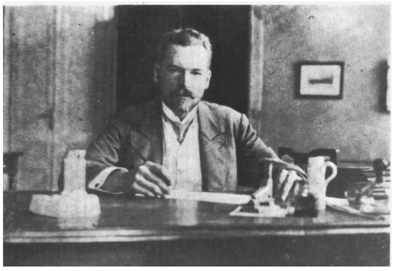

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Properly dealing with recent discoveries in suspensions of bent colloidal rods by means of a grand-canonical Landau-de Gennes theory

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Bent-core liquid crystals are mesophases formed by molecules having a "banana-like" shape that favors spontaneous bend deformations in the nematic director field. As a pure bend deformation cannot uniformly fill 3D space, Meyer and later independently Dozov argued that these local bend deformations should be accompanied by either a twist or a splay deformation [1]. In the former case, they theoretically postulated the stabilization of a spatially modulated twist-bend nematic (N_{SB}) phase; in the latter case, they predicted the onset of a spatially modulated splay-bend nematic (N_{SB}) phase.

While most of the research on bent-core liquid crystals has focused on thermotropic bent-core mesogens that become liquid crystalline upon lowering the temperature, very recently various routes have been developed to synthesize lyotropic colloidal model systems of bent particles whose liquid crystalline behavior is driven by concentration.

In this context, a stable N_{SB} phase has been experimentally observed (for the first time!) in a system of smoothly curved colloidal rods [2] and later in polydisperse bent silica rods [3]. However, the nematic nature of the discovered phases has been questioned. Recent simulations [4], indeed, have showed the (alleged) N_{SB} phases to display density modulations, which cannot be described by current Oseen-Frank and Landau-de Gennes type theories [1].

Using a novel grand-canonical Landau-de Gennes theory for colloidal suspensions of bent rods [5], we investigate [6] how spatial deformations in the nematic director field affect the local density of N_{TB} and N_{SB} nematic phases. The grand-canonical character of our theory naturally relates the local density ρ to the local nematic order parameter S. In the N_{SB} phase, we find S and hence ρ to modulate periodically along one spatial direction. As a consequence the N_{SB} phase has the key symmetries of a smectic rather than a nematic phase. By contrast, we find that S and hence ρ do not vary in space in the N_{TB} phase, which is therefore a proper nematic phase. We argue the density modulations to be inherently coupled to splay deformations in the nematic director field.

Finally, we employ our theory to study the first-order $N-N_{\text{TB}}$ phase transition observed in simulations of hard bent spherocylinders [4]. We find that the bend elastic constant K_{33} as well as its renormalized version K_{33}^{eff} remain positive at the transition, whereas K_{33}^{eff} vanishes at the nematic spinodal. This finding appears to be general and could help in understanding the problem of the softening of the elastic constants in systems with spontaneous polar order.

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