Dissociative electron attachment to SO_2 probed by velocity slice imaging

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Synopsis We report a complete kinematic study of O^-, S^- and SO^- ions forming due to dissociative electron attachment to SO_2 using velocity slice imaging technique in the incident electron energy range over the second resonance at 7.5 eV. From the angular distribution results we identified the involvement of a combination of A_1 and B_2 temporary negative ion state(s) for all the channels for the first time.

Sulphur dioxide is a tri-atomic molecule with C_{2v} symmetry. SO_2 is one of the most abundant pollutants of the atmosphere especially, in cities and areas of large factories, industries and power plants. Dissociative electron attachment (DEA) to SO_2 is commonly known to take place via the following pathways:

$$SO_2 + e^- \longrightarrow SO_2^{-*} \longrightarrow \begin{cases} O^- + SO \\ S^- + O_2 \\ SO^- + O \end{cases} \qquad (1)$$

By performing *ab initio* molecular orbital calculations for the ground state of neutral SO_2 molecule Krisnakumar *et al.* in 1996 suggested the first peak at 4.6 eV to be due to a $^2A_1$ negative ion resonant state and the second peak at 7.3 eV due to a $^2B_2$ negative ion resonant state [1].

In this presentation we report a complete kinematic study of O^-, S^- and SO^- ions formation from DEA to SO_2 around the second resonant peak observed at 7.5 eV. Based on the fitted angular distribution data, we give a clear evidence for the presence of B_2 state for the second resonance in agreement with the previous studies [1]. We also propose the presence of A_1 state along with the B_2 state for the 7.5 eV resonance. The presence of A_1 state for the 7.5 eV resonance has not been reported earlier [2, 3].

The angular distribution data for O^-, S^- and SO^- ions over the kinetic energy range 0-0.2 eV measured at incident electron energy 7.5 eV is shown in Fig. 1. The figure clearly shows the change in the angular distribution for the different ions. The forward-backward asymmetry increases with the increase in ion mass. Also, the angles at which O^- ions are having a low number of counts, the SO^- are having a peak. This may support the validation of axial recoil approximation.

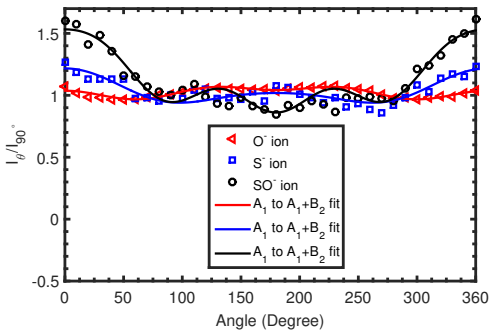

Figure 1. Angular distribution curves with A_1 to A_1 + B_2 fitted curves for O^-, S^- and SO^- ions at the 7.5 eV resonance.

We have thus developed a complete understanding of DEA to sulphur dioxide molecule for the resonant peak at 7.5 eV. We give clear evidence for the presence of two negative ion resonant states A_1 + B_2 for 7.5 eV resonance based on the angular distribution data.

References

[1] Krishnakumar E *et al* 1996 *J. Phys. B: At. Mol. Opt. Phys.* **29** L657
[2] Jana I and Nandi D 2018 *Phys. Rev. A* **97** 042706
[3] Gope K *et al* 2017 *J. Chem. Phys.* **147** 054304

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