ESF Exploratory Workshop on

Frontiers in European Research on
Liquid Crystalline Soft Matter

LC Lab Bandol, France, May 27-29th 2009

Session i: Liquid crystals in and from living matter and in medicine

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Unsolved problems in liquid crystal defects and textures, with examples from both synthetic matter and biological systems

There are numerous unsolved paradoxes in liquid crystals and also many plausible experiments which do not work, even after repeated tentatives and high level of sophistication. Traditionally negative results are never published. However, discussion of negative results can be extremely interesting in certain cases.

One example is that of thick and thin threads, observed in normal or slightly twisted nematics. These threads often form loops which decrease in diameter and disappear, or give rise to a singular point. The initial topological situations differ in such cases and considerations about energy also deserve attention.

The threads often recombine and if, for instance, threads AB and CD join at a point J which is singular and unstable, two new threads form which are either AC and BD or AD and BC, or a third situation, A,B,C,D being four fixed points. The problem is to know the initial topological situation corresponding to a well-defined type of recombination. This type of problem is also encountered in the study of blue phases with highly complex structures found between the isotropic and the cholesteric phase.

The problem of recombination is also interesting to consider in the study of chromosomes, in bacteria and in some flagellates, which show a cholesteric structure, and there are plausible analogies with the well known process of crossing-over in many types of chromosomes.

Similar examples can be discussed with smectics A and C, chiral or not, and also in the case of cholesteric phases of diverse biopolymers, collagen for instance.

I will end by some examples on a much larger scale, that of the whole individual, the embryo for instance, with a collagen network just below the future epidermis, with remarkable singularities and geometries closely related to those of disclinations and screw dislocations in cholesterics. The discussion of such structures leads to reconsider the question of curvilinear transformations of morphology introduced by D'Arcy Thompson in 1917 in his famous book *On Growth and Form*. This research field was not fully appreciated by many biologists, since their attempts to give clear drawings of these transformations on concrete examples were unsuccessful, and as usual they did not publish such work. However, the ideas of D'Arcy Thompson have been revived in many recent articles on the morphometry of diverse species, and we believe that the examination of the singularities will be unavoidable in order to have a coherent view of such transformations, either in the study of development, or at the level of biological evolution.