TOR VERGATA
UNIVERSITÀ DEGLI STUDI DI ROMA

Dipartimento di Fisica

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Seminar

Tuesday, 30 September 2025 - h. 14:00

Sala Struttura della Materia (Dipartimento di Fisica)

Stefano PISONI

TII – Technology Innovation Institute, Abu Dhabi, UAE
TUHH, Hamburg, Germany

"Tensor Network Perspective on Turbulent Flows"

Abstract

Understanding turbulence has been a long-standing open problem in classical physics. Consequently, numerical methods for fluid simulations suffer from poor accuracy when turbulent regimes are investigated. A recent promising research line in this direction proposes to adopt the Matrix Product State (MPS) representation to simulate fluid flows, with drastic savings in memory. However, it is not yet clear how the MPS compression power scales with the complexity of the flows, i.e. with the Reynolds number. In fact, no MPS fluid solver has been numerically validated in a fully developed turbulent regime yet.
In this work, we comprehensively analyze the capabilities of MPS in representing turbulent snapshots and solve for the 3D Navier-Stokes equations using the MPS-based framework. We benchmark our results against a state-of-the-art DNS of isotropic turbulence in a triply periodic cube consisting of 1024^3 grid points We further propose a native MPS algorithm to generate synthetic turbulence efficiently.
Our work addresses the main open question of scalability in simulating and capturing complex turbulent flows using the memory-efficient MPS representation.

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