

MAP-fis Annual Evaluation

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Abstract of the presentation:

In this talk I will discuss about the two main outputs of my PhD obtained so far. The first is the systematic and comprehensive treatment of two-state incoherent overlaps (also known as the fidelity measure between two quantum states, whenever at least one state is pure) developed in [1]. This work introduces a graph-theoretic formalism to investigate nonclassical properties of state ensembles (quantum coherence, quantum contextuality, quantum nonlocality, Hilbert space dimension, entanglement) using convex-linear functionals of the overlap between two states. The framework developed in [1] will be referred to as the *event graph* approach. I will report the subsequent developments that showcase the usefulness of this new formalism [2,3]. Second, we have also introduced a novel perspective in nonclassicality theory, that we termed *relational nonclassicality*. This notion matured over concretely investigating the usage of recently proposed certain circuits to estimate multivariate traces of quantum states. This research program was comprehensively presented in [4], where we have applied this analysis to the measurement of weak values, quasiprobability distributions and state spectra. I will also mention a recent byproduct [5] from this program. I will then conclude with ongoing efforts and future perspectives.

During the course of this Phd I have also contributed to other projects [6,7,8,9] that shall not be present in my thesis.

Bibliography:

Works under the main focus of the PhD program:

2021/2022

[1] Rafael Wagner, Rui Soares Barbosa, Ernesto F Galvão, “Inequalities witnessing coherence, nonlocality and contextuality”, arXiv preprint arXiv:2209.02670 (2022)

[2] Rafael Wagner, Anita Camillini, Ernesto F Galvão, “Coherence and contextuality in a Mach-Zehnder interferometer”, arXiv preprint arXiv:2210.05624 (2022)

2022/2023

[3] Taira Giordani*, Rafael Wagner*, Chiara Esposito, Anita Camillini, Francesco Hoch, Gonzalo Carvacho, Ciro Pentangelo, Francesco Ceccarelli, Simone Piacentini, Andrea Crespi, Nicolò Spagnolo, Roberto Osellame, Ernesto F Galvão, Fabio Sciarrino, “Experimental certification of contextuality, coherence and dimension in a programmable universal photonic processor”, *Science Advances*, 9 vol. 44, eadj4249 (2023)

[4] Rafael Wagner, Zohar Schwartzman-Nowik, Ismael L Paiva, Amit Te'eni, Antonio Ruiz-Molero, Rui Soares Barbosa, Eliahu Cohen, Ernesto F Galvão, “Quantum circuits for measuring weak values, Kirkwood-Dirac quasiprobability distributions, and state spectra”, arXiv preprint arXiv:2302.00705 (2023) – Accepted in *Quantum Science and Technology*

[5] Rafael Wagner, Ernesto F Galvão, “Simple proof that anomalous weak values require coherence”, *Physical Review A* 108, 4 L040202 (2023)

Works that shall not be part of the PhD thesis, but that were developed or partly concluded between 2021 and 2023 in the course of my PhD.

[6] Roberto D Baldijão, Rafael Wagner, Cristhiano Duarte, Bárbara Amaral, Marcelo Terra Cunha, “Emergence of Noncontextuality under Quantum Darwinism”, *PRX Quantum* 2 030351 (2021)

[7] Filipa CR Peres*, Rafael Wagner*, Ernesto F Galvão, “Non-stabilizerness and entanglement from cat-state injection”, arXiv preprint arXiv:2305.19988 (2023)

[8] Laurens Wallegghem, Rafael Wagner “Extended Wigner’s friend paradoxes do not require nonlocal correlations”, arXiv preprint arXiv:2310.06976 (2023)

[9] Rafael Wagner, Roberto D Baldijão, Alisson Tezzin, Bárbara Amaral, “Using a resource theoretic perspective to witness and engineer quantum generalized contextuality for prepare-and-measure scenarios”, *Journal of Physics A: Mathematical and Theoretical*. 56 505303 (2023)

*These two authors contributed equally.