Wolfgang Pauli Institut & Inst. CNRS Pauli, IRL2842 du CNRS
Forschungsplattform MMM „Mathematics-Magnetism-Materials“
Fak. Mathematik, Fakultät Physik**, Universität Wien**

24. PAULI COLLOQUIUM, jointly with

KOLLOQUIUM der Forschungsplattform MMM

The **research platform MMM „Mathematics-Magnetism-Materials”,** jointly with Fakultät für Mathematik, the Fakultät für Physik, Univ. Wien,
together with the **Wolfgang Pauli Institut** & the **“Inst. CNRS Pauli”,**

kindly invite you to the talk of **Bérengère DUBRULLE** (CNRS)

Time: Tuesday, 28. Aug 2023, 9h30 – 10:20

Place: HS11, 2nd floor, Oskar-Morgenstern-Platz 1, 1090 Wien

---

1) 9h30 – 9h35 : **Introduction :** Norbert J **Mauser** (U.Wien & WPI & CNRS)

2) 9h35 – 10h25 Uhr :

Bérengère Dubrulle (CNRS)

“Irreversibility and Singularities in Turbulence"

3) 10h25 – 10h55 : **CoffeeTea & Cake**

Norbert J Mauser
(director WPI & Inst CNRS Pauli
head research platform MMM)

cnrs wpi MMM MATHEMATICS - MAGNETISM - MATERIALS universität wien

Abstract:
In a viscous fluid, the energy dissipation is the signature of the breaking of the time-reversal symmetry (hereafter TSB) t->-t, u-> -u, where u is the velocity. This symmetry of the Navier-Stokes equations is explicitly broken by viscosity. Yet, in the limit of large Reynolds numbers, when flow becomes turbulent, the non-dimensional energy dissipation per unit mass becomes independent of the viscosity, meaning that the time-reversal symmetry is spontaneously broken. Natural open questions related to such observation are: what is the mechanism of this spontaneous symmetry breaking? Can we associate the resulting time irreversibility to dynamical processes occurring in the flow? Can we devise tools to locally measure this time irreversibility?
In this talk, I first show that the TSB is indeed akin to a spontaneous phase transition in the Reversible Navier-Stokes equations, a modification of the Navier-Stokes equation suggested by G. Gallavotti [2] to ensure energy conservation and relevance of statistical physics interpretation. I then discuss a mechanism of the TSB in Navier-Stokes was first suggested by L. Onsager in 1949 [3], in which quasi-singularities or singularities create a non-viscous dissipation. I exhibit the tools to track these quasi-singularities. I show how the application of these tools to velocity measurements in a turbulent swirling flow allows to detect Eulerian and Lagrangian signatures of irreversibility. This enables me to evidence the structures that are responsible for irreversibility and associate them with peculiar properties of the local velocity field or trajectories.

[1] G. Costa et al, PRE, submitted, (2023)
[2] *G. Gallavotti, Physics Letters A, 223, 91 (1996)*
[3] *L. Onsager , Il Nuovo Cimento, 6, 279 (1949)*
[4] V. Shukla et al, PRE, 100, 043104 (2019)

Short Biography:
Bérengère Dubrulle, a former student at École Normale Supérieure, holds a PhD in astrophysics from the Univ. Toulouse. After being a postdoc at the Tsukuba Meteorological Research Inst. in Japan, she became a research fellow at the CNRS. Since 2000, she is a CNRS director of research at the Condensed Matter Physics laboratory in Paris Saclay.
Since 2020, she is the director of the international School of Physics in les Houches.
Throughout her career, she worked in various fields of turbulence flow physics, ranging from quantum turbulence to astrophysics. Along a visiting fellowship in 1999 at the National Center for Atmospherical Research in Boulder (Colorado, USA) she became acutely aware of climate issues and initiated research on atmospheric physics and climate change related issues.
She has received several awards including the Prize Madame Victor Noury from the French Academy of science in 2008, the CNRS silver medal in 2017 and the Lewis Fry Richardson medal from the European Geosciences Union in 2021. In 2022, she was named French “Female scientist of the year”, receiving the Irène Joliot-Curie award from the French Academy of sciences.