CANONICAL AND NONCANONICAL HAMILTONIAN MODEL REDUCTION THROUGH BENCHMARK EXAMPLES

Anthony Gruber[1], Irina Tezaur[2] and Max Gunzburger[3]

[1]Center for Computing Research, Sandia National Laboratories
[2]Quantitative Modeling and Analysis, Sandia National Laboratories
[3]Oden Institute, University of Texas at Austin

ABSTRACT

Hamiltonian systems serve as ubiquitous and reliable models for disparate physical phenomena such as elasticity, water waves, and magnetohydrodynamics. Despite this, traditional methods of model reduction often fail to preserve even the most basic dynamical invariant: the system Hamiltonian. This talk explores intrusive and non-intrusive methods for Hamiltonian model reduction in the context of the authors' own work. Using relatively simple benchmark problems (linear elasticity, wave equation, Korteweg de Vries, Benjamin-Bona-Mahoney) which are designed to fail in the absence of a structure-preserving discretization, it is shown that Galerkin projection or operator inference based reduced models which are Hamiltonian-preserving retain many benefits of their full-order counterparts, leading to improved stability and more realistic results at prediction time. SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525.