HAUSDORFF RESEARCH INSTITUTE
FOR MATHEMATICS

UNIVERSITÄT BONN

School on

"Recent trends in the mathematics of complex materials"

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organized by
Arghir Zarnescu (BCAM), Xavier Lamy (Toulouse)

Abstracts

Valeria Banica (Sorbonne University)

Singular dynamics for the Schrödinger map

Abstract: In these lectures we will first introduce a chain of connected equations: the binormal flow, which is a model for vortex filament dynamics in 3D fluids, the 1D Schrödinger map with values in the 2D sphere, which is the classical continuous Heisenberg model in ferromagnetism, and the 1D cubic NLS, which arises in many physical models. We will present some general facts about them, their linking, and several results and methods. Then we will present a series of results on dynamics generating singularities in finite time.

Radu Ignat, Arghir Zarnescu (Université Toulouse 3, BCAM)

Analysis of point defects in nematic liquid crystals

Abstract: In these lectures, we present recent developments in the analysis of defects in nematic liquid crystals at the stationary level. We focus on the variational Landau-de Gennes theory that has been intensively studied in the mathematical literature in the recent years. Our aim is to analyse the symmetry, stability and minimality properties of topological point defects which are the main building blocks in this theory. We will start by reviewing these properties for topological vortex points in the simpler case of vector-valued maps, given by the Ginzburg-Landau theory. Then we extend these techniques to the matrix-valued maps for the Landau-de Gennes theory.

Richard James (University of Minnesota)

Origami and Materials Science

Abstract: In this series we develop links between origami design and materials science, highlighting the suggestive role of origami for materials design. The two subjects are intimately related through a group orbit method, which also may be a useful viewpoint for the largely unsolved crystallization problem. And quasicrystals have natural origami analogs. Phase transformations link origami and materials science in two ways: microstructures due to phase transformation are like the "microstructures of planar regions" in curved-tile origami. Also curved tile origami provides a natural way to introduce

elastic energy into an origami structure. This gives insight into the role of elasticity in biasing an origami structure toward particular configurations, whereas in phase transformations, we know almost nothing about the role of elasticity, since almost all known constructions are macroscopically free of stress.

Lucia Scardia (Heriot-Watt University)

Minimisers of nonlocal energies: The effect of anisotropy

Abstract: In this course I will give an overview on the characterisation of minimisers for a class of anisotropic, nonlocal energies inspired by the theory of dislocations.
I will start by giving a crash course on dislocations to motivate the model energy we consider, and by deriving its continuum, (anisotropic) nonlocal limit. I will then discuss the minimisation of the limiting nonlocal energy, establishing existence and uniqueness of compactly supported minimisers under suitable assumptions. Finally, I will focus on the characterisation of minimisers, and highlight how the anisotropy affects their shape.
The results I will present have been obtained in collaboration with Jose' Antonio Carrillo, Joan Mateu, Maria Giovanna Mora, Mark Peletier, Luca Rondi, Joan Verdera.
