Colloqui della Classe di Scienze

Anno Accademico 2025/2026

Sala Stemmi
Palazzo della Carovana
Scuola Normale Superiore
Piazza dei Cavalieri, 7 - PISA

28 JANUARY 2026
h 3.00 p.m.

SAURO SUCCI

Fondazione Istituto Italiano di Tecnologia Center for Life Nano-Neuroscience
La Sapienza Università di Roma
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Simulating classical fluids on quantum computers: a useful chimera?

ABSTRACT:
In the last decade quantum computing has attracted enormous interest both at academic and industrial level, mainly in connection with its tantalising potential for solving (some) problems beyond reach for any foreseeable classical computer. Even though the mainstream of quantum computing is focussed on quantum physics, engineering and information dynamics, increasing attention has recently been directed towards the exploration of the potential of quantum computing for classical physics, most notably fluid dynamics and other nonlinear transport phenomena.
The potential of quantum computing for fluids is staggering; in a bluesky scenario a quantum computer with about 100 logical qubits could perform global weather forecast simulations at sub-meter resolution. However, solving fluid dynamics on quantum computers is a challenge on top of a challenge because, unlike quantum mechanics, the physics of fluids is generally neither linear nor conservative, hence it cannot be mapped directly onto unitary quantum gates.
After a brief introduction to the quantum simulation of fluids in general, in this talk we shall focus on a specific technique, known as Carleman embedding, which trades nonlinearity for infinite dimensionality. This technique has shown excellent results on classical computers but the formulation of a corresponding quantum algorithm still faces a number of steep challenges, which we shall discuss and comment upon.
Finally, it is argued that the search of quantum algorithms for fluids bears a major foundational value, regardless of its success in achieving quantum advantage over classical computational fluid dynamics, as it sheds new light on the emergence of classical physics from the quantum world.

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