Venturi, Daniele: *"Dimension reduction in kinetic equations: Mori-Zwanzig formulation, BBGKY hierarchies and effective propagators"*

In this talk I will review well-known approaches to develop reduced-order equations for the probability density function (PDF) of quantities of interest (phase space functions) in high-dimensional stochastic dynamical systems. Such reduced-order equations allow us to avoid computing high-dimensional random flows and reduce a great mass of information to a more tractable and more interesting form. I will discuss two different classes of methods to achieve this goal: the first one is based on separated representations such as proper generalized decomposition (PGD) or high-dimensional model representations (HDMR). When applied to high-dimensional systems, these representations yield a hierarchy of low-dimensional PDF equations that resembles the Bogoliubov-Born-Green-Kirkwood-Yvon (BBGKY) hierarchy of classical kinetic gas theory. The second approach stems from techniques of irreversible statistical mechanics, in particular the Mori-Zwanzig (MZ) formulation, and it yields directly a formally exact equation for the PDF of the quantity of interest. I will address the question of approximation of MZ-PDF equations by multi-level coarse graining, perturbation series and operator cumulant resummation. Throughout the presentation I will provide numerical examples and applications of the presented methods to prototype stochastic problems such as the Duffing oscillator, Lorenz-96 system and stochastic Burgers equation.