Merons in Reciprocal Space as a Result of Photonic Spin-Orbit Interaction in Birefringent Microcavity

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Studies of light trapped in liquid crystal optical microcavities (LC MC) offer a possibility to observe a wide variety of quasiparticles and spin-related phenomena. In our work, we present analysis of experimental data and computational methods based on effective 2×2 Hamiltonians, that led to spotting in the system specific polarization patterns.

In this study, we investigate the microcavity filled with liquid crystal, which acts as tunable birefringent material. Different effective refractive indices for light polarized along and perpendicular to the LC anisotropy direction lead to splitting between the horizontally and vertically polarized cavity modes. Through applying external voltage to ITO electrodes across the microcavity, we were able to tilt the molecules around the chosen axis and, therefore, smoothly tune the energy of horizontal mode. For a certain value of applied voltage, we coupled two modes with orthogonal polarization and different parities, which resulted in an analog of the Rashba-Dresselhaus (RD) spin-orbit coupling [1]. We studied polarization of the cavity modes in reciprocal space at positive detuning with respect to RD resonance and observed the appearance of two points with purely circular polarization. Winding of the polarization states around those points in momentum space forms a pattern known as a meron [2,3].

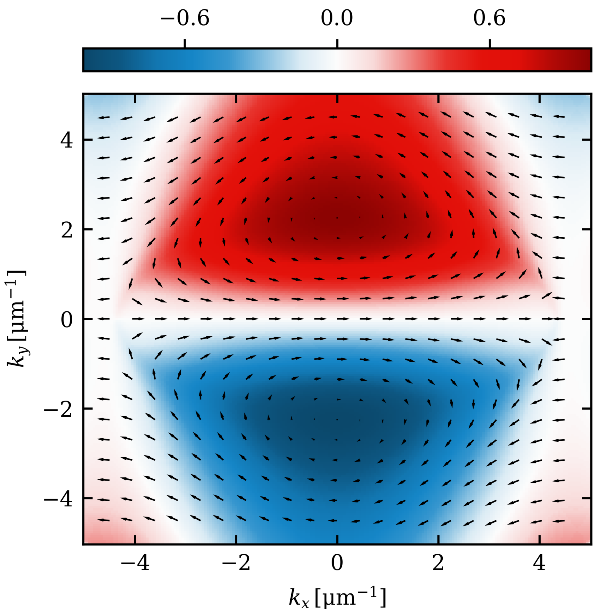

Figure 1: Theoretical results for polarization of light in momentum space calculated on resonant states in outgoing wave boundary condition for RD regime in LC MC. Parameters S_1 and S_2 are denoted as arrows $\vec{S} = [S_1, S_2]^{\mathrm{T}}$ and S_3 in a color scale.

Theoretical descriptions of these systems can be performed by well-known and highly time-consuming Berreman [4] and Schubert [5] methods, but in this work we use our simple theory, which allows us to describe these effects with satisfactory precision. Figure 1 shows the polarization structure in momentum space for the RD regime in LC MC obtained for the cavity with δ-mirrors in the outgoing wave boundary condition.

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