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Fluctuations in continuum and conservative SPDEs

Fluctuations are ubiquitous in real world contexts, ranging from thermal fluctuations in fluids, to algorithmic stochasticity in machine learning, to fluctuations caused by small-scale weather patterns in climate dynamics. A systematic understanding of the interplay of stochasticity and complex dynamical behavior aims to unveil universal properties, irrespectively of the many details of the concrete systems at hand. In the lectures, we will identify the class of conservative stochastic partial differential equations (CSPDEs) as universal fluctuating continuum models, and their analysis as a fruitful field for the discovery of new mathematical structures and methods. In particular, we will demonstrate how CSPDEs arise from fluctuating interacting particle systems, and, vice versa, how the analysis of CSPDEs can guide the mathematical insight into the nonequilibrium fluctuations of complex systems.