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Ultracold polar molecules in a 3D optical lattice

BO YAN, JILA, University of Colorado

Ultracold polar molecules, with their long-range electric dipolar interactions, offer new opportunities for studying quantum magnetism and many-body physics. KRb molecules loaded into a three-dimensional (3D) optical lattice allow one to study such a spin-lattice system in a stable environment without losses arising from chemical reactions. In the case with strong lattice confinement along two directions and a weak lattice potential along the third, we find the loss rate is suppressed by the quantum Zeno effect [1]. In a deep 3D lattice with no tunneling, we observe evidences for spin exchange interactions [2]. We use Ramsey spectroscopy to investigate the spin dynamics. By choosing the appropriate lattice polarizations and implementing a spin echo sequence, the single particle dephasing is largely suppressed, leaving the dipolar exchange interactions as the dominant contribution to the observed dynamics. This is supported by many-body theoretical calculations [3]. While this initial demonstration was done with low lattice fillings, our current experimental efforts are focused on increasing the lattice filling fraction. This will greatly benefit the study of complex many-body dynamics with long-range interactions, such as transport of excitations in an out-of-equilibrium system and spin-orbit coupling in a lattice.

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