TIPO PROGETTO: PRIN 2022 a scorrimento n. 2022R9B2MW– “finanziato dall’Unione Europe Next Generation EU”

TITOLO: The fluid dynamics of interfaces: mesoscale models for bubbles, droplets, and membranes and their coupling to large scale flows

ABSTRACT:
Multiphase flows are the next big challenge in fluid mechanics. Applications like clean combustion, CO2 absorption by the mist/bubbles at the ocean interfaces, floating pollution on the oceans, oil industry-related problems, and in general pharmaceutical and food industry processes all rely on multiphase flows. These flows are strongly influenced by the fluid/fluid interface, and while simple fluids are well understood, with simulation tools widely available also on the market, our current comprehension of the ubiquitous interface-dominated flows is still unsatisfactory, due to the enormous range of involved scales spanning from molecular (nanometers) to macroscopic (meters).
This proposal focuses on multiscale approaches for interface-dominated flows and concerns the development of physical models and
simulation tools for HPC (High-Performance Computing) applications. Bridging the scale gap and developing tools for exploiting modern supercomputers is a key to developing enabling technology for a variety of industrial applications, thereby fostering a knowledge-based society. The project aims at building an intertwined collection of physical models and implementing them on massively parallel computers, along the line initiated by the PI with an ERC Advanced Grant concerning the dynamics of cavitation nuclei and, independently, by the co-PI who worked on the coupling with turbulence. The two research units will form an extraordinarily strong team of unprecedentedly wide expertise ranging from fundamental research aimed at developing computational tools for engineering to the technology transfer to the industry, as envisaged by the Italian PNRR (National Recovery and Resilience Plan) that promotes "national champions" of R&D on some Key Enabling Technologies. Specifically, MUR is funding a National Center for Simulation, Computation, and High-Performance Data Analysis.
The PI’s UNIT 1 will mainly develop physical and computational models for different kinds of interfaces, accounting for phase change in flowing fluids or the topological rearrangement of membranes. The co-PI’s UNIT 2 will be mainly concerned with coupling the interfaces with large-scale, turbulent fluid motions. The conception of predictive models and their implementation will require the
strict interaction of the two units, envisaged through the joint conception of models, the co-implementation of software, and the exchange of simulation codes: these actions will be realized via a series of periodic meetings and with the personnel hired in this MUR - BANDO 2022Ministero dell'Università e della Ricerca
project exchanging periods at the two research sites.
The expected results, to be communicated through publications in top-rank journals and disseminated to the general public with dedicated events, consist of a substantial advancement in our understanding of interface-dominated flows and in new, effective computational tools for interfacial and multiphase flows to empower applications in industry, technology, biology, and medicine.

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