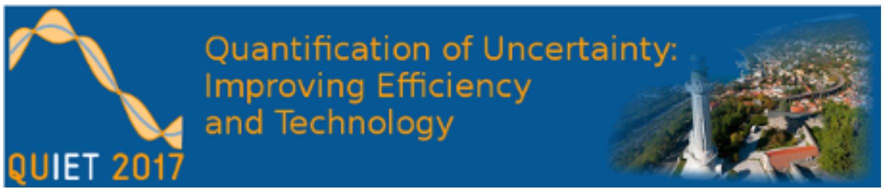

Structure Preserving Reduced Order Models

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The development of reduced order models for complex applications, offering the promise for rapid and accurate evaluation of the output of complex models under parameterized variation, remains a very active research area. Applications are found in problems which require many evaluations, sampled over a potentially large parameter space, such as in optimization, control, uncertainty quantification and applications where near real-time response is needed.

However, many challenges remain to secure the flexibility, robustness, and efficiency needed for general large scale applications, in particular for nonlinear and/or time-dependent problems.

In this talk, we discuss recent developments of reduced methods that conserve chosen invariants for nonlinear time-dependent problems. We pay particular attention to the development of reduced models for Hamiltonian problems and propose a greedy approach to build the basis [1]. As we shall demonstrate, attention to the construction of the basis must be paid not only to ensure accuracy but also to ensure stability of the reduced model. The performance of the approach is demonstrated for both ODEs and PDEs.

We discuss how to extend the approach to include more general dissipative problems through the notion of port-Hamiltonians, resulting in reduced models that remain stable even in the limit of vanishing viscosity [2]

To extend this to more general classes of problems, not endowed with a Hamiltonian structure, we consider methods that preserve specific quantities, e.g., mass conservation or Casimirs, and show that the combination of structure preserving Runge-Kutta methods with a carefully chosen basis results in stable reduced order methods for general classes of nonlinear time-dependent problems.

References

[1] B. Afkham and J. Hesthaven. Structure-preserving model-reduction of parametric hamiltonian systems. - *submitted*, 2016.

[2] B. Afkham and J. Hesthaven. Structure-preserving model-reduction of dissipative hamiltonian systems. - *submitted*, 2017.