, 0 T, +0.35 T, and 0.6 T Voigt with an excitation power of 100 μW with a 637 nm cw diode laser.

References

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