Scientific Area	Theoretical physics, quantum information, quantum computation, statistical physics
Topic title	Quantum error correcting codes and models of phase transitions
Main host institution	Centre Européen de Sciences Quantiques https://www.cesq.eu/
Supervisor/institution	Jérôme DUBAIL, Directeur de recherche CNRS https://www.cesq.eu/people/
Co-Supervisor/institution	Mario Ruben / Karlsruhe Institute of Technology : https://www.int.kit.edu/1938_mario.ruben.php
Mentor[1]/institution	TBC
Secondment institution	TBC
Topic description	
Successful quantum error correction is key to fault-tolerant quantum computing. Quantum error correction codes encode quantum information redundantly in entangled multi-qubit states, allowing to counteract decoherence by measuring quantum correlations. In general, there is a threshold in the amount of noise that a correcting code can tolerate, such that below threshold the quantum information is recovered with fidelity approaching one. This is analogous to a percolation transition in a porous material, when the material remains impermeable with probability one below the percolation threshold. A seminal work by Dennis, Kitaev, Landahl and Preskill in 2002 showed that the toric code, a famous error correcting code, could be mapped to the Random Bond Ising model, a paradigmatic model of a classical phase transition. Here we propose to explore new models of quantum error correcting codes and their mappings to classical phase transition problems, aiming at pinpointing their universal aspects.	
Recommended applicant's profile	

[1] Mentor: The primary role of the mentors will be to identify and facilitate specific training objectives, advise on any problems faced by the DC, including career matters with an external perspective and provide mediation in the case of disputes.

The Gen-Q programme has received funding from the European Union's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie grant agreement number 101217386.

the applicant should be highly motivated and possess a strong background in quantum physics. Good programming knowledge (e.g. in python or julia or C++) is also required. The applicant should have received training in theoretical physics during their master thesis, both on analytical and numerical methods. Knowledge of quantum computing, quantum information, quantum error correction, and/or of statistical models and phase transitions would be a plus, but is not required.

During the research project, the student will have the opportunity to develop the following skills: perform analytical calculations (using integrability techniques, field theory techniques), computer programming and numerical simulations (exact diagonalisation, tensor networks), team work, project implementation and management, writing and presentation skills (scientific paper writing, seminars and presentations in international conferences). The applicant should be motivated to carry out team work in a collaborative, international and multidisciplinary environment.

The Gen-Q programme has received funding from the European Union's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie grant agreement number 101217386.