OBSERVATION OF NEW DYNAMICS IN THE STATE-RESOLVED COLLISIONAL RELAXATION OF HIGHLY EXCITED MOLECULES

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The dynamics of collisional deactivation of highly energized molecules, pyrazine-h_4 and pyrazine-d_4, by HCl molecules at 300 K show evidence of a new mechanism for collisional energy transfer. Highly vibrationally excited (E_{vib} = 37,900 cm^{-1}) pyrazine-h_4 and pyrazine-d_4 molecules are produced in separate experiments by pulsed excitation with the fourth harmonic output of a Nd:YAG laser at λ = 266 nm. Collisions between the energized isotopes and HCl molecules are monitored by measuring the nascent transient IR absorption of scattered HCl in individual rotational states. The results indicate that HCl molecules are scattered with a gain in rotational and translational energy, but the largest recoil energies are observed for the lowest rotational energy states of HCl. This behavior is opposite to that seen for other bath molecules including DCl and CO_2. The results point to differences in intermolecular interactions between the energy donor and acceptor molecules as contributing factors to the observed differences in the mechanism of energy transfer.