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Ion Imaging Studies of Ultra-Cold Molecule Production DAVID W. CHANDLER, Combustion Research Facility, Sandia National Laboratories — We report the cooling of molecules in a single collision between an atom and a molecule in a crossed molecular beam apparatus. In particular we will show data on cooling NO by collision with Ar and NH3 in collisiosn with Ne. We have produced in significant numbers ($\sim 10^8$ molecules cm^{-3} per quantum state) translationally cold NO($^2\Pi_{1/2}$,v$'$=0,j$'$=7.5) molecules in a specific quantum state with an upper-limit laboratory-frame rms velocity of 14.8$\pm$1.1 m/s, corresponding to a temperature of 406$\pm$28 mK. The translational cooling results from the kinematic collapse of the velocity distribution of the NO molecules after collision. We present experimental evidence to show that increasing the collision energy by a factor of $\sim$2.6 does not change the velocity spread of the cold NO molecules. Similarly, the energy condition for producing the cold NO does not depend on the energy of the Ar beam. However, the energy of the Ar beam does shift the scattering angle at which the cold molecules appear. We will highlight new studies on utilizing these cold molecules for collisional studies. This work was done in collaboration with Professor James Valentini of Columbia University.

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