MAR06-2005-005674

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Liquid Crystal Phases of Molecular Bananas: Polarity and Chirality as Broken Symmetries[1]

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The study of the interplay of chirality and polarity has been a particularly rich theme of soft matter science since Meyer's seminal discovery that tilted smectics of chiral molecules are macroscopically polar. This event, and the subsequent realization of polar domains and high-speed electro-optic switching in chiral smectics, engaged the liquid crystal community in a worldwide pursuit of novel smectics for applications, featured by the synthesis of more than 50,000 new liquid crystal compounds, and by a consequent broad diversification of the palette of liquid crystal phases and possibilities for supermolecular ordering. A current important activity in this scenario is the study of polar order in synthetically achiral molecules, for example, in molecular bananas, which, as their shape suggests, might be expected to organize in a polar way. Indeed they do, but beyond this, almost everything learned about them has been surprising, including their persistent tendency to exhibit chirality as a spontaneously broken symmetry. I will discuss some of these new phases and phenomena, including the discovery of fluid conglomerates (Pasteur's experiment in a fluid), triclinic fluid order, chiral twist grain boundary phases of achiral molecules, chirality flipping and field-induced deracemization, ferroelectric and antiferroelectric phases with supermolecular-scale polarization modulation, and chiral thermotropic sponge phases.

[1]Work in collaboration with the Boulder Liquid Crystal Group, supported by NSF MRSEC Grant DMR 0213918.