Contribution ID: **26** Type: **not specified**

Biaxiality vs uniaxiality in Landau-de Gennes minimisers in 2D discs

Thursday, June 27, 2024 3:00 PM (30 minutes)

We consider the problem of minimising the (simplest) Landau-de Gennes (LdG) energy in two-dimensional discs, under axial symmetry, a physically relevant pointwise norm-constraint in the interior, and radial anchoring on the boundary. The goal is to study the uniaxial or biaxial character of minimisers. We show that the latter depends crucially on the value of a parameter $\lambda \geq 0$ appearing in front of the potential and penalising biaxiality. For λ large, minimisers are uniaxial. As λ decreases, biaxiality is less penalised and a threshold $\lambda_* > 0$ is met at which uniaxial and biaxial minimisers coexist. Below λ_*, all minimisers are biaxial. For all biaxial minimisers, complete biaxial escape occurs. The cornerstone of the argument consists in an energy gap between small and large maps in the associated minimisation problem for the Dirichlet integral (i.e., for $\lambda = 0$). Here, a map is called small if it does not escape the spherical cap containing the image of the boundary data, and large otherwise. The energy gap is made fully explicit by describing the set of optimal maps in both the small and the large case. A major difficulty in the analysis lies in dealing with a lack of compactness in minimising sequences.

This problem arose in a natural way in the framework of a broader investigation, carried out in a joint work with Vincent Millot and Adriano Pisante, of qualitative properties of LdG minimisers in 3D cylinders.

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