MAP-fis Essay Proposal, 2014-2015

(*please write in English*)

Supervisor

Name: João Lopes dos Santos

e-mail:jlsantos@fc.up.pt

Title

Entanglement as a Condensed Matter Tool

Area

(*Materials, Optics, Condensed Theory, High Energy Theory,....*);

Condensed Matter Theory

Summary of Proposal

Entanglement is a distinctive feature of quantum correlations, first discussed by Schroedinger . In quantum mechanics it is possible to have complete information about a system, and only partial information of one of its parts.

Entanglement features in any discussion of quantum foundations, and has long been used as a resource in quantum information theory.

In recent years it has been recognized as an important tool in Condensed Matter Physics. Highly successful numerical methods for 1D quantum systems, (such as the Dynamical Matrix Renormalization Group), owe their accuracy to specific features entanglement spectrum of parts of of the full system[1] In general new insights into strongly correlated systems have arisen from consideration of the features of the entanglement spectrum[2,3]. New types of order, not derivable from broken symmetry situations, such as topological phases, have been discussed in terms of maximally entangled states[4].

In this essay the purpose is to review the applications of the concept of entanglement in the context of Condensed Matter. We expect that it will be possible to grasp some of the key concepts in the field, review some of the techniques to make partial traces, determine entanglement spectra, and also learn to extract relevant information of the many body quantum states from this perspective.

References

(*to allow students first look at topic*)

[1] Eisert, J.; Cramer, M. & Plenio, M. B.
Colloquium : Area laws for the entanglement entropy
Rev. Mod. Phys., American Physical Society, 2010, 82, 277-306

.
[2]Poilblanc, D. Entanglement Hamiltonian of the quantum Néel state
Journal of Statistical Mechanics: Theory and Experiment, 2014, 2014, P10026

[3]Andrade, E. C.; Steudtner, M. & Vojta, M. Anderson localization and momentum-space entanglement Journal of Statistical Mechanics: Theory and Experiment, 2014, 2014, P07022

[4]Chen, X.; Gu, Z.-C. & Wen, X.-G.
Local unitary transformation, long-range quantum entanglement, wave function renormalization, and topological order
Phys. Rev. B, American Physical Society, 2010, 82, 155138 .