Quantum computers are one of the most promising technologies of current research and might sustainably shape industry and economy. However, the biggest obstacle when building actual quantum computers is their low stability due to effects of noise. One quite promising approach to overcome this drawback are topological quantum computers, which are protected against noise and hence less sensible. Unfortunately, the computational power of quantum systems suitable for topological quantum computation is severely limited. This can be ameliorated by adding defects to the system, such as vacancies in a lattice. In our work, we create a framework to describe how quantum systems with defects appropriable for topological quantum computation evolve in time.

In the absence of external forces, we leave the total number of defects indefinite. Each lattice site is then described by a “maybe link” which can either be a regular occupied link or a defect, respectively. In the presence of external forces, the situation is more subtle. Here, we encode dynamical information in the system energy, which reduces the problem to a combinatorial one. We then study a specific one-dimensional example with our technique, which indeed reveals a model with higher computational power when adding defects.

All in all, we deploy a general framework to physically make sense of defects in quantum systems suitable for topological quantum computation. Studying more examples, in particular in higher dimensions with our technique would be an interesting question since inserting defects allows to enhance their computational power.