Structure preserving discretisations for CFD

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ABSTRACT

Numerical simulation is the third pillar of science alongside theory and experiment. With an ever-increasing complexity of problems being numerically approximated, it becomes harder to develop accurate and stable discretisations, and to distinguish between numerical failures and physically meaningful results. This is particularly critical in many real-world applications, e.g., quantum mechanical systems, biophysical flows, solid mechanics, aerodynamics, fluid dynamics of plasmas, geophysical flows, and particularly in coupled multi-physics problems.

Partial differential equations resulting from physical field laws contain rich structural properties that are intimately related to fundamental physical properties, e.g., conservation laws, symmetries, positivity structures, de Rham cohomology. The well-posedness of the continuous PDEs is known to derive from these properties, for these reasons it is essential that these structural properties are also preserved at the discrete level. With these goals in mind, several different approaches have been proposed within traditional discretisation methods, [1], [2], [3]: finite element exterior calculus, mimetic finite differences, discrete exterior calculus, etc.

This mini-symposium will be devoted to the different approaches to include structure information into discretisations for CFD and its applications. These will include variational techniques (such as Lagrangian and Hamiltonian approaches), hybridisation, and pre-conditioning.

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