ULTRAFAST HYDORGEN MIGRATION IN ALLENE INDUCED BY AN INTENSE FEMTOSECOND LASER FIELD

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Abstract. Ultrafast hydrogen migration in allene $(CH_2=C=CH_2)$ induced by intense laser fields was investigated by Coulomb explosion coincidence momentum imaging (CMI)...

Key word: Hydrogen migration, Allene, Intense laser field.

I. INTRODUCTION

During the past few years, an ultrafast hydrogen migration process within a molecule in intense laser fields has been an attractive research theme, not only because of the findings that hydrogen atoms (or protons) move extremely rapidly within a molecule, but also their potential applicability for controlling chemical bond breaking processes [1, 2]...

II. EXPERIMENTS

The schematic diagram of the experimental setup used in this experiment is shown in Fig. 1. The light source used in the experiments was a Ti:Sapphire femtosecond laser system (Pulsar 5000, Amplitude Technologies)...

III. RESULTS AND DISCUSSION

Figure 1 shows the recorded time-of-flight (TOF) mass spectrum of the ionic species generated from C_3H_4 in the intense laser field...



Fig.1. Time-of-flight mass spectrum of allene in an intense laser field (40 fs, 2×10^{13} W/cm²).

The momentum imaging maps of CH_m^+ (m = 1-3) appearing in coincidence with $C_2H_{4-m^+}$ are shown in Figs. 3a-3c, which represent the two-body Coulomb explosion pathways Eq. (1).

$$I(\theta) = 1 + \sum_{L} b_{L} \prod_{k=1}^{L/2} \frac{(1/\tau\omega)^{2} + (2k-1)^{2}}{(1/\tau\omega)^{2} + (2k)^{2}} P_{L}(\cos\theta_{m}^{0}) P_{L}(\cos\theta) \quad (L=2, 4, 6)$$
(6)

where P_L denotes the Legendre polynomial and b_L reflects the angular distribution of the molecular principal axis of the parent molecules with respect to the laser polarization direction.

Table 1. The $\langle \cos^2 \theta \rangle$ values of the fragment ions, H_n^+ and the parameters obtained by least-squares fits of Eq. (6)

Explosion pathways	$\theta_m^{0}/{\rm deg}$	$ au\omega$	$ au/\mathrm{ps}$	$<\cos^2\theta>$
$C_{3}H_{3}^{+} + H^{+} (n = 1)$	29(2)	>5.0	>1.9	0.37
$C_{3}H_{2}^{+} + H_{2}^{+}(n=2)$	23(2)	>5.0	>1.9	0.38
$C_3H^+ + H_3^+ (n=3)$	12(4)	3.2 (1.1)	1.2(4)	0.39

IV. CONLUSION

The two-body and three-body Coulomb explosion of allene induced by an ultrafast intense laser field has been investigated by using the coincidence momentum imaging method...

V. ACKNOWLEDGMENTS

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References

- [1] A. Hishikawa, H. Hasegawa, and K. Yamanouchi, *J. Electron Spectrosc. Relat. Phenom.* Vol. **141**, 2004, pp. 195-200.
- [2] T. Kato, K. Yamanouchi, J. Chem. Phys. Vol. 131, 2009, pp.164118(1-14).

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