COLLISIONAL X- AND A-STATE KINETICS OF CN USING TRANSIENT SUB-DOPPLER HOLE BURNING

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We examine the collisional kinetics of the CN radical using transient hole-burning and saturation recovery. Narrow velocity groups of individual hyperfine levels in CN are depleted ($X^2\Sigma^+$) and excited ($A^2\Pi$) with a saturation laser, and probed by a counterpropagating, frequency modulated probe beam. Recovery of the unsaturated absorption is recorded following abrupt termination of an electro optically switched pulse of saturation light. Pressure-dependent recovery kinetics are measured for precursors, ethane dinitrile, NCCN, and pyruvonitrile, CH$_3$COCN, and buffer gases, helium, argon and nitrogen with rate coefficients ranging from $0.7-2.0 \times 10^{-9}$ cm$^3$ s$^{-1}$ molecule$^{-1}$. In the case of NCCN, recovery kinetics are for two-level saturation resonances, where the signal observed is a combination of $X$- and $A$-state kinetics. Similar rates occur for three-level crossover resonances, which can be chosen to probe selectively the hole-filling in the $X$ state or the decay of velocity-selected $A$-state radicals. However in the case of CH$_3$COCN, which has a dipole moment of 3.45 D, the $X$-state kinetics are faster than the $A$-state due to an efficient dipole-dipole rotational energy transfer mechanism as the $X$-state dipole moment is 1.5 D and the $A$-state dipole moment is 0.06 D. The observed recovery rates are 2-3 times faster than the estimated rotationally inelastic contribution and are a combination of inelastic and velocity-changing elastic collisions.

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