

# 2025 Winter School in Mathematical Physics



**Sunday 5 January 2025 - Friday 10 January 2025**

**Maison des Congrès**

## **Scientific Programme**

**Chiral conformal field theory** by Andre Henriques (University of Oxford)

In this mini-course, we will study 2-dimensional Chiral conformal field theory from the mathematical point of view. Starting from the axioms of Graeme Segal (functorial field theory), we will discuss various examples of chiral CFTs, including the chiral free fermions, and the chiral WZW models. The latter will be explored in greater detail. We will see the role played by representations of affine Lie algebras, and we will study the fusion product of representations. Throughout the mini-course, I will try to emphasise the numerous open problems in this area.

**Calabi-Yau threefolds, quivers, and quantum algebras** by Andrei Negut (EPFL)

BPS counting on Calabi-Yau threefolds is an important problem in mathematical physics, and recently there has been a lot of emphasis on the algebras that control the symmetries of the problem. Using shuffle algebras as tools, we will completely describe these "BPS algebras" in the toric case, and connect them to the not-yet-defined K-theoretic Hall algebras of Calabi-Yau threefolds.

**Quantum chaos, random matrices and low-dimensional quantum gravity** by Julian Sonner (University of Geneva)

In recent years random-matrix integrals (or more generally "random matrix theories") have received renewed interest in the study of quantum gravity, and in particular in the 2D and 3D asymptotically anti-de Sitter context. In these so-called holographic dualities, an explicit random-matrix description of the boundary theory can be derived, and related to a bulk description in terms of semi-classical gravity. A decisive role is played by the theory of quantum chaos, which constitutes the underlying reason and source of a random-matrix like description, and equips us with a powerful mathematical framework to access non-perturbative physics. I will begin this series of lectures with an introduction to the required basic notions in the theory of quantum chaos and low-dimensional holography, before moving on to explaining recent progress in formulating random matrix and random tensor models for AdS2/CFT1 and AdS3/CFT2 dualities.