Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Statistical analysis and simulation of random shock waves in scalar conservation laws[1] DANIELE VENTURI, HEYRIM CHO, GEORGE KARNIADAKIS, Brown University — Hyperbolic conservation laws subject to additive random noise and random initial conditions can develop random shock waves at random space-time locations. The statistical analysis of such waves is quite complex, due to non-linearities, high-dimensionality and lack of regularity. By using the Mori-Zwanzig formulation of irreversible statistical mechanics, we derive formally exact reduced-order equations for the one- and two-point probability density function of the solution field. This allows us to perform numerical simulations and determine the statistical properties of the system. We consider the inviscid limit of the stochastic Burgers equation as a model problem and determine its solution in physical and probability spaces by using adaptive discontinuous Galerkin methods. In particular, we study stochastic flows generated by random initial states and random additive noise, yielding multiple interacting shock waves collapsing into clusters and settling down to a similarity state. We also address the question of how random shock waves in space and time manifest themselves in probability space. The mathematical framework is general and it can be applied to other systems, leading to new insights in high-dimensional stochastic dynamics and more efficient computational algorithms.

[1]This work was supported by OSD-MURI grant FA9550-09-1-0613, DOE grant DE-SC0009247 and NSF/DMS-1216437 grant

Daniele Venturi
Brown University

Date submitted: 19 Jul 2014 Electronic form version 1.4