Abstract

This thesis is devoted to the study of spin effects in planar microcavities. Investigated optical resonators were composed of two dielectric mirrors, with the space between them filled with different materials providing polarization dependent effects.

At first the cavity was filled with a layer of nematic liquid crystal. Such birefringent material are characterized with different effective refractive indexes depending on the relative orientation of the linear polarization plane versus the axis of the crystal, which leads to the splitting of the linearly polarized modes of the cavity.

In such system, we investigated a spatial polarization textures arising when polarized light was transmitted through the sample for different orientations of the optical anisotropy of the liquid crystal and observed configurations of second order meron and second order antimeron.

In an analogous system we observed effects resulting from polarization dependent losses. Depending on the non-Hermicity degree we measured shift in the momentum space and following annihilation of the exceptional points originating from different diabolical points.

Second, by incorporation into the cavity a layer of two-dimensional perovskite, we were able to observe emergence of strong coupling regime between the photonic modes and excitons in the perovskite. By additional orientation of the liquid crystalline layer into a twisted nematic structure, we lifted the degeneracy at the diabolical points around the regime of Rashba-Dresselhauss sin orbit coupling. This lead to a polarized band structure of the cavity modes exhibiting nonzero Berry curvature.

Using the strong coupling regime we obtained a polarized emission from the polariton states in a fully isotropic microcavity incorporating monolayers of tungsten diselenide. To achieve this we used, unique for transition metal dichalcogenides monolayers, spin-valley locking, where an exciton with a given spin orientation is confined within a specific valley in the momentum space with limited possibilities for spin flipping and scattering. Utilizing this property by quasiresonantly exciting excitons with a given spin orientation by circularly polarized pump beam we were able to create exciton polaritons exhibiting nonzero degree of the circular polarization of the emitted light.