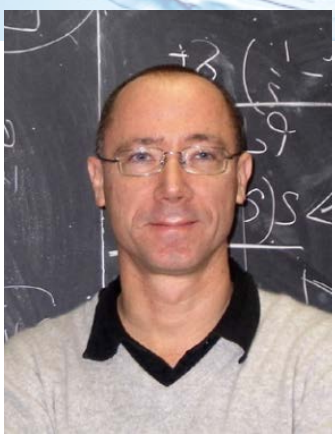
SIBLEY SCHOOL OF MECHANICAL AND AEROSPACE ENGINEERING

JOINT SPECIAL SEMINAR & CORNELL FLUIDS SEMINAR

"Learning from Smart Lagrangian particles: one-way and two-way coupling"



Luca Biferale

Professor of Theoretical Physics and Numerical and Mathematical Modeling
University of Tor Vergata Rome, Italy

Wednesday, September 5th, 12:00 pm, Upson 116
Pizza at 11:45 am

Abstract: We present a series of original ideas crossing the boundaries between Theoretical Engineering and Applied Physics using innovative algorithms from Artificial Intelligence (AI) to track and/or reconstruct extreme events in turbulent and complex flows. One example is based on a numerical simulation of small instrumented objects/probes that are able to sense the flow and learn from these measurements how to navigate inside the flow [1,2]. We discuss a proof-of-concept using inertial drifters able to change their buoyancy in order to optimise vorticity tracking in 2D and 3D flows by using Reinforcement Learning. We also argue how to use the information gathered by the particles to reconstruct the underlying flow via a Lagrangian Nudging of the equations of motion [3]. Finally, we discuss original Lagrangian forcing mechanisms, optimised to add/remove vorticity fluctuations in the flow.

[1] Smart Inertial Particles. S. Colabrese, K. Gustavsson, A. Celani and L. Biferale. Phys. Review Fluids 3, 084301 (2018).
[2] Flow navigation by smart microswimmers via reinforcement learning. S. Colabrese, K. Gustavsson, A. Celani and L. Biferale. Phys. Rev. Lett. 118 (15), 158004 (2017)
[3] Unravelling turbulence via physics-informed data-assimilation and spectral nudging. P.D. Leoni, A. Mazzino and L. Biferale. Submitted to Phys. Review Fluids arXiv:1804.07680 (2018).

Biographical Sketch: Luca Biferale is a full professor of theoretical physics, and numerical and mathematical modeling at the University of Rome 'Tor Vergata' (PhD in 1993). He has a twenty-five-year-long experience with numerical and theoretical Lagrangian and Eulerian turbulence, micro- and nano-flows, kinetic methods for multiphase and multicomponent fluids, stochastic processes, multifractal and –more recently- the application of Machine Learning to complex flows. He has published more than 220 papers with an h-index of 46. He has been elected fellow of the APS (2008) and of the EUROMECH (2012). He has served as associated editor of Physical Review Letters and he is a member of the editorial board of EPJE for the fluid dynamics section.