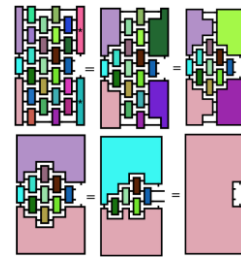




Master / PhD Thesis Project

Tensor networks, quantum computers and the many-body problem.

In recent years, tensor networks have emerged as a class of method both versatile and extremely powerful in a variety of situations ranging from the simulation of correlated phases of matter in one dimension to quantum computers [1] to the calculation of Feynman diagrams that arise in many-body problems and quantum field theories [2] or even to replace neuron networks in machine learning applications. Very interestingly, they succeeded in solving problems that would naively be considered as unfeasible on a classical computer. Mathematically, tensor networks generalize linear algebra to objects with more than two indices, see the appendix A of [3] for a short introduction.



In this internship, we will use these techniques to study the physics of quantum nanoelectronics devices that are candidates to build quantum computers. In particular, we will focus on the physical processes with which entanglement is generated and the competition between the good entanglement (the one that we seek) and the bad entanglement (entanglement with other degrees of freedom a.k.a. decoherence). We will use and continue to develop advanced many-body techniques that combine traditional tools from many-body theory with tensor networks [2] to calculate the real time evolution of physical observables of interest. The project could continue with a simulation of the microscopic process by which a quantum bit gets entangled with the measuring apparatus and eventually its wavefunction gets “projected”.

Good mathematical skills as well as scientific programming are necessary for the success of the project. The work will involve theoretical / formalism aspects as well as numerics. The Internship/PhD will take place within the theory group of CEA Grenoble, IRIG, PHELIQS (Photonics NanoElectronics and Quantum engineering). Our group contains 15-20 researchers working on nanoelectronics, superconductivity, magnetism and electronic correlations in close collaboration with experimental groups. The group has a long standing commitment in the development of open source softwares such as the Kwant project (<http://kwant-project.org>) and the Tkwant project (<http://tkwant.kwant-project.org>). The project itself will be done under the direction of Xavier Waintal. We seek highly motivated students with a strong background in theoretical physics, quantum nanoelectronics and/or numerical simulations. The master project could naturally be extended into a PhD thesis upon mutual agreement.

[1] <https://journals.aps.org/prx/abstract/10.1103/PhysRevX.10.041038>

[2] <https://arxiv.org/abs/2207.06135>

[3] <https://arxiv.org/abs/2207.05612>

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To apply for this position, send your application (including CV) by e-mail to: xavier.waintal@cea.fr

French Commission for Atomic Energy and Alternative Energies

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