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Variational Quantum Simulation

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Key properties of condensed matter systems, such as for instance the occurrence of high-temperature superconductivity, are governed deep down by fundamental quantum effects such as superposition, interference and entanglement. Likewise, molecular structure calculations that could help explain and understand chemical reaction rates (with tremendous industrial impact) also require a full quantum description.

However, the complexity of simulating quantum systems notoriously scales exponentially with the number of elementary constituents. A possible solution to this problem is quantum simulation: use one quantum system, to simulate another. A well-controlled quantum system is built in the laboratory that mimics the system under study. The hope is that such devices can open up unexplored territory outside the reach of classical numerical simulations, and provide new insights into quantum matter.

In this talk we discuss experimental quantum simulation (and quantum computation) platforms built from ultracold atoms and ions. We will discuss an example of a current research direction of variational quantum simulation, where a computer is hooked up to a quantum experiment and in a feedback loop attempts to variationally create interesting quantum states.

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