SINGLE-PHOTON VACUUM ULTRAVIOLET RYDBERG TAGGING TIME-OF-FLIGHT STUDY OF NASCENT $O(^3P_{2,1,0})$ FORMED IN THE 193.3 NM PHOTODISSOCIATION OF SO_2

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Single-photon Rydberg tagging time-of-flight study on oxygen atom has been firstly demonstrated. The pulsed field ionization photoion (PFI-PI) spectrum for oxygen atoms $O(^3P_{2,1,0})$ resulting from the 193.3 nm photodissociation of SO_2 have been measured using tunable vacuum ultraviolet (VUV) laser radiation in the frequency range of 109 200 - 110 000 cm^{-1}. The PFI-PI measurement reveals over 120 Rydberg lines, which have been assigned as Rydberg states [$2s^2 2p^3$ ($^4S^o{}_{3/2}$) nd ^3D (n = 12-62)] converging to the ground ionic state $O^+(^4S^o{}_{3/2})$ formed by the VUV excitation of $O(^3P_{2,1,0})$. The identification of these Rydberg series has led to the development of the single-photon O-atom Rydberg tagging time-of-flight method. Oxygen atoms excited to high-n Rydberg levels were field ionized at the detector. As expected, the translational energy distribution obtained from oxygen atom Rydberg tagging time-of-flight measurement has a higher energy resolution than, but agrees with that derived from the velocity mapped images of the SO/O radical photofragments. Both confirm vibrational structure related to the formation of SO in the ν = 0,1,2 levels, with ν = 2 dominating the partition of available energy. This novel single-photon VUV-excited atom Rydberg tagging technique may prove to be universally applicable to other atoms, and thus become a promising avenue for future photodissociation and reaction dynamic studies.