Structure-preserving Reduced Order Modelling

Tobias Blickhan, Benedikt Brantner, Michael Kraus, Tomasz Tyranowski

Max-Planck-Institut für Plasmaphysik
Boltzmannstraße 2, 85748 Garching, Deutschland
and
Technische Universität München, Zentrum Mathematik
Boltzmannstraße 3, 85748 Garching, Deutschland

Reduced order models aim to describe the key behaviour of more complex systems at lower computational cost. For parameter-dependent systems, reduced order models often employ a reduced basis that is constructed by identifying dominant modes from the results of sample 'training' simulations for select parameter values.

It has been recognised that it is critical to account for the underlying structure of the system, e.g. Lagrangian or Hamiltonian, in the construction of the reduced basis in order to guarantee stability of the reduced model.

After a brief review of structure-preserving reduced basis methods, we will discuss novel approaches to structure-preserving hyper-reduction, i.e. the treatment of nonlinear operators, in particular the combination of Variational Integrators and Hamiltonian Neural Networks as well as SympNets.

Finally, we apply these techniques to construct structure-preserving reduced order models for the Vlasov–Poisson system.