MODELLING MOLECULES WITH IONS AND LASERS: ANALOG QUANTUM SIMULATION OF TIME-DOMAIN SPECTROSCOPY AND BEYOND

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For roughly a century, spectroscopy has been our window into the molecular domain. It has served as a benchmark for the development of new theoretical methods in quantum chemistry, which in turn have aided the assignment and characterization of molecular spectra. The advent of quantum computing is no exception. Quantum computers have the potential to greatly increase the scale and accuracy of simulated molecular systems. However, current "digital" quantum computers will remain limited in size and number of operations in the near future due to environmental noise. Conversely, analog quantum computers may be used to simulate realistic molecular systems with current technology. They consist of controllable quantum devices with a system-specific mapping onto a quantum system of interest, such as a molecule. I will present our recent work on the development of an analog quantum toolkit for the simulation of vibronic coupling Hamiltonians, including the prediction of vibronic spectra. I will show the theoretical capabilities and limits of our approach, and show proof-of-principle experimental results from collaborators. Finally, I will discuss what is next in the exciting world of analog quantum simulation.