北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Special Seminar

A quantum gas of polar molecules in an optical lattice

Dr. Steven Moses

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Time: May 13, Friday, 4pm

Venue: W563, Physics building, Peking University

地点：北京大学物理楼，西563会议室

Abstract

Ultracold polar molecules, because of their long-range, spatially anisotropic interactions, are a new quantum system in which to study novel many-body phenomena. In our lab, we create and study 40K87Rb polar molecules. These molecules were found to undergo exothermic chemical reactions, and this led to interesting studies of chemistry near absolute zero. By creating the molecules at individual sites of a 3D optical lattice, we completely suppress these chemical reactions, and the polar molecule gas becomes stable and lives for tens of seconds. This allows us to explore coherent, many-body phenomena resulting from long-range dipolar interactions in the lattice. By encoding a spin-1/2 system in the rotational states of the molecules, we were able to realize spin-exchange interactions based on a spin Hamiltonian, which is one of the first steps in studying quantum magnetism with polar molecules. While this study was the first realization of such coherent dipolar interactions with polar molecules in a lattice, its full potential was limited by the low lattice filling fractions. Using our ability to exquisitely control the initial atomic gas mixture, we loaded a Mott insulator of Rb and a band insulator of K into the lattice. This quantum synthesis approach led to significantly higher molecular filling fractions and represents the first fully connected system of polar molecules in an optical lattice. This low-entropy quantum gas of polar molecules opens the door to interesting quantum simulations, which should be attainable in the next generation of the experiment.

About the Speaker

I received by BS in physics and mathematics from the University of Michigan in 2010. During my undergraduate studies, I worked in several labs, including a summer internship at CERN in Switzerland. My senior honors thesis was a materials science project dealing with thermoelectric materials; however, my interests gradually shifted towards atomic physics. Hence, I decided to go to graduate school at JILA and the University of Colorado, Boulder, where I worked with Debbie Jin and Jun Ye on the ultracold polar molecule experiment. My PhD work focused on studying KRb molecules in optical lattices. I defended my PhD thesis in March 2016, and I plan to do a postdoc in quantum information science.