To all members of the
Faculty of Physics

Invitation to the public defense of the doctoral thesis

"Spacetime and Relationalism in Black Box Quantum Information"

by

Stefan Lukas Ludescher

Thursday, 18 December 2025, 10:00 a.m.
Kurt-Gödel-Lecturehall, ground floor, Boltzmanngasse 5, 1090 Vienna

In my thesis, I explored the interplay between space-time physics and quantum theory across several directions. First, I investigated Quantum Reference Frames, where colleagues and I quantified the quality of reference-frames. In the special case of clock frames, this provides a quantitative formulation of the Page–Wootters slogan "time replaced by quantum correlations."

Next, collaborators and I studied rotation boxes: black-box devices that take spatial rotations as inputs and respect rotational symmetry. We characterized a rotation-box random-number generator with two inputs whose randomness certification relies solely on symmetry assumptions, specifically, on bounding a generalized spin, not on the validity of quantum theory. We then analyzed rotation boxes with continuous inputs and found that, for spins $\{0, 1/2, 1\}$, the correlation sets of general and quantum rotation boxes coincide, while for spins $\geq 3/2$ a gap appears, which closes again in the infinite-spin limit.

Finally, I examined gravity-mediated entanglement experiments, showing with colleagues, using the language of C*-algebras, that even an infinite-dimensional local classical mediator cannot generate entanglement.

Defense committee:
John H. Selby, Uniwersytet Gdansk, PL (reviewer)
Paolo Perinotti, Università di Pavia, IT (reviewer)
Markus Müller (supervisor)
Caslav Brukner (supervisor)
Thomas Pichler (chair)