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Soft Matter Physics – Alberto Group

Postdoctoral Fellow

Research Area

The goal is to investigate soft matter under different geometries while the interest is in understanding topological defects.

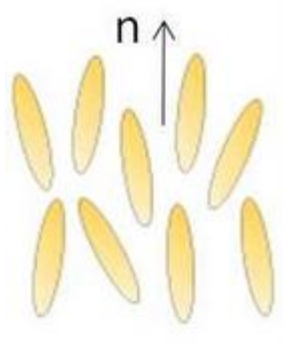
Groups Members Involved in this project

Alberto (Leader of the group), Ekapop (graduate student) and of course myself

Over View

Liquid crystals are substances that exhibit properties of both liquids and crystals. They have high orientational order found in crystalline solids as well as the low positional order found in liquids. The variety of different phases displayed by liquid crystalline materials has led physicists to investigate in two different fields such as phase transitions and topological defects.

One of the most exciting mesophase seen in almost all the laptops today is the nematic phase. The nematic liquid crystals has long range orientational order but no long range positional order. The average orientation of the molecules is represented by a dimensionless unit vector ***n*** called the director. The direction of individual molecules change smoothly and slowly from point to point in the medium as shown in Figure 1.



Liquid Crystal

The concept of defect was first introduced in order to explain the process of plastic deformation in metals. Defects in Liquid Crystals has no exception in this respects. By confining nematic liquid crystals to a curved surface, the topology imposes distortion in the molecular orientation which was studied by our previous group members for details look at the publication tab. In certain regions the molecular orientation is such that the director cannot be defined. Such regions are called topological defects.

We study topological defects that arise when nematic liquid crystals are confined to toroidal geometries as well as high genus nematic liquid crystal droplets. One of our motivation for studying toroidal droplets is that the transition seen in DNA torus from the twisted structure to the bend structure with variation of solvent concentration [1] and the number and type of defects in a drop of liquid crystal is subject to the geometrical constraints so, from Poincare-Hopf theorem the total topological charge must equal to the Euler Characteristic X, which is given by $X=2(1-g)$, where g is the genus of the surface. Thus on a torus we must have $X=0$ and on a figure eight one must have $X=-2$ *and so on……..*

These toroidal droplets are produced a rotating continuous phase that exerts a viscous force on the inner phase while it is injected into the first one using a needle. The system is stabilized using a viscoelastic force on the inner phase while it is injected into the first one using a needle. The shape is stabilized using a viscoelastic continuous phase that allows the formation of the drop while rotating, but that freezes the shape once the rotation is stopped [2]. For full details look at Ekapop home page.

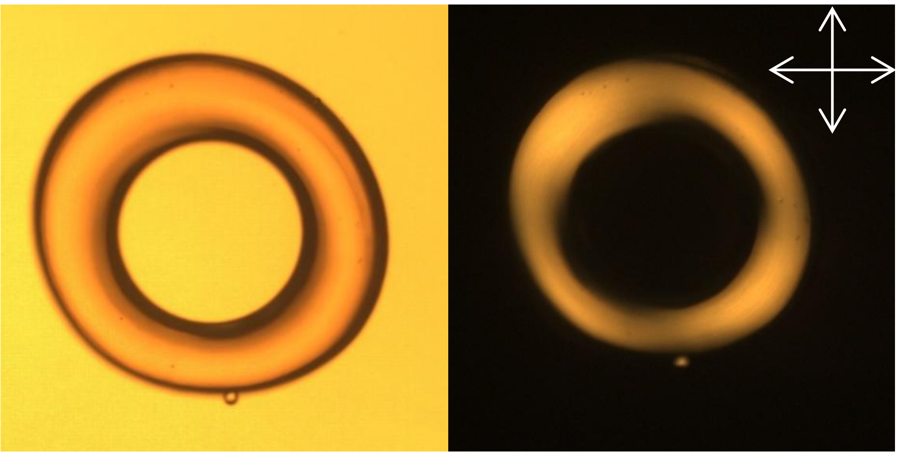


Figure 2: (a) top view under bright field (b) Top view under cross polarizers.

Nematic liquid crystal toroidal droplets stabilized using the above mentioned method under planar anchoring conditions is shown in Figure 2. Side view of torus under cross polarizers is shown in Figure 3 which looks bright for all rotation of sample suggest presence of twist director pattern.

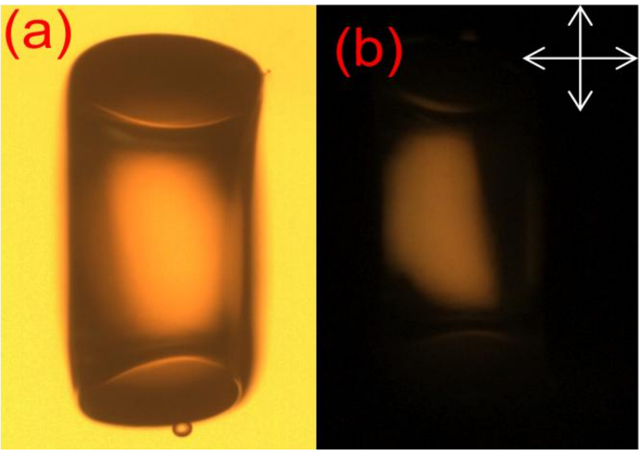


Figure 3: (a) Side view under bright field (b) Corresponding cross polarized image.

What happens by increasing number of handles and where the defects are located curious to see......please come back after some time.........it's under construction....................thank you!

References:

1. E. Pairam, A. Fernandez-Nieves, *Generation and stability of toroidal droplets in a viscous liquid,* Physical Review Letters 102, 234501 (2009).
2. I. M. Kulic, D. Andrienko ´ and M. Deserno, Twist-bend instability for toroidal DNA condensates, Europhys. Lett., 67 (3), pp. 418–424 (2004).