RICE QUANTUM GROUP MEETING SEMINAR SERIES

Trapped-ion quantum simulation of electron transfer models with tunable dissipation

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Visal is a graduate student working in Prof. Guido Pagano's experimental group, where he uses trapped ions as the quantum simulator to study fundamental models of spin and spin-boson systems. His research interests are quantum simulation of many-body systems, quantum information science, atomic and optical physics, and physics education.

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ABSTRACT

The properties of trapped ions make them a pristine platform for simulating the quantum dynamics of spin and spin-boson systems. In this talk, I will provide an introduction to the trapped-ion platform. Then, I will present our work on simulating a paradigmatic model of electron transfer from a donor state to an acceptor state governed by the open-system dynamics with a pair of trapped $^{171}Yb^{+}$ and $^{172}Yb^{+}$ ions. We encode the electronic degree of freedom in the hyperfine ground states of the $^{171}Yb^{+}$ ion. Using the $^{2}S_{1/2}$ – $^{2}D_{3/2}$ optical transition of the $^{172}Yb^{+}$ ion for sympathetic cooling, we perform reservoir engineering on a collective motional mode encoding a reaction coordinate that is coupled to the donor and acceptor states via coherent spin-phonon drive. By independently controlling the donor-acceptor energy difference, the electronic and vibronic couplings, and the motional relaxation rate, we observe the transfer dynamics and measure their rates in nonadiabatic and strongly adiabatic regimes. Our results provide a testing ground for models of molecular charge transfer processes, paving the way for the design and development of efficient bioenergetics and molecular electronics.

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