Colloqui della Classe di Scienze

Anno Accademico 2024/2025

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

11 DECEMBER 2024
h 3.00 p.m.

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The Mathematics of Turbulent Flows: A Million Dollar Problem!

ABSTRACT:
Turbulence is a classical physical phenomenon that has been a great challenge to mathematicians, physicists, engineers and computational scientists. At the end of the last century, chaos theory was developed to explore similar phenomena that occur in a wide range of applied sciences, but the eyes have always been on the big ball – Turbulence. Controlling and identifying the onset of turbulence would have a great economic and industrial impact, ranging from the reduction of the drag on cars and commercial airplanes to better designs of fuel engines, and more reliable weather and climate predictions.
It is widely accepted by the scientific community that turbulent flows are governed by the Navier-Stokes equations, for large Reynolds numbers, i.e. when the nonlinear advective effects dominate linear viscous ones (internal friction within the fluids) in the Navier-Stokes equations.
As such, the Navier-Stokes equations form the main building block in any fluid model, in particular in global climate models. Whether or not the solutions to the three-dimensional Navier-Stokes equations remain smooth, indefinitely in time, is one of the most challenging mathematical problems. Therefore, by the turn of the millennium, this was identified by the Clay Institute of Mathematics as one of the seven most outstanding Millennium Problems in mathematics, and they set a one million US dollars prize for solving it. Notably, reliable computer simulations of turbulent flows are way out of reach even for the most powerful state-of-the art supercomputers. In this talk I will describe, using layman language, the main challenges that the different scientific communities are facing while attempting to attack this problem. In particular, I shall emphasize the mathematical point of view on turbulence.

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in presence and also available on **Zoom**