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DISCRETE CONSERVATION PROPERTIES FOR FLUID FLOWS: FROM FUNDAMENTALS TO APPLICATIONS

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N. VALLE[*], F.X. TRIAS[†], F. CAPUANO[^], G. COPPOLA[°] AND R.W.C.P VERSTAPPEN[*]

[*]University of Groningen
Nijenborgh 9, 9747 AG Groningen, The Netherlands
n.valle.marchante@rug.nl, r.w.c.p.verstappen@rug.nl

[^] Politecnico di Bari
Via Orabona 4, 70125 Bari, Italy
francesco.capuano@poliba.it

[†] Universitat Politècnica de Cataluna
c/Colom 11, 08222 Terrassa, Barcelona
francesc.xavier.trias@upc.edu

° Università degli Studi di Napoli "Federico II"
Piazzale Tecchio 80, 80125 Napoli, Italy
gcoppola@unina.it

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ABSTRACT

Over the last two decades, the simulation of complex multi-scale and multi-physics flows has benefited from the development of so-called *symmetry-preserving* numerical methods [1, 2]. This class of discretization algorithms aims to discretely preserve the underlying mathematical structure of the continuous differential operators appearing in the Navier-Stokes equations. Typically, this results in the conservation at the discrete level of primary invariants (i.e., mass, momentum, etc.) as well as of secondary quantities (e.g., kinetic energy, helicity, entropy, enstrophy in 2D flows, etc.), thereby improving the physical fidelity of the numerical results and providing enhanced robustness to the simulations. This class of methods have proven invaluable in studying challenging flow features such as turbulence [3], and have also been extended to more complex flows [4].

The first objective of the minisymposium is to gather researchers from different CFD-related disciplines working on the development of cutting-edge symmetry-preserving numerical methods, including invariant-preserving algorithms for high-order schemes (e.g., discontinuous Galerkin, spectral element), mimetic methods, geometric time integration schemes, boundary conditions with summation-by-parts properties, entropy-stable methods, physics-based implicit and explicit large-eddy simulation models, among others.

Despite its enormous potential benefits, the application of symmetry-preserving methods to real-world problems is still rather limited. The second objective of the mini-symposium is to bridge the gap between academic developments and industrial needs, by focusing on successful applications of such methods in the context of complex engineering or biological flows. Topics include, but are not limited to: compressible aerodynamics, multiphase flows, flow instabilities, reacting flows, bubble dynamics, natural convection, cardiovascular flows, heat and mass transfer intensification or drag reduction, among others.

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