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Many-body physics with spin states of trapped Rydberg atoms[1]

SVETLANA MALINOVSKAYA, Stevens Institute of Technology — Atoms in their highly excited electronic states, referred to as Rydberg atoms, have extraordinary nonlinear optical properties. Such atoms are highly polarizable and interact with each other via the dipole-dipole interactions or the van-der-Waals interactions. At ultra-cold temperatures, Rydberg atoms possess quantum properties that are strongly dependent on their interatomic interactions leading to condensed matter-like collective behavior. Owing to these features, Rydberg atoms became a new platform to study quantum many-body physics. Spin degrees of freedom of trapped Rydberg atoms bring rich new physics including quantum magnetism, new quantum phases, and entanglement, which is a crucial resource in many quantum information and quantum communication tasks. In this talk, I will discuss properties of alkali rubidium atoms trapped in an optical lattice and excited to Rydberg states by laser radiation. I will present a quantum control methodology to create entangled states of two typical classes, the W and the GHZ. I will show that the entangled states of Rydberg atoms can be used to create the multiphoton entangled radiation states in a cavity and in free space. The methodology exploits chirped pulse adiabatic passage.

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Svetlana Malinovskaya
Stevens Institute of Technology

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