DAMOP08-2008-000707

Abstract for an Invited Paper
for the DAMOP08 Meeting of
the American Physical Society

Ultracold dense gas of heteronuclear deeply bound molecules[1]

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The preparation of a dense ultracold polar molecular sample is a long standing goal of AMO physics. Polar molecules have bright prospects as systems with anisotropic interactions, for precision measurements and for quantum information science. One approach towards this goal is to combine Feshbach molecule creation in heteronuclear quantum gases with coherent optical deexcitation schemes and thereby produce an ultracold dense gas of heteronuclear molecules in deeply bound vibrational levels where the heteronuclear molecules exhibit a significant dipole moment. We report about a key step along this route. Starting from an ultracold dense gas of heteronuclear ^{40}K^{87}Rb Feshbach molecules, we coherently transfer these molecules into a vibrational level of the ground-state molecular potential bound by $> 10\,$GHz. We thereby increase the binding energy and the expected dipole moment of the ^{40}K^{87}Rb molecules by more than four orders of magnitude in a single transfer step. While dipolar effects are currently not observable yet, the presented technique can be extended to access much more deeply bound vibrational levels and ultimately those exhibiting a significant dipole moment. The preparation of an ultracold quantum gas of polar molecules might therefore come within experimental reach.

[1]Work done in collaboration with A. Pe'er, K.-K. Ni, J. J. Zirbel, B. Neyenhuis, S. Kotochigova, P. S. Julienne, J. Ye and D. S. Jin.