Joint Quantum Seminar

Wednesday, October 2, 4:00 pm
Jefferson 250

Prof. Marcello Dalmonte

International Centre for Theoretical Physics (ICTP)

"Quantum simulating lattice gauge theories: 'particle physics' with Rydberg atom arrays"

Gauge theories are the back-bone of our understanding of nature at the most fundamental level as captured by the standard model. Despite their elegance and conceptual simplicity, gauge theories have historically represented a major computational challenge in many-body theory - including, for instance, the real-time dynamics describing heavy-ion collisions at colliders, which is inaccessible to classical simulations based on Monte Carlo sampling. These challenges have motivated a flurry of theoretical activity over the last ten years, devoted at developing strategies for the quantum simulation of their discretized version - lattice gauge theories.

In this first part of the talk, I will review the status of the field, highlighting potential applications as well as roadblocks, and discussing the first realization of gauge theory dynamics in a trapped ion quantum computer.

In the second part of the talk, I will show how Rydberg atoms trapped in optical tweezers offer unprecedented opportunities for the realization of lattice gauge theories in AMO systems. In particular, I will describe how recent experiments have already realized the real-time dynamics of the lattice Schwinger model (the one-dimensional version of quantum electrodynamics) in the presence of a topological angle. Beyond demonstrating that quantum simulation of gauge theory is an experimental reality at large scales, the analogy between Rydberg atom arrays and gauge theories provides a powerful field theoretical tool to understand the slow-dynamics describing such systems - that immediately opens the door for its generalization to other models sharing the same field theoretical description. Finally, I will describe how other archetypical physical phenomena of lattice gauge theories - such as the effect of confinement on the dynamics, and the evolution of mesons - can be observed within the same platform.

Student Presentation will begin at 4:00 PM
Guest Presentation will begin at 4:30 PM
Refreshments will be provided

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