

# **Anomalous Transport and Anomalous Diffusion**

**Monday, 16 March 2026 - Friday, 20 March 2026**

**Palazzo del Castelletto**

## **Scientific Programme**

## Lectures

### **Luisa Beghin - Anomalous Diffusion, Lévy Processes, and Fractional Calculus**

The aim of the course is to provide a comprehensive introduction to the mathematical foundations of anomalous diffusion and its modeling through fractional calculus.

As a first step, we will review Markov processes and introduce Lévy processes as stochastic models characterized by stationary and independent increments. We will then explore the fundamental concepts of fractional operators (e.g. Riemann-Liouville, Caputo, Riesz derivatives and integrals), highlighting their inherent non-locality and application in modeling physical memory effects. We also analyze the connection between the microscopic dynamics—specifically the Continuous-Time Random Walk (CTRW) model—and its macroscopic limit via the Stable Central Limit Theorem, which generates the stable Lévy distributions. Finally, the course will cover the derivation and solution of fractional diffusion equations both in the time- and the space-fractional cases, as tools for modeling sub- and super-diffusions.

### **Zhen-Qing Chen and Takashi Kumagai - Anomalous subdiffusion and time-fractional differential equations**

Anomalous diffusion phenomenon has been observed in many natural systems, from the signaling of biological cells, to the foraging behavior of animals, to the travel times of contaminants in groundwater. This short course will consist of two parts.

The first part will discuss the interplay between anomalous sub-diffusions and time-fractional differential equations, including how they arise naturally from limit theorems for random walks. We will then present some recent results in this area, in particular on the probabilistic representation to the solutions of time fractional equations with source terms. An interesting feature of the latter is that they involve two fundamental solutions. The second part will discuss applications of anomalous sub-diffusions to scaling limits of trap models, and the two-sided estimates of the fundamental solutions arise in the time-fractional parabolic equations.

### **Tomasz Komorowski and Stefano Olla - TBA**

TBA

## Seminars

### **Giada Basile - TBA**

TBA

### **Krzysztof Bogdan - TBA**

TBA

**Tomasz Grzywny - TBA**

TBA

**Jozsef Lorinczi - TBA**

TBA

**Michal Ryznar - TBA**

TBA

**Marielle Simon - TBA**

TBA

**Bruno Toaldo - TBA**

TBA

**Vanja Wagner - TBA**

TBA