

S E M I N A R



Prof Robert de Mello Koch
(Huzhou University, China)

Date:

Tuesday, 28 July 2026

Time:

13h15-14h15 SAST

Venues:

- Honours Presentation Room P213,
2nd floor, School of Physics
East Campus
University of the Witwatersrand
- Online

Who should attend?

All are welcome!

Enquiries:

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Overcrowding and the finite N Hilbert space

ABSTRACT:

Finite-N trace relations reorganise the Hilbert space of gauge-invariant operators beyond the freely generated large-N description. We study this structure using the Hironaka decomposition of the invariant ring of d Hermitian $N \times N$ matrices. We first prove that the primary invariants may always be chosen to be homogeneous single-trace operators. We then show that, for any such choice, a nontrivial secondary invariant must appear by degree $\sim \log(N)$, which is parametrically below the first universal trace identity at degree $N+1$. This is a global overcrowding effect: exponentially many independent short single traces compete for only $1+(d-1)N^2$ algebraically independent coordinates. Low-rank examples show that secondary invariants can distinguish configurations with identical primary data and, for suitable dynamics, label semiclassical sectors connected by instantons. These results identify the Hironaka decomposition as a natural framework for organising perturbative and intrinsically finite-N information in collective descriptions of gauge theories.

Robert de Mello Koch is a Professor of Theoretical Physics at Huzhou University, China. An internationally acclaimed theoretical physicist, he specialises in string theory, quantum field theory, and supersymmetry. He completed all of his higher education at Wits. He is widely recognised for his pioneering work on the AdS/CFT duality, bilocal holography, and the interplay between deep learning and the renormalisation group.

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