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Formation of p-wave Feshbach molecules in a gas of ultracold 6Li atoms

Takashi MUKAIYAMA
Strongly Correlated Quantum Gases Group,
Japan Science and Technology Agency (JST),
Tokyo, Japan

Abstract:

Fermionic p-wave superfluidity presents a rich variety of novel phenomena caused by the complex order parameters. Recent experimental advances in controlling interactions of ultracold atomic gases have awakened expectations for realizing p-wave superfluidity of fermionic atoms, which would offer great opportunities to study superfluid phases with the precise control of atomic physics. In this work, we have observed the formation of p-wave Feshbach molecules in the lowest atomic spin states of 6Li, which is free from the dipolar relaxation. While s-wave Feshbach molecules are highly stable against vibrational quenching near a Feshbach resonance, it is not known to what extend p-wave molecules suffer from inelastic collisions. Therefore, studying collisional properties of p-wave Feshbach molecules is an important step toward realization of p-wave molecular condensates.
By sweeping the magnetic field to a value near the p-wave Feshbach resonance, p-wave molecules were created from a degenerate Fermi gas of lithium atoms. After the formation of the molecules, the residual atoms were removed from the trap by applying the resonant light pulse in order to prepare a pure molecular sample. The dimer-dimer inelastic collision rate is determined from the measurement of the decay of the molecules as a function of hold time. The measured inelastic collision rate is almost independent of magnetic field detuning on the bound side of the Feshbach resonance. The atom-dimer collision rate is also determined in the experiment without shining the resonant light to remove unpaired atoms. The dimer-dimer elastic collision rate is estimated from the time scale in which the heating due to the inelastic collisions is reflected to the spatial and the momentum distribution of the molecular cloud. Our results show the ratio of elastic and inelastic rate is two. In the current experimental condition, the phase space density of the molecular gas is estimated to be 4x10^{-3}.