

# POLARIZED LIGHT FIELD MICROSCOPY OF THIN BIREFRINGENT FILMS

Rudolf Oldenbourg<sup>1,2</sup>, Edward Barry<sup>3</sup>, Zvonimir Dogic<sup>3</sup>

<sup>1</sup> Marine Biological Laboratory, Woods Hole, MA 02540, USA

<sup>2</sup> Physics Department, Brown University, Providence RI 02912, USA

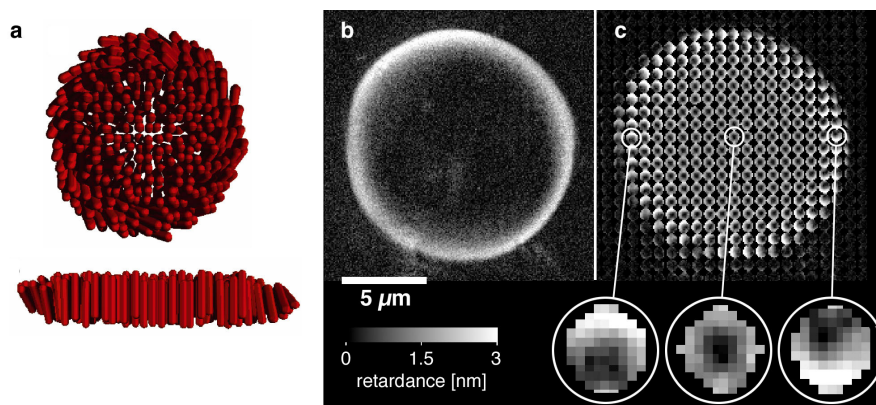
<sup>3</sup> Martin Fisher School of Physics, Brandeis University, Waltham MA 02545, USA

Email: rudolfo@mbledu

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Polarized light microscopy is typically practiced in two, mutually exclusive observation modes, called orthoscopy and conoscopy. In orthoscopy, the specimen is viewed directly, while in conoscopy the ocular is replaced by a telescope lens revealing the conoscopic interference figures formed in the back focal plane of the objective lens. Conoscopy reveals the inclination angle of the optic axis of a uniformly birefringent specimen region. In orthoscopy, the inclination angle, which is the angle between the optic axis and the plane of observation, is usually not evident.

We have developed a new method called “polarized light field microscopy” that is based on a polarizing microscope that includes a microlens array located in the image plane of the objective lens [1]. A CCD camera behind the array captures a hybrid image that consists of a large array of small conoscopic images, each specific to a small sample area. The technique combines an orthoscopic view of the specimen with a multitude of conoscopic images in one single camera exposure. In addition, the liquid-crystal universal compensator of the LC-PolScope (CRi, Woburn MA, <http://www.cri-inc.com>) is used to analyze the conoscopic birefringence patterns projected by each microlens, including the azimuth and inclination angle of the optic axes. Using this new technique, we have analyzed the birefringence of thin films including the colloidal membrane shown in Fig. 1.



**Figure 1:** Cartoon and images of colloidal membrane. **a)** Perspective drawings of a circular colloidal membrane (top and side view) illustrating the alignment of rods confined to the layer. **b)** Retardance image of colloidal membrane composed of rod-like fd virus particles observed in top view with a conventional LC-PolScope. The bulk appears isotropic, as rods align perpendicular to the membrane. The birefringence near the edge is possibly caused by tilted fd particles as indicated in the cartoon. **c)** Retardance image of same membrane observed with Light Field LC-PolScope. Each small disc represents the objective's back focal plane, specific to a small region of the membrane. The three insets are taken from the left, center, and right edge, confirming the change in tilt angle of the optic axis caused by the chiral symmetry of alignment between fd particles near the edge.

[1] R. Oldenbourg, “Polarized light field microscopy: an analytical method using a microlens array to simultaneously capture both conoscopic and orthoscopic views of birefringent