MAP-fis Essay Proposal, 2013-2014

(*please write in English*)

Supervisor

Name: Carlos Martins

E-mail: Carlos.Martins@astro.up.pt

Title

Cosmic Paleontology: Searching for Superstrings

Area

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

Particle Cosmology, Astrophysics

Summary of Proposal

Topological defects necessarily form at phase transitions in the early universe. Being non-linear objects, their study requires a combination of phenomenological analytic modeling and complex HPC numerical simulations. Among the possible defects, superstring networks are particularly interesting, and recent work suggests their unavoidable formation at the phase transition that ends inflation. Characterizing their evolution and consequences can provide us with unique clues on fundamental physics and the dynamics of the early universe.

Although cosmic superstrings share many of the properties of standard strings that have been extensively studied in the past, there are important differences: they don't always intercommute when they intersect and the formation of junctions occurs naturally as a result of string interactions. Hybrid networks with various types of defects can also form, with non-trivial dynamics. Understanding such realistic networks is an open problem that warrants further study, since it has a direct impact on the observational signatures of (and searches for) these objects. The availability of high-precision data from the ESA Planck Surveyor makes this study particularly timely.

The project may have a more theoretical or a more numerical/observational focus, depending on the background and interests of the student. In the latter case, the student's work may also contribute to further define the science case

of future ESA missions such as CorE+ and eLISA and allow him/her to join the corresponding science teams. In either case a foreign co-supervisor will be chosen accordingly in due course.

References

(t*o allow students first look at topic*)

The canonical textbook in the area is Vilenkin and Shellard (Cosmic Strings and Other Topological Defects, CUP), which provides a basic (if slightly out of date) overview of the field. Examples of recent work in the area include arXiv:1201.5064 for analytic modelling and arXiv:1206.6043 and arXiv:1312.2123 for numerical work, while arXiv:1310.3614 provides a short overview of recent results and open issues.