Diego Ferreira

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Brazilian, born in 15/Oct/1989

I am a researcher scientist and PhD physics student at Federal University of Minas Gerais, Brazil, and I work with various topics in Quantum Information and Condensed Matter Systems. I develop and apply Tensor Network techniques to theoretically study the dynamics of Quantum many-body systems. I have experience in program development and simulations, using C++, Matlab and Fortran, as well as in analytical solutions of selected models. My interest is advance the tensor network mathematical framework and solve frontier science problems in Quantum Information and Condensed Matter Theory.

Area of research

Quantum Information, Condensed Matter and Statistical Physics.

Topics of Interest

- Many-body localization and thermalisation;
- Open dissipative dynamics;
- Tensor networks renormalization algorithms and numerical methods for time evolution of closed and open systems, for both 1D and 2D;
- Quantum phase transitions;
- Quantum correlations in systems of indistinguishable particles;
- The fermionic extended Hubbard model.

Education

2016 - Present **Ph.D. in Physics**

Quantum Information Group (Infoquant), Federal University of Minas Gerais (Brazil, Belo Horizonte)

- *Title:* Tensor Network Techniques applied in the study of the Extended Hubbard Model and the Diamond Chain
- *Advisor:* Prof. Reinaldo O. Vianna
- *Co-advisor:* Prof. Fernando Iemini (UFF - Brazil, Rio de Janeiro)

2014 - 2016 **M.Sc. in Physics**

Quantum Information Group (Infoquant), Federal University of Minas Gerais (Brazil, Belo Horizonte)

- *Title:* Multipartite Entanglement in one-dimensional Tensor Networks in the MPS approximation
- *Advisor:* Prof. Reinaldo O. Vianna

2010 - 2013 **B.Eng. in Physics with emphasis in Computational Physics**

Federal University of Sao Joao del-Rei (Brazil, Minas Gerais)

- *Title:* Study of Effective Models for Quantum Cromodynamics: Equilibrium and Dynamics out of Equilibrium
- *Advisor:* Prof. Ricardo L. S. Farias

Languages

- *English:* Full professional proficiency
- *Portuguese:* Native proficiency

Professional Experience

2016 - Present Ph.D. Researcher at UFMG (Brazil, Minas Gerais)

- I doing my PhD working mainly on the subjects: (i) quantum phase transitions and analysis of the entanglement spectrum distribution of the two-body reduced density matrix in the Extended Hubbard Model, (ii) the presence of many-body localization in the diamond chain and its implications, and (iii) a purely dissipative Lindblad dynamics which can produced a geometrical frustrated 1D quantum system by competition of distinct dissipative channels in a non-equilibrium evolution. During this time I gained experience in developing various types of open and closed systems time evolution algorithms in C++, as well as a fast algorithm for calculating a fourth-order correlator in a fermionic system.

- During my PhD I made a visit for a period of one month (2018) at the ICTP/Trieste in Italy, where I had the opportunity to attend a school which greatly added to my doctorate and allowed the collaboration that I have with Dr. Rosario Fazio and Prof. Dr. Fernando Iemini (postdoctoral fellow at the time). I also participate on a school for tensor network approaches to Quantum many-body systems, where I learned various topics on the state of the art of the tensor network theory, and I was able to develop more general and robust algorithms.

- *Achievements:* two manuscripts accepted in Physical Review A (impact factor 3.14) and Physical Review B (impact factor 4.036), one submitted in Physical Review B as first author (approved by referees and under small revisions), and other two under review in the peer review journals Physical Review A and Europhysics Letters (impact factor 1.957). Two poster presentations in international conferences. Two ongoing projects mentioned above, two of them as the first author: the first (on the Hubbard model) submitted, and the second (diamond chain) with preliminary results and a draft.

- *Skills:* Numerical modeling with Tensor Network formalism; analytical solving of many-body problems; experience in C++ and Matlab.

2014 - 2016 M.Sc. Researcher at UFMG (Brazil, Minas Gerais)

- I worked in the understanding of the multipartite entanglement structure in the Ising Model, where I gained experience with tensor network methods (matrix product states and density matrix renormalization group in particular) in the study of many body systems, as well as the formal theory of quantum correlations.

- *Skills:* Numerical simulation of quantum 1D models.

2010 - 2013 B.Eng. Researcher at UFSJ (Brazil, Minas Gerais)

- I've worked with the bi-dimensional classical Ising Model, developing the Monte-Carlo algorithm for the system simulation and calculations of various thermodynamic quantities,studying the effect of bond dilution on these quantities. Later on, I've worked in a Quantum Field Theory laboratory studying analytical and numerical non-perturbative methods to solve a stochastic Langevin equation of motion for a scalar field (order parameter) in a effective QCD model.

- *Skills:* Numerical simulations using fortran.

Scientific Production

Preprint Quantum correlations, entanglement spectrum and coherence of two-particle reduced density matrix in the Extended Hubbard Model

Diego L. B. Ferreira, Tiago O. Maciel, Reinaldo O. Vianna and Fernando Iemini.

arXiv:2111.00085 (2021) *submitted to Physical Review B*

Journal Determination of the critical exponents in dissipative phase transitions: coherent anomaly approach

Jiasen Jin, Wen-Bin He, Fernando Iemini, Diego Ferreira, Ying-Dan Wang, Stefano Chesi and Rosario Fazio.

Physical Review B, 104 (2021) 214301

Preprint Quantum Statistical Complexity Measure as a Signalling of Correlation Transitions

André T. Cesário, Diego L. B. Ferreira, Tiago Debarba, Fernando Iemini, Thiago O. Maciel, Reinaldo O. Vianna.

arXiv:2002.01590 (2020)

Preprint Probing Genuine Multipartite Entanglement in Large Systems

Lucas B. Vieira, Diego L. Braga Ferreira, Thiago O. Maciel and Reinaldo O. Vianna.

arXiv:1911.04649 (2019)

Journal Completely positive maps for reduced states of indistinguishable particles

Leonardo da Silva Souza, Tiago Debarba, Diego L. Braga Ferreira, Fernando Iemini, and Reinaldo O. Vianna.

Physical Review A, 98 (2018) 052135

Poster Tensor Network Techniques applied in the Extended Hubbard Model

Diego L. Braga Ferreira, Thiago O. Maciel, Fernando Iemini and Reinaldo O. Vianna.

Presented at "Tensor Network based approaches to Quantum Many-Body Systems", Donostia International Physics Center, Donostia-San Sebastián, Spain (2019).

Poster Tensor Network Techniques applied in the Extended Hubbard Model

Diego L. Braga Ferreira, Thiago O. Maciel, Fernando Iemini and Reinaldo O. Vianna.

Presented at "Summer School on Collective Behaviour in Quantum Matter", ICTP, Trieste, Italy (2018).

References

Prof. Reinaldo Oliveira Vianna

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Prof. Fernando Iemini

Physics Institute, Fluminense Federal University (Brazil, Niterói)

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Dr. Thiago O. Maciel
GIQSUL, Federal University of Santa Catarina (Brazil, Santa Catarina)
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