Biaxial nematics: their possible symmetries and domain structure

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The theoretical possibility of a biaxial nematic phase was demonstrated, first by M.J. Freiser, in 1970 (1). The prediction envisaged an achiral apolar phase with three mutually orthogonal symmetry axes. This corresponds to the D_{2h} symmetry group and constitutes the most natural choice for illustrating the theoretical possibility, in the sense that it introduces the minimal asymmetry to the uniaxial nematic phase (i.e. the minimal symmetry breaking of $D_{\infty h}$) that could be reflected on the second rank tensor physical properties characterising an apolar nematic phase.

Understandably, most of the subsequent theoretical and computer simulation works on biaxial nematics dealt, either explicitly or implicitly, with phases of this high symmetry. However, such restriction is neither warranted by theory, where a variety of symmetries for the biaxial nematic phase are *a priory* possible, nor imposed by experiment, particularly in the case of the recent experimental evidence of biaxiality in thermotropic nematics(2,3). We demonstrate that there are in fact strong experimental indications that phase biaxiality in these systems could be of lower symmetry than D_{2h}.

We also consider the spatial aspects of biaxial order in the context of the cluster model (4), wherein macroscopic biaxiality can result from the field-induced alignment of biaxial and possibly polar domains. The implications of different symmetries, in conjunction with the microdomain structure of the biaxial phase, on the alignment of biaxial nematics and on the measurements of biaxial order are also discussed.

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