Non-equilibrium fluctuations in interacting particle systems and conservative stochastic PDE

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Interacting particle systems have found diverse applications in mathematics and several related fields, including statistical physics, population dynamics, and machine learning. We will focus, in particular, on the zero range process and the symmetric simple exclusion process. The large-scale behavior of these systems is essentially deterministic, and is described in terms of a hydrodynamic limit. However, the particle process does exhibit large fluctuations away from its mean. Such deviations, though rare, can have significant consequences—such as a concentration of energy or the appearance of a vacuum—which make them important to understand and simulate.

In this talk, which is based on joint work with Benjamin Gess, I will introduce a continuum model for simulating rare events in the zero range and symmetric simple exclusion process. The model is based on an approximating sequence of stochastic partial differential equations with nonlinear, conservative noise. The solutions capture to first-order the central limit fluctuations of the particle system, and they correctly simulate rare events in terms of a large deviations principle.