MAX-PLANCK-INSTITUT
FÜR DYNAMIK UND SELBSTORGANISATION

LMP Seminar: Pattern formation by turbulent cascades

LMP Seminar

DATUM: **24.02.2026**

TIME: **2:00 PM - 3:30 PM**

SPEAKER: **Dr. Michel Fruchart**

CNRS researcher at Gulliver in ESPCI and PSL University, France

LOCATION: **Max Planck Institute for Dynamics and Self-Organization (MPIDS)**

ROOM: **Riemann Room 1.40 & ZOOM Meeting ID: 997 1155 2453 Passcode: 771001**

HOST: **MPIDS / LMP**

CONTACT: **golestanian-office@ds.mpg.de**

Fully developed turbulence is a universal and scale-invariant chaotic state characterized by an energy cascade from large to small scales at which the cascade is eventually arrested by dissipation. Here, we show how to harness these seemingly structureless turbulent cascades to generate patterns. Pattern formation entails a process of wavelength selection, which can usually be traced to the linear instability of a homogeneous state. By contrast, the mechanism we propose here is fully nonlinear. It is triggered by the non-dissipative arrest of turbulent cascades: energy piles up at an intermediate scale, which is neither the system size nor the smallest scales at which energy is usually dissipated. Using a combination of theory and large-scale simulations, we show that the tunable wavelength of these cascade-induced patterns can be set by a non-dissipative transport coefficient called odd viscosity, ubiquitous in chiral

fluids ranging from bioactive to quantum systems. Odd viscosity, which acts as a scale-dependent Coriolis-like force, leads to a two-dimensionalization of the flow at small scales, in contrast with rotating fluids in which a two-dimensionalization occurs at large scales. Apart from odd viscosity fluids, we discuss how cascade-induced patterns can arise in natural systems, including atmospheric flows, stellar plasma such as the solar wind, or the pulverization and coagulation of objects or droplets in which mass rather than energy cascades.