Controlling Topological Defect in Nematic Liquid Crystal with Focuesed Laser

Dept. of Physics, Kyoto Univ.
Masahiro Kojima[1] , Jun Yamamoto and Kenichi Yoshikawa

シュリーレンテクスチャを擁するネマチック液晶試料中に、集光レーザーを位置を変えながら連続照射することで多重のリング状 wall 構造をつくり出した。この wall 構造はその中心から動径方向にダイレクタが回転している秩序構造であると考えられるが、実際に時計回りと反時計回りの二種類が存在することを実験的に確認した。また輝度解析によりリングの半径が等比数列になっていることを発見し、それを数理モデルにより説明した。

Liquid crystal has an anisotropic optical property that gives huge ordered and disorderd spatio-temporal patterns through a polarizing microscopy. Here, we report a new orderd structure formation mediated by a defect of liquid crystal together with a convergent linearly polarized laser beam Lnearly polarized laser beam have an ability to reorient illuminated liquid crystalline molecules along the laser polarization direction[1].

Nematic liquid crystal (5CB) prepared in a cell with a few μm gap was illuminated by a focused laser beam (Nd:YAG λ= 1064nm). By a continuous counterclockwise displacement of the beam spot around a wedge disclination(depicted in fig.1 (A)), a triplet ring-like wall structure is emerged(fig.1 (B)). In the structure, the direction of molecules are only dependent on the distance from the circular center. When the laser irradiation is shut off, the structure disappeared at about two seconds. It was found that the radii of the rings become almost a geometric progression. The above mentioned characteristics may be explained by minimizing the expression of Frank elasticity[2] with a proper boudary condition. The azimuth angle of the diretor psi at a distance r from the structure cnter given as

$$\psi = (\psi_b - \psi_c)\frac{\log(r/r_c)}{\log(r_b/r_c)} + \psi_c \qquad (1)$$

where ($\psi(r_c) = \psi_c$, $\psi(r_b) = \psi_c$) is boundary condition including the laser effect and bulk alignment.

There are two type of multiple wall structure whose raii spread or shrink by a same analyzer rotation(fig.2). The difference originates from the clockwise or counterclockwise director rotation along the radial direction of the structure. By a qualitative discussion, shrink one correspond to counterclockwise director rotation along the radial direction and spread one is clockwise rotation.(fig.2 (B)).

[1]E-mail: kojima@chem.scphys.kyoto-u.ac.jp

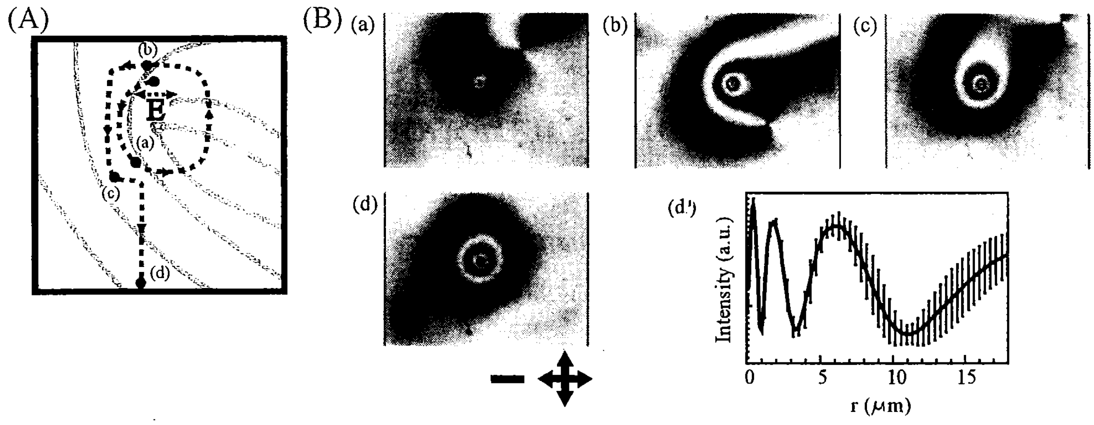

Figure 1: Formation of triple ring-like wall induced by a orbiting trajectory of beam spot illustrated in (A) around a +1/2 wedge disclination. The correspoinding snapshots are inserted in (B). (a)-(c) The snapshots showing the single, double and triple wall structure respectively. (d) Triple ring-like wall structure averaged for 6 seconds. (d') Averaged radial intensity profile of (d) with error bars every four data point. When the laser irradiation is shut off the multiple ring structure dissolve over a period of a few seconds. Scale bar represents 10 μm. The crossed black double-head arrow represents the direction of crossed Nicols.

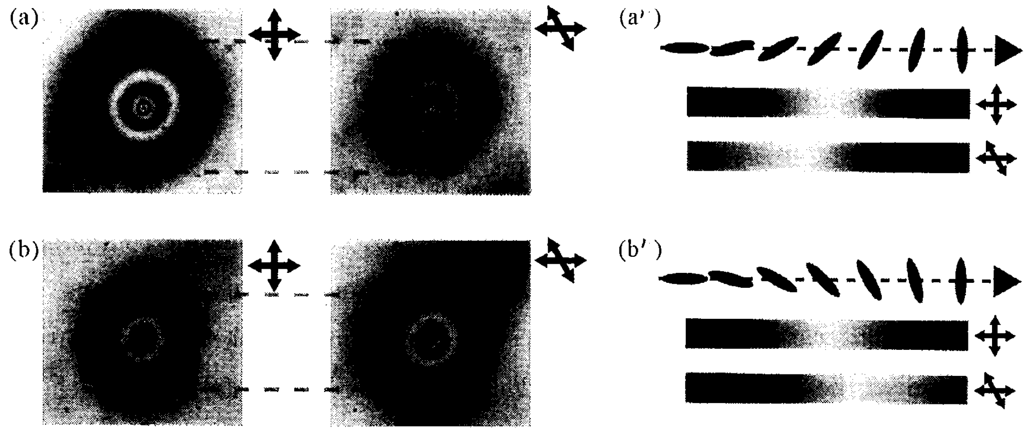

Figure 2: (a) Shrink and (b) spread of the multiple wall structure observed by a analyzer rotation. Primed figures are the schematic representation of the director rotation and the transmitted light intensity along the radial direction. The double-head arrow is the direction of analyzer and polarizer.

References

[1] F. Simons and O. Franceangeli, J. Phys. Cond. Matt. **11** (1999), R439.

[2] P. G. de Gennes and J. Prost, *The Physics of Liquid Crystals*, 2nd ed. (Oxford Science Publications, Oxford, (1993).