TIME-SLICE VELOCITY-MAP ION IMAGING STUDIES OF THE PHOTODISSOCIATION OF ASTROPHYSIC IMPORTANT SMALL MOLECULES IN THE VACUUM ULTRAVIOLET REGION BY RESONANT SUM/DIFFERENCE FOUR-WAVE MIXING

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We have recently built an apparatus that combines two tunable vacuum ultraviolet (VUV) radiation laser systems and a time-slice velocity-map ion imaging (TSVMI) detection system to study the photodissociation dynamics of astrophysical important small molecules. The two tunable VUV lasers are both generated in rare gases jets by resonant four-wave sum and difference-frequency mixing (FWSDFM) in the energy range from 8.0 eV to 15.4 eV and used respectively for state-selected photodissociation and state-selected photoionization. Preliminary experimental results on state-selected photodissociation of CO will be presented. In this experiment, the CO molecule is excited to one of its ro-vibronic states by absorbing one VUV photon, and it undergoes predissociation to produce C($^3P_{0,1,2}$ or $^1D_2$) and O ($^3P_{0,1,2}$ or $^1D_2$) atoms. The C atom in one of the $^3P_0$, $^3P_1$ and $^3P_2$ states is selectively ionized by using the second VUV beam and detected with the time-slice velocity-map ion imaging (TSVMI) system. From the images, we can obtain the branching ratio between each of the spin orbit states of carbon atoms with an oxygen atom in the ^3P state or the ^1D state. The results indicate that the ratio is strongly dependant on which sub-level of the C(^3P) is being probed. It is also strongly dependant on which state of CO is excited. We are going to use this method to study the photodissociation dynamics of other astrophysical important small molecules, like N_2, NO, C_2, CO_2 and H_2O, in the VUV region by state-selected detection of the C, O and N atoms.

Acknowledgements: a) H. Gao, Y. Song, Y. Pan, and W. M. Jackson were supported by NSF under grant # CHE-0957872. b) H. Gao, L. Yang, and C. Y. Ng were supported by AFOSR under Grant # FA9550-06-1-0073, NASA under Grant No. 07-PATM07-0012, DOE on Contract # DEFG02-02ER15306 and NSF on Grant # CHE 0910488.