XVIII INTERNATIONAL CONFERENCE ON HYPERBOLIC PROBLEMS
THEORY, NUMERICS, APPLICATIONS
Málaga, June 20-24, 2022

Non-equilibrium large deviations and parabolic-hyperbolic PDE with irregular drift

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Large deviations of conservative interacting particle systems, such as the zero range process, about their hydrodynamic limit and their respective rate functions lead to the analysis of the skeleton equation; a degenerate parabolic-hyperbolic PDE with irregular drift.

In this talk, we present a robust well-posedness theory for such PDEs in energy-critical spaces based on concepts of renormalized solutions and the equation's kinetic form. We establish these properties by proving that renormalized solutions are equivalent to classical weak solutions, extending concepts of [DiPerna, Lions; Ann. Math., 1989], [Ambrosio; Invent. Math., 2004] to the nonlinear setting.

The relevance of the results toward large deviations in interacting particle systems is demonstrated by applications to the identification of l.s.c. envelopes of restricted rate functions, to zero noise large deviations for conservative (singular) SPDE, and to the Γ-convergence of rate functions. The first of these solves a long-standing open problem in the large deviations for zero range processes. The second makes rigorous an informal link between the non-equilibrium statistical mechanics approaches of macroscopic fluctuation theory and fluctuating hydrodynamics.

Joint work with Ben Fehrman (University of Oxford)

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