EFFICIENT SUPER ENERGY TRANSFER COLLISIONS THROUGH REACTIVE-COMPLEX FORMATION: H + SO$_2$

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Translational-to-vibrational energy transfer (ET) from a hyperthermal H atom to ambient SO$_2$ was characterized using time-resolved Fourier transform infrared emission spectroscopy. Vibrational excitation of SO$_2$, following collisions with H atoms containing 59 kcal/mol of kinetic energy, generated from the 193 nm photolysis of HBr, is detected in two distinct energy distributions: one with excitation predominantly at the fundamental vibrational levels is attributable to classical impulsive collisions, while the other, accounting for 80% of the excited SO$_2$ with vibrational energy as high as 14,000 cm$^{-1}$, is proposed to arise from the formation of a transient reactive-complex during the collision. The cross-section for this super ET collision is determined to be 0.53±0.05 Å$^2$, or roughly 2% of all hard sphere collisions. This observation reveals that in collisions between a hyperthermal atom and an ambient molecule, for which a reactive-complex exists on the potential energy surface, a large quantity of translational energy can be transferred to the molecule with high efficiency.