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**Non-adiabatic dynamics of reactions of O($^1$D) with Xe, CO, $NO_2$, and $CO_2$ from crossed atomic and molecular beam experiments**

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Reactions of the first excited state of atomic oxygen, O($^1$D), with small molecules such as CO, $NO_2$, and $CO_2$ continue to be of interest in aeronomy and atmospheric chemistry, thus providing additional motivation to understand the dynamics of these reactions and how well they are predicted by theory. In collaboration with Prof. Jim Lin of the Institute of Atomic and Molecular Sciences, Academia Sinica, Taiwan, we have studied the dynamics of quenching and non-quenching reactions between O($^1$D) and various small molecules using a universal crossed atomic and molecular beam apparatus. New experimental results for the dynamics of quenching of O($^1$D) by Xe and CO will be presented and compared with previous results for $NO_2$ (K.A. Mar, A.L. Van Wyngarden, C.-W. Liang, Y.T. Lee, J.J. Lin, K.A. Boering, J. Chem. Phys., 137, 044302, doi: 10.1063/1.4736567, 2012) and $CO_2$ (M.J. Perri, A.L. Van Wyngarden, K.A. Boering, J.J. Lin, and Y.T. Lee, J. Chem. Phys., 119(16), 8213-8216, 2003; M.J. Perri, A.L. Van Wyngarden, J.J. Lin, Y.T. Lee, and K.A. Boering, J. Phys. Chem. A, 108(39), 7995-8001, doi: 10.1021/jp0485845, 2004). Among the most intriguing of the new results are for quenching of O($^1$D) by Xe, for which marked oscillations in the differential cross sections were observed for the O($^3$P) and Xe products. The shape and relative phase of the oscillatory structure depended strongly on collision energy. This behavior is likely due to the quantum nature of the collision dynamics, caused by interferences among multiple curve crossing pathways accessible during electronic quenching, known as Stueckelberg oscillations.