

## NON-LINEAR DATA DRIVEN MODEL REDUCTION TECHNIQUES FOR STOCHASTIC PDE SYSTEMS

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### ABSTRACT

Significant improvements in computational capability in recent years have opened up the possibility of utilizing simulation frameworks to direct experiments and provide insights towards the control and design of complicated and critical physical phenomena. Most of these phenomena exhibit multiscale, multiphysics and multidomain characteristics. Due to the large complexity of such systems, it is impossible to determine/quantify the forces, parameters or properties exactly. For reliable analysis, it becomes essential to include the effects of such input uncertainties in material properties as well as system characteristics into the system and understand how they propagate and alter the final solution. Furthermore, the enormous (yet incomplete) amount of input data available as well as the considerable complexity of the physical systems poses significant strain on the available computational resources. In this context, we will present a mathematical framework that provides a paradigm shift in the predictive modeling for complex systems in the presence of uncertainties. In particular, we will discuss a *non-linear* data-driven model reduction strategy to utilize experimentally available information to dynamically construct low-order realistic models of input uncertainties. These strategies are based on ideas in manifold learning used in cognitive sciences and signal processing. The reduced-order models developed will be used with new stochastic analysis techniques (hierarchical adaptive sparse grid collocation based on the Smolyak algorithm) to address uncertainty propagation in critical data-driven applications in random heterogeneous media.