

Realizing tunable evolution of bound states in the continuum and circularly polarized points by symmetry breaking

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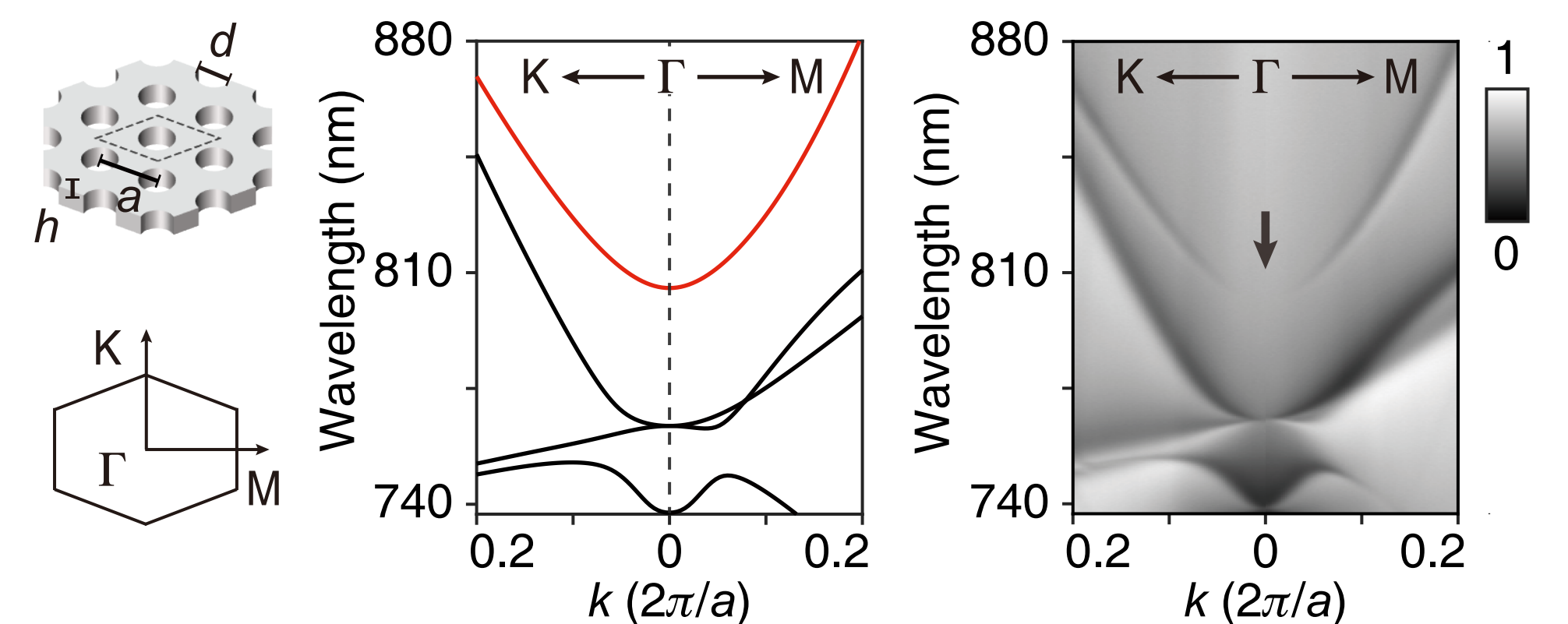
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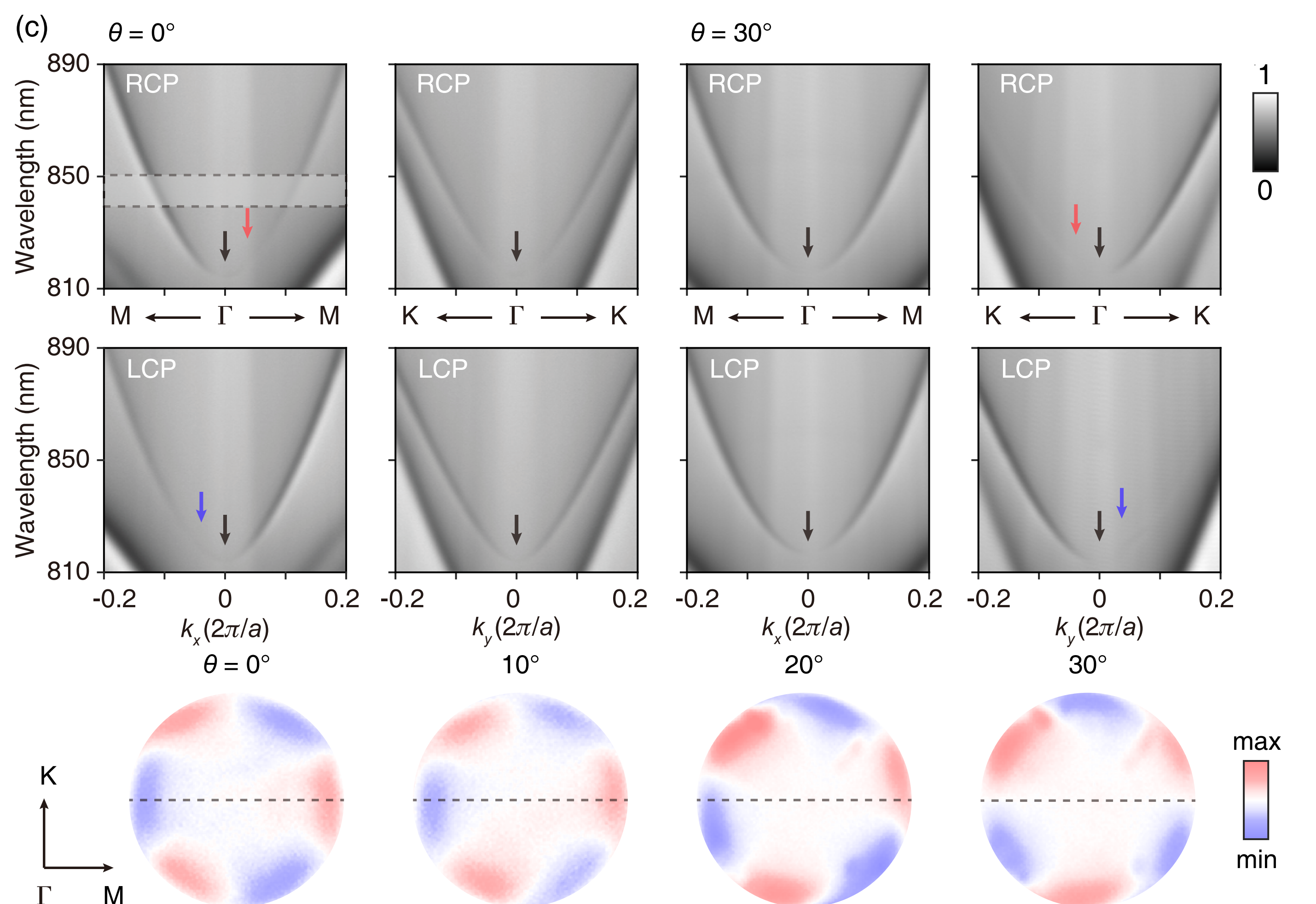
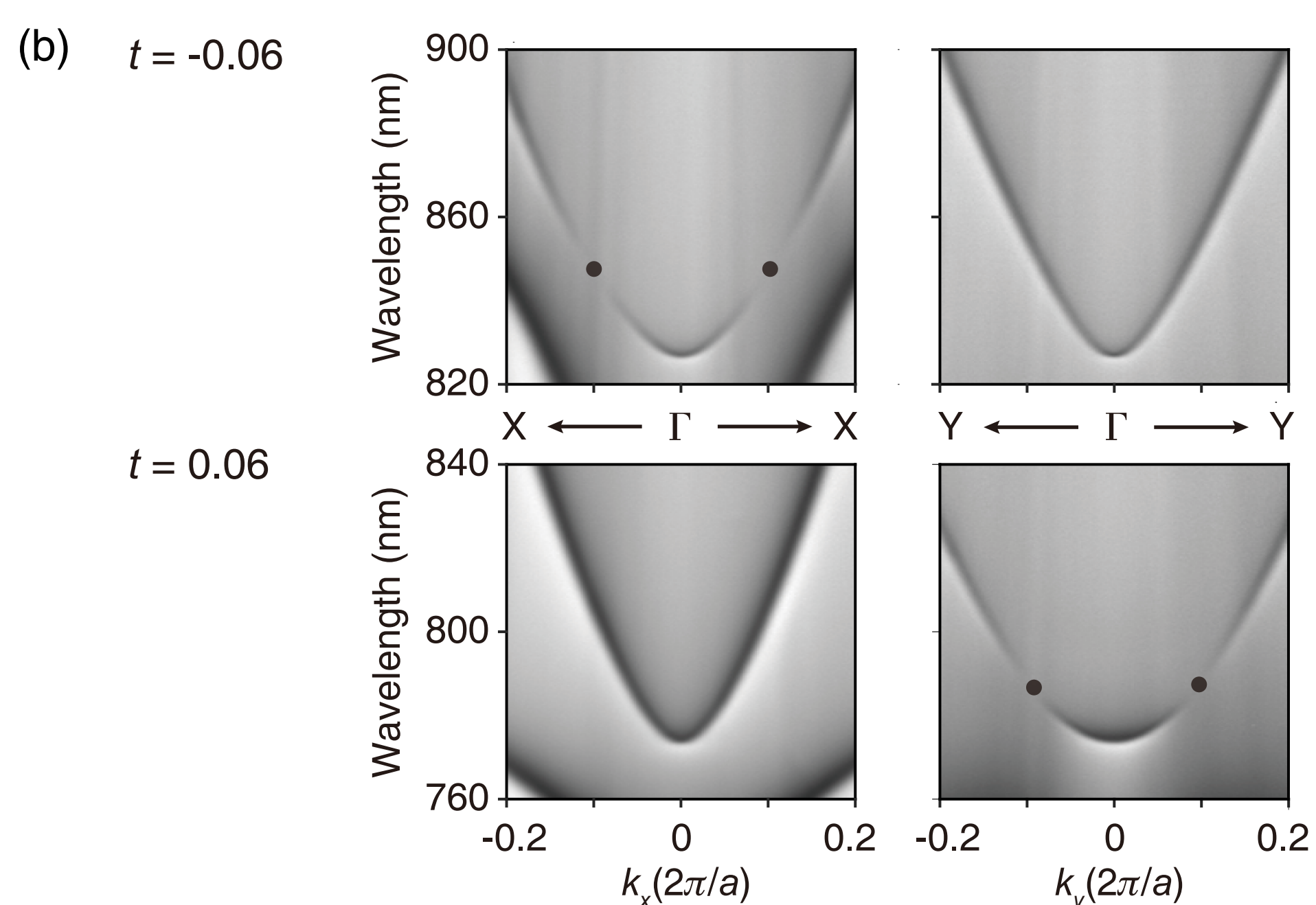
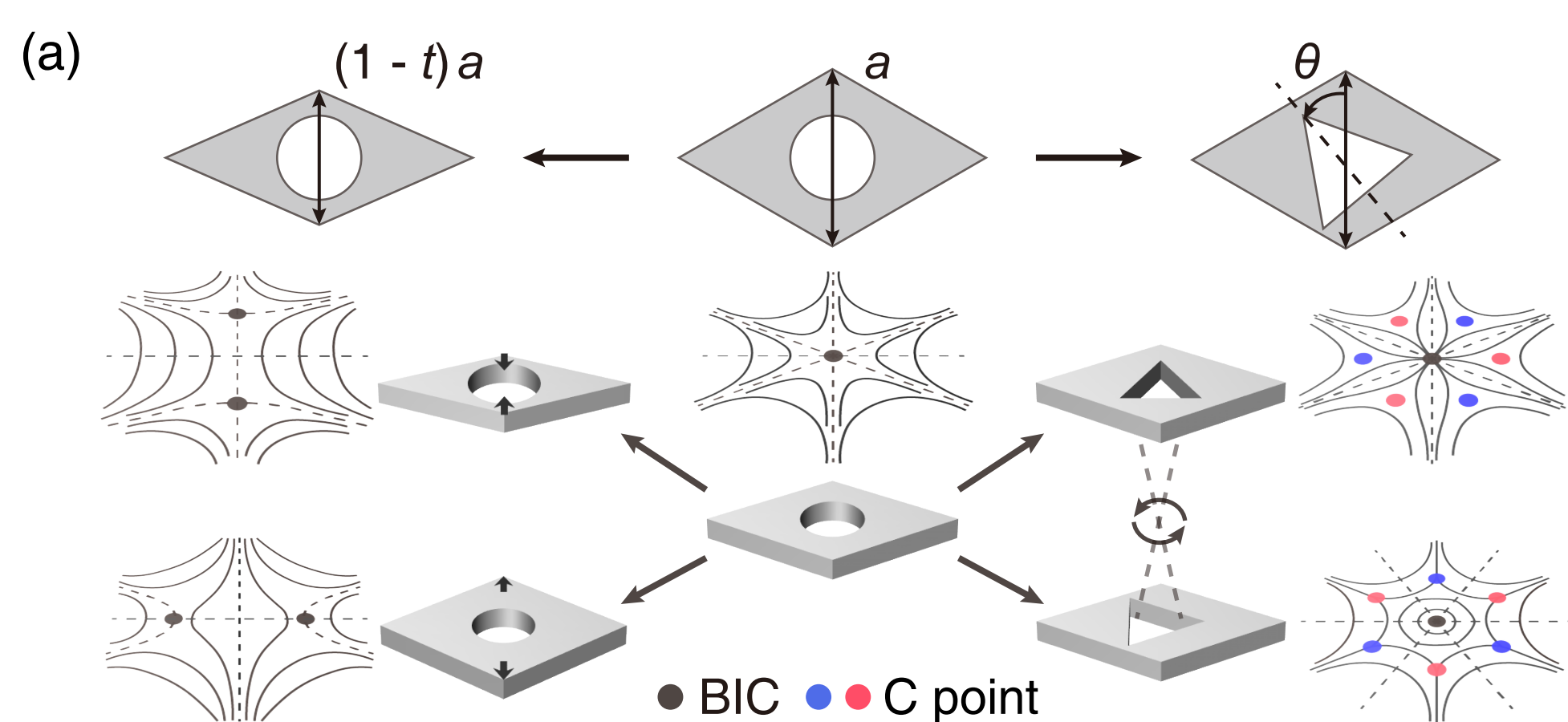
Abstract Bound states in the continuum (BICs) and circularly polarized points (C points), being well-known momentum-space polarization singularities in photonic crystal (PhC) slabs, have attracted much attention for their novel properties. Recently, it was theoretically proposed that starting from a high-order BIC, various evolutions of BICs and C points could be realized by symmetry breaking. To date, there is still no experimental realization of tunable evolutions of polarization singularities from a high-order BIC. Here, we experimentally realized tunable evolution of BICs and C points in momentum space by symmetry breaking on purpose. Starting from a high-order BIC, we observed the generation of polarization singularities under corresponding in-plane symmetry. The symmetry breaking factors were further applied to continuously modulate the movement of polarization singularities in momentum space. Our results can provide effective approaches of symmetry breaking to on purpose designing BICs and C points in momentum space.

High-order BIC in the C_6 -symmetry PhC slab



Schematic view of the free-standing 2D PhC slab with C_6 symmetry and the high-order BIC at the Γ point.

Evolutions of various polarization singularities under corresponding symmetry breaking



(a) Schematic view of the unit cells of the PhC slabs with different in-plane symmetries and illustration of the polarization vector fields in momentum space and their corresponding unit cells. (b) Experimental demonstration of off- Γ BICs under C_2 symmetry. (c) Experimental demonstration of the at- Γ BIC of +1 charge and C points of -1/2 charge under C_3 symmetry and the rotational evolution of C points.

Summary

For the PhC slab of triangular lattice with C_6 symmetry, a high-order at- Γ BIC with -2 charge was experimentally observed and characterized. By breaking the C_6 symmetry to the C_2 symmetry, off- Γ BICs were generated and could be continuously modulated in momentum-space by the symmetry-breaking factor. By breaking the C_6 symmetry to the C_3 symmetry, C points would spawn from the high-order at- Γ BIC, and another BIC with +1 charge emerged and fixed at Γ point. The generated C points were rotated in momentum space by applying the rotation operation on the unit-cell configurations.