

## 1. Introduction

Application of the universal crossed molecular beams method to problems in bimolecular scattering and photodissociation have had a profound impact on our understanding of the underlying mechanisms of chemical reactions.<sup>1</sup> In most cases these experiments achieve universality in product detection by means of electron impact (EI) ionization.<sup>2</sup> Product angular and translational energy distributions are measured by time-of-flight of the neutral products. With the use of EI, a very steep price is paid to achieve the universality that has led to so many successful experiments. Principal among these shortcomings of EI based experiments is fragmentation of the neutral molecules leading to appearance of the product ion at a different mass-to-charge ratio than that of the neutral. This greatly complicates interpretation of the experimental results, particularly for complex molecules and hydrocarbons where fragmentation is especially troublesome. The development of third generation synchrotron radiation sources with associated VUV photon fluxes greater than  $10^{18}$  photons/cm<sup>2</sup>/s has opened the door to a new era in universal crossed-beam scattering studies relying on VUV photoionization (PI) rather than EI. A universal crossed molecular beam endstation employing tunable undulator radiation for product photoionization based detection has recently been constructed on the Chemical Dynamics Beamline<sup>3</sup> at the Advanced Light Source.<sup>4</sup> This chapter will be devoted to introducing this apparatus and documenting the range of experiments that can be carried out.

## 2. Experimental

The endstation is based in principle on a single molecular beam source apparatus<sup>5</sup> employing EI detection that has been used very successfully for photochemistry studies. The design has been adapted to feature two crossed molecular beams along with oil free pumping to ensure compatibility with the synchrotron storage ring vacuum requirements.

The machine, shown schematically in Fig. 1, features two differentially pumped molecular beam sources each of which is pumped by 2000 l/s high throughput magnetic bearing turbomolecular pumps. The sources are fixed at 90° and housed in a chamber that rotates about an axis parallel to the undulator probe beam. The molecular beams cross inside a main chamber pumped by a 2000 l/s turbopump. Scattered products fly out of the interaction region and those that enter a small aperture pass into a