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GEOMETRIC AND STRUCTURE-PRESERVING METHODS FOR COMPUTATIONAL MODELING

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ABSTRACT

Most models of physical systems have a natural form description in terms of geometric mechanics formulations, such as variational, Hamiltonian and metriplectic/GENERIC approaches. Based on understanding a system's configuration space and its corresponding symmetries, these geometric descriptions enable accurate representation of both reversible (thermodynamic energy-conserving) and irreversible (thermodynamic entropy-generating) dynamics, including fundamental features such as involution constraints and conservation laws. Additionally, this approach leads to formulations that contain the correct choice of field unknowns that enable the direct construction of structure-preserving discretizations, eliminating unnecessary ad hoc transformations prior to the discretization step.

Building on these geometric mechanics formulations, it is possible to develop discrete models that preserve the fundamental geometric features of the continuous models. Such structure-preserving discretizations display remarkable benefits over more naive discretizations, including freedom from spurious/unphysical numerical modes, consistent energetics leading to long-time stability, controlled dissipation of enstrophy or thermodynamic entropy, and stable coupling between subsystems.

This minisymposium brings together researchers studying these ideas at the continuous level, discrete level, and the interface between the continuous and discrete levels. We welcome contributions related to all areas of geometric mechanics and structure-preserving discretizations including (but not limited to) novel geometric mechanics formulations; structure-preserving spatial, temporal and spatiotemporal discretizations; structure-preserving

reduced order models; structure-preserving scientific machine learning; and geometric optimal control.