

## Many body quantum calculations -- a route to understanding emergence in condensed matter

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**Abstract:** All the matter that we interact with at the human scale is made of nuclei and electrons. Out of these rather simple ingredients, we observe an amazing diversity of behavior, from the huge variety of chemical behavior to the semiconductors, insulators, metals, superconductors, and more unusual electronic states. The transition from simple ingredients to complex collective behavior is called emergence. A major challenge in studying this subject is that the constituent particles behave according to quantum mechanics, whose equations are extremely difficult to solve for many particles.

This talk will cover some of the new progress in simulating many-body quantum particles using classical computers. By using clever algorithms, it turns out that it is possible to achieve quite accurate results that are useful and predictive of experimental results, even when the electrons in the system are strongly interacting. Secondly, by using modern data science techniques, I will show how one can use the results of the highly accurate many-body simulations to discover coarse-grained descriptions of materials that can be used to understand emergence of collective motion.