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To all members of the
Faculty of Physics

Vienna, 04 April 2025

Invitation to the public defense of the doctoral thesis

**“Quantum Reference Frames: From Quantum
Information to Spacetime”**

by

Anne-Catherine de la Hamette

Friday, 11 April 2025, 15:00 p.m.

Ludwig-Boltzmann-Lecture Hall, ground floor, Boltzmannngasse 5,
1090 Vienna

This thesis explores the quantum information-theoretic aspects of quantum reference frames (QRFs) and their application at the interface between quantum theory and gravity. QRFs offer a relational perspective that reshapes our understanding of concepts such as superposition, entanglement, subsystem structure, and the localisation and causal order of events. By extending and applying QRF frameworks, this thesis provides new insights into both quantum theory and its intersection with gravity.

The first part focuses on the information-theoretic foundation of QRFs, extending the perspective-neutral framework to general symmetry groups, studying non-ideal frames, and establishing quantitative relationships between asymmetry, entanglement, and subsystem coherence. The second part explores the application of QRFs to superpositions of semi-classical spacetimes and indefinite causal structures, advancing quantum symmetry principles as a means of making predictions testable in near-future tabletop experiments and examining the relational nature of localisation and causal order in non-classical spacetimes. By employing QRFs across multiple conceptual and formal frameworks, this work sheds light on the relational nature of the physical world.

Defense committee:

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