**Nonperturbative phase diagram of interacting disordered Majorana nanowires**

F. Crépin$^1$, G. Zarand$^2$, P. Simon$^3$

1 Institute for Theoretical Physics and Astrophysics, University of Wuerzburg, 97074 Wuerzburg, Germany
2 Institute of Physics, Budapest University of Technology and Economics, H-1521 Budapest, Hungary
3 Laboratoire de Physique des Solides, CNRS UMR-8502, Université Paris Sud, 91405 Orsay Cedex, France

Majorana fermions (MF) have recently attracted a lot of attention in condensed matter systems. In a seminal work, Kitaev [1] constructed a simple model for a one-dimensional (1D) topological superconductor with p-wave pairing, hosting Majorana edge states at each end. Parallel to Kitaev’s work, a disordered version of the same toy model has been studied by Motrunich et al, who showed that these these edge states survive the presence of moderate disorder [2]. We develop a Gaussian variational approach in replica space to investigate the phase diagram of a one-dimensional interacting disordered topological superconducting wire in the strong coupling regime. This method allows for a non-perturbative treatment in the disorder strength, electron-electron interactions and the superconducting pairing amplitude. We find only two stable phases: a topological superconducting phase, and a glassy, non-topological localized phase, characterized by replica symmetry breaking [3].

---