MAP-fis Essay Proposal, 2015-2016

(*please write in English*)

Supervisor

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Title

Topology and geometrical frustration in itinerant electronic systems

Area

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

Condensed Matter Theory

Summary of Proposal

Topology in condensed matter physics is currently a hot topic of research. Most of the interest is associated with the recent discovery of topological insulators and superconductors [1,2]. Topological insulators are bulk insulators but have conductive edge states, which are topologically protected against any local scattering sources such as scattering by non-magnetic impurities, lattice defects, and surface distortions.

While in the case of topological insulators and superconductors, one classifies topologically the band structure of these systems, that is, one has topological invariants in momentum space, real space topology also plays a very important role in the case of the geometrically frustrated lattice models [3]. Destructive interference in these lattices leads to localized states (and to flat bands in the band structure) that have an extension interval, which is dependent on the applied magnetic field [4]. The possible interplay of edge states with bulk localized states is an open problem, in particular in the context of magnetism and superconductivity.

The objective of this this essay proposal is the study of magnetism and superconductivity in electronic systems where topology, geometrical frustration and anomalous density of states play a determinant role.

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References

(*to allow students first look at topic*)

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[2] König, Markus; Wiedmann, Steffen; Brüne, Christoph; Roth, Andreas; Buhmann, Hartmut; Molenkamp, Laurens W.; Qi, Xiao-Liang; Zhang, Shou-Cheng (2007) Quantum Spin Hall Insulator State in HgTe Quantum Wells. Science 318 (5851): 766–770

[3] R. G. Dias and J. D. Gouveia (2015), Origami rules for the construction of localized eigenstates of the Hubbard model in decorated lattices, Sci Rep. 2015; 5: 16852.

[4] Lopes, A. A.; Antonio, B. A. Z.; Dias, R. G. (2014) Conductance through geometrically frustrated itinerant electronic systems. Phys. Rev. B 89, 235418.