Artificial Gauge Field for Photons Under the Strong Light-Matter Coupling Conditions

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The artificial gauge field for photons strongly coupled to the excitonic resonance of a semiconductor can be synthesized by means of applying crossed electric and magnetic fields. The appearance of the gauge potential can be ascribed to the motional (magneto-electric) Stark effect, which is responsible for the presence of a linear-in-momentum contribution to the exciton kinetic energy. We propose an efficient approach that takes advantage of the crossover from the hydrogen-like exciton to the strongly dipole-polarized exciton state at a specific choice of electric and magnetic fields. The strong sensitivity of the exciton energy to the momentum in this regime leads to the large values of the gauge field. We consider the specific example of a GaAs ring-shaped polariton Berry phase interferometer and show that the flux of the effective magnetic field may approach the flux quantum value in the considered crossover regime. The proposed approach allows for fast and local control of the U(1) gauge field for the light, which paves the way for the investigation of the many-body physics of light.