

## 5. Concluding Remarks

In this chapter, we have briefly reviewed the recent developments in the molecular beam apparatuses in our laboratory. Specifically, the improved universal molecular beam apparatus and the new VUV ionization based molecular beam apparatus are described. We have also reviewed the research works using these two apparatuses in details, especially the multiple channel reaction dynamics of complex reactions and photochemical processes. The most interesting systems studied with the improved universal apparatus are the  $O(^1D)$  reactions with the small alkane molecules. In these reactions, the dominant reaction mechanism is the O atom insertion into the C–H bond, while direct abstraction mechanism is also important in the OH formation channel. While the reaction mechanism is similar for all these reactions, the product channels are quite different because of competitions among reaction channels. For example, in the  $O(^1D)$  reaction with methane, OH is the dominant process while H atom is a significant process. In the  $O(^1D)$  reaction with ethane, however, the  $CH_3 + CH_2OH$  is the most important process, OH is still significant and H atom formation is minor. A new type O atom insertion mechanism (insertion into a C–C bond) is also inferred from the  $O(^1D)$  reaction with cyclopropane. Extreme complicated reactions such as triple product channels have also been observed in the  $O(^1D)$  reaction with silane. Through these comprehensive studies, rather complete dynamical pictures of many multiple channel chemical reactions studied could be obtained. Such detailed studies now can also provide a bridge between the dynamics and kinetics researches. Because of the extremely low  $H_2$  background in the improved universal crossed beam apparatus, atomic and molecular hydrogen elimination processes from hydrocarbon molecules can also be studied in great details. In this chapter, we have also described many excellent examples of such processes, such as photodissociation of propane, ethylene, propyne and methanol at 157 nm. These studies show that atomic and molecular hydrogen eliminations from hydrocarbon molecules could also be very site specific even at very high photon energy excitation (7.9 eV).

In addition to the improved universal apparatus, we have described a new tool in our laboratory, i.e. the synchrotron VUV ionization based molecular beam apparatus. This new tool is relatively more sensitive in comparison with the similar apparatus at ALS in Berkeley. New results on the photodissociation studies of polyatomic molecules have also been presented in order to demonstrate the power of this new apparatus. It is quite

promising that this new apparatus will become an important instrument for radical-molecule and radical-radical reactive scattering studies. Finally some perspectives on the future developments in the experimental reactive scattering studies are provided.

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