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Multistability for Liquid Crystal Applications

Abstract:

Liquid crystals are classical examples of mesogenic materials, i. e. materials that are intermediate in character between solids and liquids. Nematic liquid crystals are the simplest and most widely studied class of liquid crystals. Nematics are simply speaking anisotropic liquids or liquids with special directions and this directional anisotropy manifests in unique optical, mechanical and rheological properties. Notably, nematics form the backbone of the multi-billion dollar liquid crystal display industry.

In recent years, there has been substantial interest in bistable liquid crystal devices which can support multiple stable nematic configurations with contrasting optical properties so that power is needed only to switch between different optical states but not to maintain a static image. In principle, such devices offer the promise of much enhanced resolution and optical properties at reduced costs.

We briefly describe the mathematical modelling of two bistable liquid crystal devices - the Post Aligned Bistable Nematic device designed by Hewlett Packard and the Planar Bistable Nematic Device. We model both devices in a macroscopic framework, discuss the governing set of partial differential equations, their solutions and singularities and show how relatively simple mathematical models can reveal a new topological mechanism for bistability/multistability and demonstrate the existence of new stable solutions not previously captured by numerical simulations and experimental investigations. The new stable solutions, referred to as Order Reconstruction solutions, have potential for new applications.