Cavity-control of bright and dark interlayer excitons in van der Waals heterostructures

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Monolayer transition metal dichalcogenides integrated in optical microcavities host exciton-polaritons as a hallmark of the strong light-matter coupling regime [1]. Analogous concepts for hybrid light-matter systems employing spatially indirect excitons with a permanent electric dipole moment in heterobilayer crystals promise realizations of exciton-polariton gases and condensates with immanent dipolar interactions. Here, we identify optical signatures of spatially indirect momentum-bright and momentum-dark interlayer excitons in vertical $MoSe_2$-WSe_2 heterostructures and implement cavity-control of both exciton manifolds. To this end we employ a tunable open-access cavity with one curved fiber-based mirror [2] and one planar mirror with extended $MoSe_2$-WSe_2 heterobilayer flakes on top. The configuration of controlled intermirror spacing and lateral scanning capabilities is used to explore the light-matter coupling of excitons as a function of the cavity length at representative positions of heterobilayers selected by two-dimensional cavity imaging. Our experiments quantify the strength of interlayer excitons and demonstrate Purcell enhancement in cavity-modified photonic environments [3].

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