Bound states in the continuum in subwavelength gratings made of an epitaxial transition metal dichalcogenide

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Optical bound states in the continuum (BICs) are non-radiating states localized inside the light cone, exhibiting topological character revealed through polarization vortices. Achieving BICs in ultrathin photonic structures, such as subwavelength gratings, remains a challenge due to insufficient refractive index contrast in systems made of conventional dielectrics. Promising candidates for subwavelength gratings are transition metal dichalcogenides (TMDs) – especially $MoSe_2$ with its exceptionally high refractive index (4.4 at 1100 nm) and negligible absorption in the near infrared. So far, implementation of TMDs in photonics has been hindered by the limitations of exfoliated flakes – small size and nonuniform thickness. In this work, we overcome these constraints and demonstrate BICs in subwavelength $MoSe_2$-based subwavelength gratings, fabricated from a homogeneous, thickness-controlled, epitaxial layer of inch-scale dimensions. We confirm both experimentally and by numerical calculations the existence of BICs. Moreover, we confirm their potential for enhancing nonlinear optical effects by observation of the efficient third harmonic generation [1].

Figs. 1a and 1b show dispersion curves of a BIC and a leaky mode, at $\lambda = 1100\,\mathrm{nm}$ and $\lambda = 980\,\mathrm{nm}$ respectively, in a 42-nm-high $MoSe_2$-based subwavelength grating. The signature of the BIC's topological protection emerges in the form of a polarization vortex, as shown in Figs. 1c and 1d.

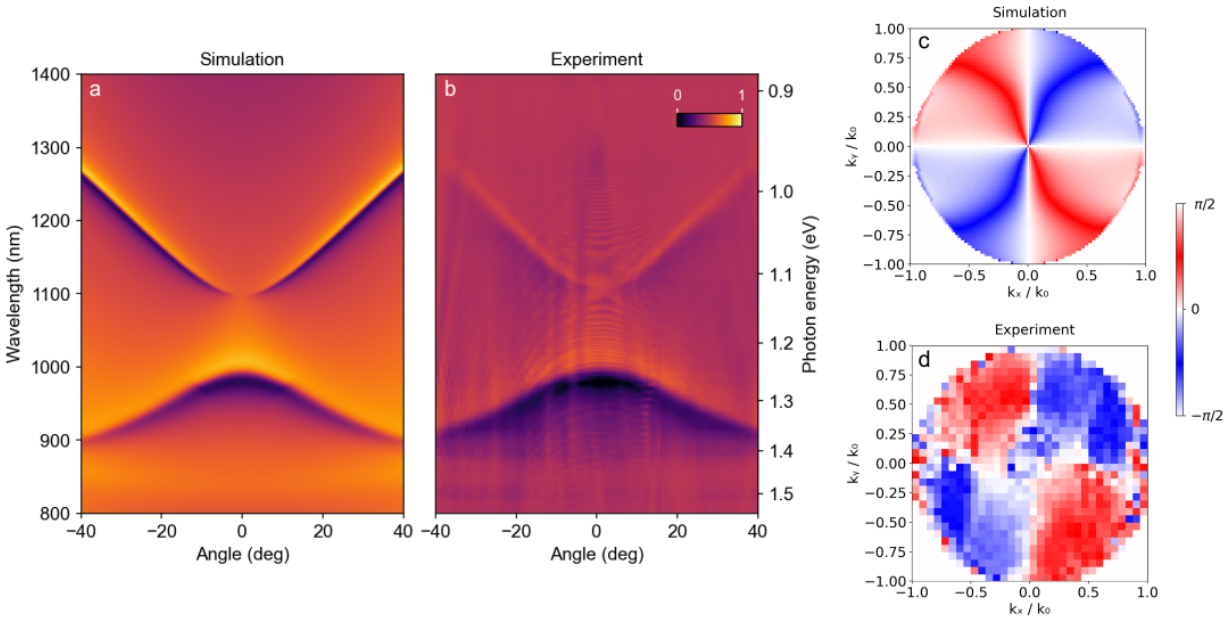

Figure 1: Calculated (a) and experimental (b) angle-resolved reflectivity of the $MoSe_2$ grating for TE polarization. Angle of the polarization vector of the reflected light calculated (c) and measured (d) reveals the presence of the vortex assisting the BIC.

References

[1] E. Pruszyńska-Karbownik et al., arXiv:2502.03121 (2025).

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