Part I (6 lectures, week I): "**Mathematical theories of liquid crystals**", Epifanio G. Virga (Università di Pavia)

Abstract

Liquid crystals are intermediate states of matter with a wide range of modern applications. This is because liquid crystals, as soft materials, are extremely sensitive to external stimuli. Although liquid crystals were discovered experimentally in the late 1800's, satisfactory theoretical descriptions were not developed until the early 1950's. From the very beginning, the theories that succeeded in explaining the observed behaviour of liquid crystals had a strong mathematical content and posed new mathematical questions. This part of the course will be mainly concerned with the statistical mechanics foundations of the nematic phase. We shall try to harmonize the (only) apparently contrasting roles that attractive and repulsive intermolecular forces play in inducing an orientational order among the elongated molecules that constitute liquid crystals.

Chapter 1 of the following book is suggested as a preparatory reading,
A.M. Sonnet & E.G. Virga, *Dissipative Ordered Fluids: Theories for Liquid Crystals*, Springer, New York, 2012.

Part II (6 lectures, week 2): "**Analysis of liquid crystals and their defects"**, John Ball (University of Oxford and Heriot-Watt University)

Abstract

This part of the course will discuss classical continuum models of the equilibrium of liquid crystals, in particular the Oseen-Frank and Landau – de Gennes theories, and how they describe defects. By a defect we mean a point, curve or surface, in the neighbourhood of which the order parameter describing the orientation of the liquid crystal molecules varies very rapidly. Defects can be observed optically, for example using polarized light, but it is difficult to obtain definitive information about their small-scale structure via microscopy. Depending on the theory used, a defect may or may not be represented by a mathematical singularity in the order parameter field. One of the themes running through the lectures is the importance of a proper function space setting for the description of defects.

Chapter 1 of the following book is suggested as a preparatory reading,
E. Feireisl, E. Rocca (eds.), *Mathematical Thermodynamics of Complex Fluids*, Springer Lecture Notes in Mathematics 2200, https://doi.org/10.1007/978-3-319-67600-5_1