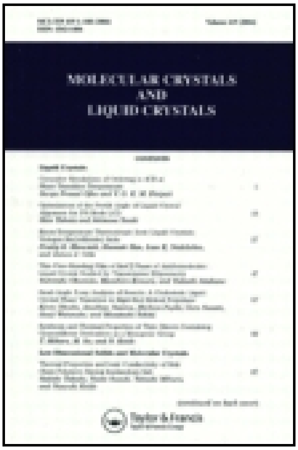

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On Dislocations And Disclinations

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ON DISLOCATIONS AND DISCLINATIONS

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Abstract The similarity between the mathematical descriptions of crystal dislocations and of liquid crystal disclinations is discussed.

The aim of this note is to point out the close similarity between the properties of screw dislocations in crystals and those of disclinations in nematic liquid crystals. In the case of a screw dislocation the fundamental parameter describing the atomic displacement is the Burgers vector[1] $\vec{b}$, while in the case of a disclination the analogous parameter describing the director orientation is $2\pi s$, where s is the strength of the disclination.[2] We consider the situation in which the atomic displacement w or the director tilt θ is a function of x and y only and not of z, the singular axis. The most important properties are summarized in Table 1.

From the results set out in Table 1 it follows at once that by effecting the transformation $\mu \to k$, $b \to 2\pi s$ and $\nu \to -1$ (incompressible solid) one can arrive at the properties of disclinations from those of dislocations.

A similar analogy evidently exists between edge dislocations in crystals and twist disclinations in liquid crystals (such as those observed in the Grandjean-Cano wedge[5]). For example, in the case of the edge dislocation,

TABLE 1

	Screw dislocation	Disclination
Equation of equilibrium	$\nabla^2 w = 0$	$\nabla^2 \theta = 0$
Structure	$w = \frac{b}{2\pi}\tan^{-1}\frac{y}{x}$	$\theta = s\,\tan^{-1}\frac{y}{x}$
Energy (R=sample radius r_o=core radius)	$E = \frac{\mu b^2}{4\pi}\ln\frac{R}{r_o}$	$E = \pi k s^2 \ln\frac{R}{r_o}$ (ref.3)
Attractive force between unlike defects at a distance r	$f = \frac{\mu b^2}{2\pi r}$	$f = \frac{2\pi k s^2}{r}$ (ref.4)
Strain energy of an unlike pair	$\varepsilon = \frac{\mu b^2}{2\pi}\ln\frac{r}{r_o}$	$\varepsilon = 2\pi k s^2 \ln\frac{r}{r_o}$ (ref.4)
Tension (λ = kink length)	$T = \frac{\mu b^2}{2\pi(1-\nu)}\ln\frac{\lambda}{r_o}$	$T = \pi k s^2 \ln\frac{\lambda}{r_o}$ (ref.5)
Reactions	$\vec{b}_1 + \vec{b}_2 = \vec{b}$ ($b_1 + b_2 = b$ for parallel dislocations)	$s_1 + s_2 = s$ (ref.3,4
Boundary effects	The boundary attracts or repels the defect with an image force.[1,5]	

μ = Crystal shear modulus, ν = Poisson ratio,

$k(= k_1 = k_3)$ = Liquid crystal elastic constant

the displacement normal to the dislocation line and the half plane varies as $\tan^{-1}(x/\xi)$. The same law describes the variation of the tilt of the director normal to cholesteric planes near a twist disclination.[6]

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