



## Departmental PhD Thesis Exam

Thursday, August 29th, 2024 at 11:00 a.m. (sharp)  
via Zoom

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Supervisor : Kevin Costello & Nick Rozenblyum

Thesis title : Holography and Koszul Duality in Quantum Field Theory



### Abstract

In this thesis, we investigate mathematical constructions related to holography principle from physics, organized into three main parts. Firstly, we introduce the concept of quadratic duality for chiral algebras, extending the construction from associative algebras. We establish its relationship with the Maurer-Cartan equation, bridging it with physical intuition. Secondly, we define the notion of a vertex operator algebra (VOA) in a (pseudo)-tensor category. Specifically, We study a  $\beta\gamma$  VOA in the Deligne category. This construction provides a rigorous mathematical definition for the large  $N$  vertex algebra relevant to holography. Thirdly, we analyze the structure of the higher dimensional Laurent series, which are analog of the  $1d$  Laurent series  $\mathbb{C}((z))$ . Here, the derived structure becomes crucial, distinguishing it from the  $1d$  case. We compute the  $A_\infty$  structure on the cohomology and explore various variations of this model. These  $A_\infty/L_\infty$  algebraic structures can define certain (vertex) Poisson algebra. As a consequence of the holography conjecture, the vertex Poisson algebra is isomorphic to the one constructed from the  $\beta\gamma$  system in the Deligne Category. We provide several checks of this conjecture.