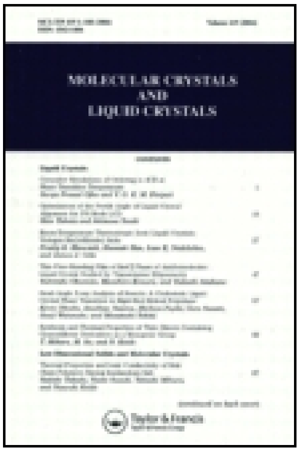

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Observation of Apparent High Strength Singularities in Mixtures of Nematic Thermotropic and Lyotropic Liquid Crystals

H. Lee [a] & M. M. Labes [a]
[a] Department of Chemistry, Temple University, Phila., Pa., 19122
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OBSERVATION OF APPARENT HIGH STRENGTH SINGULARITIES IN MIXTURES OF NEMATIC THERMOTROPIC AND LYOTROPIC LIQUID CRYSTALS

H. LEE AND M. M. LABES
Department of Chemistry, Temple University, Phila., Pa. 19122

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High strength singularities (up to +4) are observed in emulsions of lyotropic with thermotropic nematic phases. They are most likely associated with multiple disclinations emerging near a microdroplet of one phase in the other.

In the schlieren textures of nematic liquid crystals observed between crossed polarizers, there are certain singular points indicative of disclinations in the material.[1] The end of the disclination line, running almost normal to the sample plane, appears as a point attached to the surface of the glass, or, in a free droplet, at the surface of the sample.[2] The "strength" of these singularities, which can be measured by the number of "brushes" which are observed and the direction of their apparent movement when polarizer and/or analyzer are moved is given by $|s|$ = number of brushes divided by 4. S has been observed to take on only the values $\pm\frac{1}{2}$, ± 1. Singularities are not independent -- they may interact and extinguish one another, as the phase attempts to achieve a state of minimum tension.

In the course of our recent work on aqueous lyotropic mesophases, we have mixed thermotropic and lyotropic nematics. Such a mixture emulsifies, and very small droplets, of the order of optical wavelengths or below, can be formed of the water phase in the neat thermotropic material, or the reverse. These are not truly microemulsions, and break in the order of 1 - 20 minutes. Such mixtures, when spread on a microscope slide, sheared with a cover slip, and observed after removing the cover slip, contain a rich array of singularity points with as many as 16 brushes emerging from a single core. The samples involved are mixtures of the thermotropic liquid crystal 4-cyano-4'-pentylbiphenyl (CPB) to which a droplet of the lyotropic liquid crystal disodiumcromoglycate[3]-water-ethylene glycol (DSCG|H_2O|EG) in the weight ratios 15:60:25 is added (Fig. 1). Mixing is accomplished either manually or ultrasonically and the sample observed immediately. Similar results are observed when a mixture of CPB with EG is examined as EG diffuses into CPB and destroys the phase (Fig. 2). Also, when p-methoxybenzylidene-n-butylaniline (MBBA) is added to DSCG|H_2O|EG, similar phenomena are observed (Fig. 3).

It is, of course, very difficult to distinguish between a "true" high singularity or several points bunched around an immiscible droplet of sub-microscopic size. The singularities undoubtedly originate from the strong director fluctuation at the droplet interface. Some contain brushes representing surface pinned disclinations combined with bulk disclinations.[4] As the emulsions break, the singularities divide to give conventional ±1 singularities. It appears likely that it is only around a microdroplet core with a high fluctuation of the surface tension that such high strength singularities have some stability.

It is interesting to speculate whether true microemulsions of a liquid crystalline phase might lead to stabilization of such high strength singularities.

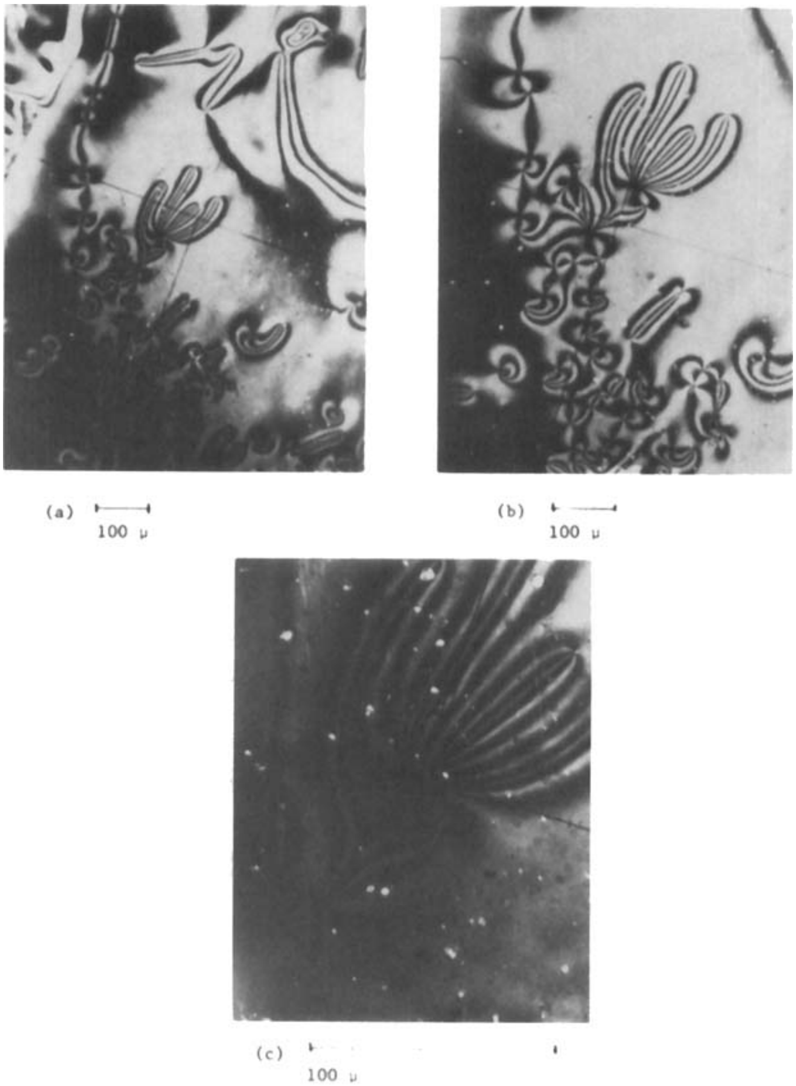

Figure 1. Photomicrographs (crossed polars) of CPB mixed with a droplet of DSCG|H_2O|EG. (a) +4, +2, +2½ singularities; (b) the +2 and +2½ singularities of photo (a) have combined; (c) enlargement of +4 and +3 singularities observed in (b), where +3 has begun to divide.

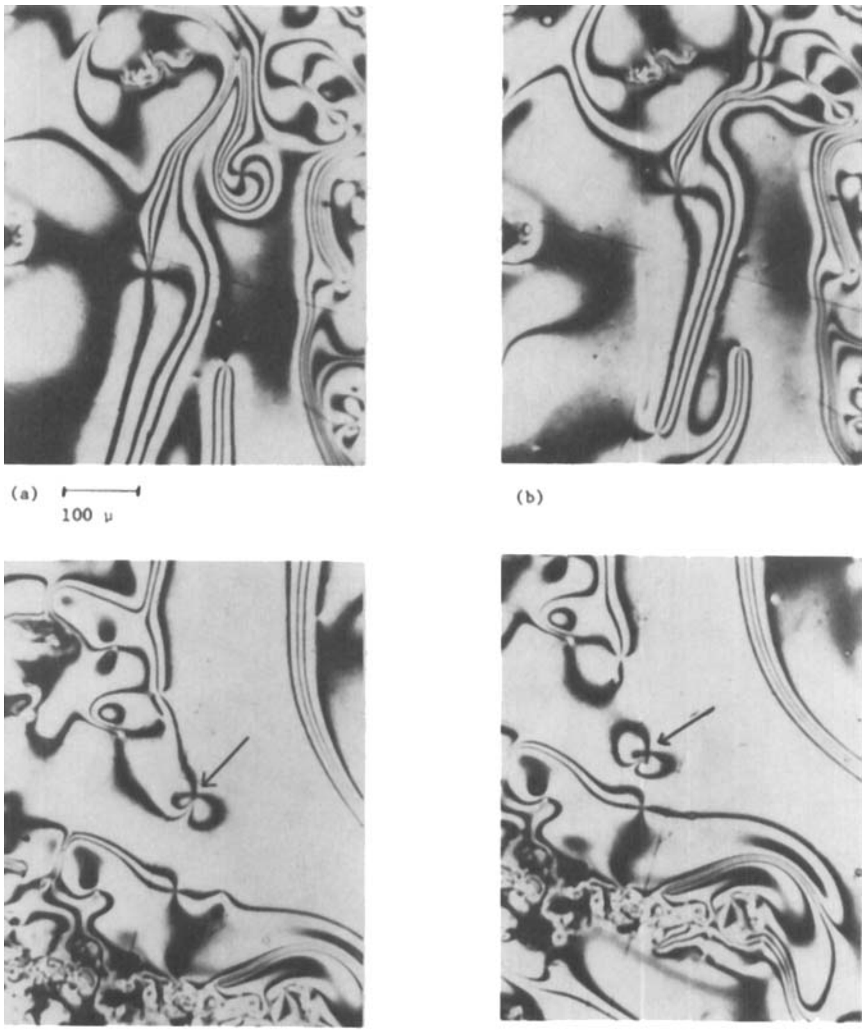

Figure 2 (a - d). Photomicrographs (crossed polars) of CPB mixed with a droplet of EG. Note the +1½ point which reduces to a +1 singularity. Time interval between photos is ∿ ½ minute.

Figure 3. Photomicrograph (crossed polars) of MBBA mixed with a droplet of DSCG|H_2O|EG. High strength singularities from ½ to 4 are oɒserved.

Experiments to this end are in progress.

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