Three-dimensional solitons in nematic liquid crystals

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We analyze a recently discovered type of solitons that develop in nematic liquid crystals, with negative dielectric and conductive anisotropy, subject to an alternating electric field. The soliton consists of a concentrated chevron pattern of molecular alignment of the liquid crystal propagating through a uniformly oriented sample. The undistorted liquid crystal is enclosed between two parallel plates, and it is uniformly aligned along the horizontal direction, supporting an electric field applied along the direction perpendicular to the plates. It is observed that solitions form and propagate along the direction perpendicular to the undistorted director and to the applied electric field.

The mathematical model, based on the coupled Poisson-Nernst-Planck and liquid crystal equations, confirm the experimental finding that flexoelectric polarization is the main source of soliton propagation, followed by a mesoscopic electric charge concentration found to enhance its speed. The presentation has three main parts:
(i) We first show that the static counterpart of the soliton dynamics is the Lavrentiev phenomenon, dictating the existence of an unstable local minimizer, with lower energy than that of the uniformly aligned state.
(ii) We present a linear analysis, based on the study of the Floquet exponents of the dynamical system, which serves to identify the aspect ratio and speed of propagation of the soliton.
(iii) The subsequent nonlinear analysis addresses the well-posedness of the governing system.
This work is part of the Ph.D thesis by Ashley Earls (University of Minnesota, 2019).