



**TOR VERGATA**  
UNIVERSITÀ DEGLI STUDI DI ROMA

Dipartimento di Fisica



**European Research Council**  
*Established by the European Commission*

## ***Seminar***

Monday, 11 September 2023 - h. 14:30

*Fisica della Materia room (Department of Physics)*

### **Prof. Vikrant GUPTA**

*Southern University of Science and Technology,  
Shenzhen, Guangdong, China 518055*

## **“Predicting Turbulent Systems from Limited Measurements: Classical Methods to Machine Learning”**

### ***Abstract***

The study of fluid mechanics is undergoing a transformation due to recent advancements in measurement techniques and computational power. As a result, data assimilation and neural networks can now be utilized to forecast increasingly complex turbulent flows. However, it remains unclear under what conditions these data-driven methods can be effective and what role classical methods can still play. This seminar will analyse three main predictive methods: linearised (low-rank approximation) models, data assimilation, and model-free neural networks. On the one hand, linearised models require little measurement data but necessitate deep understanding of system dynamics. On the other hand, model-free networks require high-resolution space-time measurement data but require minimal knowledge of system dynamics. I will demonstrate that the measurement conditions required for effective application of data-driven methods, whether model-free or model-based, are closely related to complexity measures from chaos theory. These findings can guide the systematic collection of data and selection of predictive methods for turbulence forecasting in practical systems.

**ERC-2019-ADG Grant N. 882340 “Smart-TURB”**  
**(P.I. Prof. Luca Biferale)**

Dipartimento di Fisica - Università degli Studi di Roma “Tor Vergata”  
C.F. n. 80213750583 – Partita IVA n. 02133971008 - Via della Ricerca Scientifica, 1 – 00133 ROMA