Calculations for interacting quantum many–body systems are usually very difficult. On the one hand, correlation effects – in particular the Coulomb correlations – render analytical calculations in most cases at least unreliable, with difficult to estimate errors introduced by applied approximations. On the other hand, the size of the corresponding Hilbert space, growing exponentially with the number of particles, makes exact numerical calculations limited to very small systems. Other numerical methods, like various versions of Quantum Monte Carlo (MC) for fermionic systems do not work at low temperatures because of the infamous *fermionic sign problem* or are limited to low–dimensional systems, as in the case of some of the Renormalization Group–type approaches. Also other methods, like the Dynamical Mean Field Theory or the Dynamical Cluster Approximation, have their own limitations.

However, the competition between the interaction energy and the kinetic energy – which makes the calculations so difficult – leads to plethora of extremely interesting and useful, also from a practical point of view, phenomena. High–temperature superconductivity, quantum Hall effect, Mott insulating states, are only a few examples of effects observed in strongly correlated systems. Therefore, it very important to develop new, highly efficient methods that would allow us to attack the computational problems posed by these systems. And this is one of the aims of the present project. Namely, we plan to develop numerical methods well suited for studying some particular class of quantum many–body systems – systems with slow and fast degrees of freedom. If the dynamics of these degrees are significantly different, the slow variables can be treated in the strict adiabatic limit as classical variables. The main advantage of this approximation is that the original fully interacting quantum many–body problem can be mapped into a problem of noninteracting fermions coupled with, in general, spatially fluctuating classical fields. Despite the fact that the fermions are noninteracting, tracing them out can be a numerically challenging task, what makes the calculations rather slow. We propose to overcome this problem in a very unorthodox way, by using *neural networks*. Very recently physicists started to use this approach to represent complex quantum many–body states. In this project, we plan to apply one of the techniques used in *Machine Learning* – Restricted Boltzmann Machines (RBM). RBM is a type of stochastic neural network that is capable of learning internal representations. We believe that properly *trained* RBMs can describe the effective Hamiltonian obtained by tracing out the fermionic degrees of freedom. Then, they can be used to perform MC simulations. We also plan to develop and implement other, more "traditional", numerical methods. All these methods will be used to study some interesting groups of complex quantum materials, for example, electrons coupled to spin textures, functionalized graphene, nanowires with exotic Majorana quasiparticles, etc.