

SIMIS Seminar series on Quantum computing, Quantum simulation and Strongly-correlated systems

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“How Entanglement Builds Spacetime: A Berry Phase Story”

Abstract

A central challenge in holography is understanding how spacetime emerges from the boundary conformal field theory (CFT). Entanglement provides a geometric lens through kinematic space—the space of CFT point pairs. By defining parallel transport of modular Hamiltonians, a Berry connection emerges on kinematic space, enabling bulk reconstruction. In this talk, I will introduce a new class of Berry phases governed by a change of state, the holographic counterpart of geometric phases in quantum mechanics. Remarkably, the Berry curvature in this framework exactly matches a bulk symplectic form on the entanglement wedge—the bulk region dual to a boundary subregion, while its induced quantum information metric encodes the bulk canonical energy. Time permitting, I will also discuss recent work on new topological kinematic spaces and a two-sided Crofton formula that reconstructs wormhole geometries via integral geometry.

Biography of the speaker

Dr. Ricardo Espíndola Romero obtained his PhD at the String Theory group of the University of Amsterdam in 2022. He has carried out research at various institutions including the ICTP in Trieste, KU Leuven, University of Southampton, UB Barcelona, and UNAM Mexico (where he was awarded the Alfonso Caso medal). More recently, he joined the group at the Institute for Advanced Study at Tsinghua University as a postdoctoral researcher where he holds a Shuimu Tsinghua Scholarship, which is Tsinghua’s flagship program for attracting the best postdocs from the world. His main research focus is the holographic correspondence. The methods and concepts he has used during his research include modular Berry phases, wormhole replicas, von Neumann algebras, and traversable wormholes.

Date and Place: April 25th 2025, 16:00h-17:00h. Room: 1310. Send comments or questions to: Hamed Adami (Host) hadami@simis.cn or Miguel Tierz (Seminar organizer) to tierz@simis.cn