Laser Studies of the Photodissociation Dynamics of Cometary Radicals

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In the past year we have shown that in the 193 nm photolysis of \( \text{C}_2\text{H} \), the \( \text{C}_2 \) radical is produced in a variety of electronic, vibrational, and rotational states. The relative population of the vibrational and rotational states of \( \text{C}_2(A^1\Pi_g) \), \( \text{C}_2(B^1\Sigma^+ \text{g}) \), and \( \text{C}_2(a^3\Pi_u) \) have been determined in a static gas cell and in a pulsed molecular beam. It seems as though the original angular momentum of the \( \text{C}_2\text{H} \) molecule appears as part of the angular momentum of the \( \text{C}_2 \) radical. We are now trying to discover the mathematical relationship that governs this mapping. This work has supplied new information about the bond dissociation energy of the \( \text{C}_2 \) radical. We have also detected \( \text{C}_2(b^1\Sigma^+) \) and \( \text{C}_2(^1\Delta_g) \) in the photolysis of \( \text{C}_2\text{H} \) via time resolved infrared emission spectroscopy. In the former case vibrational excitation up to \( v'=4 \) is observed. All of our results suggest that the \( \text{C}_2 \) models in comets need to consider the presence of vibrationally excited \( \text{C}_2 \) radicals in comets.

The laser induced fluorescence spectra of the \( \text{C}_2 \) has been observed as a product of the 193 nm photolysis of allene and propyne. The populations of the rotational levels are identical in both cases. This result has led us to conclude that an isomerization reaction occurs in the photolysis of propyne which leads to the same \( \text{C}_2\text{H}_2 \) intermediate that is formed in the photolysis of \( \text{C}_2\text{H}_4 \). Since the former molecule is one of the most abundant in the interstellar medium it is also likely that its precursor is also present in comets. This would explain why \( \text{C}_3 \) is observed in comets.

Publications


3. 1990 R.S. Urdahl, Yihan Bao, and W.M. Jackson. An Experimental Determination of the Heat of Formation of \( \text{C}_2 \) and the \( \text{C-H} \) Bond Dissociation Energy in \( \text{C}_2\text{H} \). Accepted for publication by Chem.Phys.Letts.