Department of Mathematics

Alexander Ziwet Lectures

April 15-16, 2025

Irene Fonseca

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Director of Center for Nonlinear Analysis
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A reception for Professor Fonseca will be held Tuesday, April 15th at 5:00 p.m. in the Mathematics Upper Atrium, East Hall

From Phase Separation in Heterogeneous Media to Learning Training Schemes for Image Denoising

Lecture I: Tuesday, April 15, 4-5 pm - 1360 East Hall - *Reception to Follow*

What do these two themes have in common? Both are treated variationally, both deal with energies of different dimensionalities, concepts of geometric measure theory prevail in both, and higher order penalizations are considered.

Phase Separation in Heterogeneous Media: Modern technologies and biological systems, such as temperature-responsive polymers and lipid rafts, take advantage of engineered inclusions, or natural heterogeneities of the medium, to obtain novel composite materials with specific physical properties. To model such situations using a variational approach based on the gradient theory of phase transitions, the potential and the wells may have to depend on the spatial position, even in a discontinuous way, and different regimes should be considered.

Learning Training Schemes for Image Denoising: Due to their ability to handle discontinuous images while having a well-understood behavior, regularizations with total variation (TV) and total generalized variation (TGV) are some of the best known methods in image denoising. However, like other variational models including a fidelity term, they crucially depend on the choice of their tuning parameters. A remedy is to choose these automatically through multilevel approaches, for example by optimizing performance on noisy/clean image training pairs.

Mathematical Analysis of Novel Advanced Materials: Epitaxy and Quantum Dots, Wetting and Dewetting

Lecture II: Wednesday, April 16, 4-5 pm - 4448 East Hall

Quantum dots are man-made nanocrystals of semiconducting materials. Their formation and assembly patterns play a central role in nanotechnology, and in particular in the optoelectronic properties of semiconductors. Changing the dots' size and shape gives rise to many applications that permeate our daily lives, such as the new Samsung QLED TV monitor that uses quantum dots to turn "light into perfect color"!

In this talk we will use methods from the calculus of variations and partial differential equations to model and mathematically analyze the onset of quantum dots, the regularity and evolution of their shapes, and the nucleation and motion of dislocations. Further, using the H^{-1}-gradient flow structure of the evolution law, short-time existence for a surface diffusion evolution equation with curvature regularization is established in the context of epitaxially strained two-dimensional films. The main novelty, as compared to the study of the wetting regime, is the presence of moving contact lines.

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