# Reflective Geometric Phase in Liquid Crystal Photonics

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Besides the dynamical phase that light accumulates during its propagation, a polarized optical wave can experience a geometric phase-shift that depends only on the geometric properties of followed path. The geometric phase can be observed during transformation of degrees of freedom of light such as: propagation direction, Rytov-Vladimirskii-Berry phase; and polarization, Pancharatnam-Berry (PB) phase [1]. To obtain the PB phase, the polarization is modulated using wave plates with spatially varying optical axis. For a half-wave plate with optical axis at angle $\theta$, and an incident circular polarized light of handedness $\sigma$, the phase is known to be $2\sigma\theta$ [2,3]. These spatially varying wave plates can be realized using sub-wavelength gratings [2] or liquid crystals [3]. After the seminal paper of Marrucci et al. [3], a wide range of Pancharatnam-Berry optical elements (PBOEs) with advanced phase shaping functionalities were demonstrated using statically structured liquid crystalline media [3,4]. Dynamical PBOEs device have also been developed using electro-optical liquid crystals valves [5,6], and were used to generate singular optical beams. In the above cases of PB phase, light need to propagate through the medium.

By using twisted Bragg reflectors such as cholesteric liquid crystals (CLCs), we demonstrated a novel type of geometric phase where the interaction of light and matter is ideally limited to the surface of reflection and the polarization state is unchanged. Even though planar CLC layers reflect circular polarized light with the same handedness as the helix without changing the polarization state, we demonstrated that reflected light exhibit a geometric phase $\phi_B(\theta) = 2\sigma\theta$, where $\theta$ is the angle of the optical axis at the input face and $\sigma$ the handedness of the polarization [7]. This result has been validated numerically (Fig. 1 (a)), and experimentally with planar CLC reflector with piecewise uniform optical axis at the input interface (Fig. (b-d)).

This finding opens new route to reflective geometric phase optical elements, with the possibility to design asymmetric devices where different functionalities can be encoded in the front and back faces via different optical axis patterns.

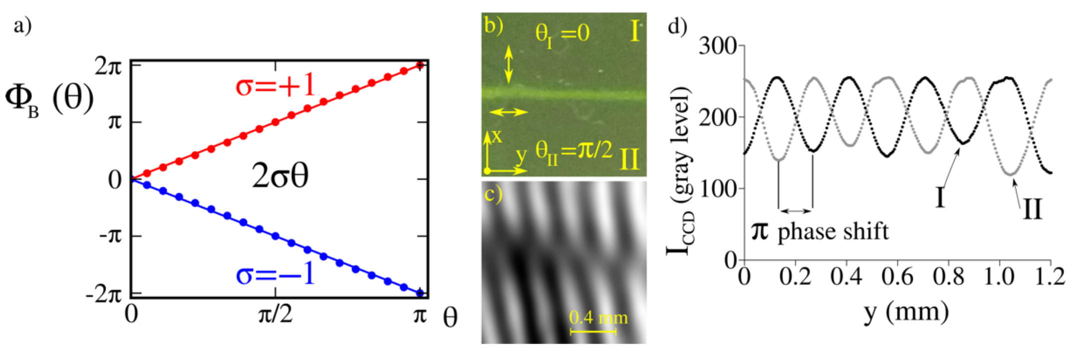


**Fig. 1** (a), Geometric phase $\phi_B$versus the input optical axis angle $\theta$ of a reflected circularly polarized light with handedness $\sigma$ (theory and simulation, resp. lines and dots). (b) Micrograph of a CLC reflector with $\pi/2$ step-wise uniform input optical axis. (c) Plane wave interference with a reflected circular polarized beam. A $\pi$ phase shift between the fringes in region I and II can be clearly appreciated.

## References

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