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Ultrafast and ultracold quantum simulator/ computer with attosecond precision

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Abstract

Many-body correlations govern a variety of important quantum phenomena including the emergence of superconductivity and magnetism in condensed matter as well as chemical reactions in liquids. Understanding quantum many-body systems is thus one of the central goals of modern sciences and technologies. Here we demonstrate a new pathway towards this goal by generating a strongly correlated ultracold Rydberg gas with a broadband ultrashort laser pulse. We have applied our ultrafast coherent control with attosecond precision [1] to a strongly correlated Rydberg gas in an optical dipole trap, and have successfully observed and controlled its ultrafast many-body electron dynamics [2-4]. This new approach is now applied to an atomic BEC, Mott insulator lattice, and arbitrary array assembled with optical tweezers to develop into a pathbreaking platform for quantum simulation and computation on the ultrafast timescale [5-7].

This project is in progress in tight collaboration with Hamamatsu Photonics K.K..

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“A metal-like quantum gas: A pathbreaking platform for quantum simulation”