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Dalian Coherent Light Source reveals new dissociation channels in ethane photochemistry

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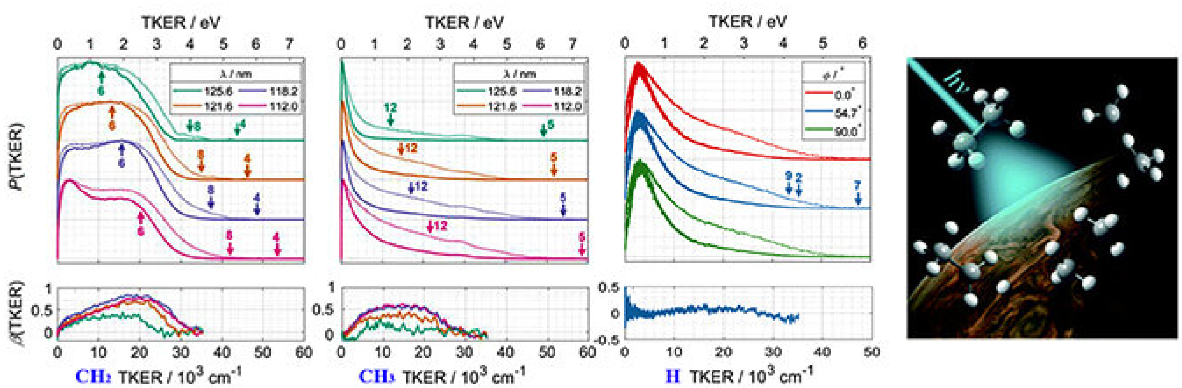

The CH_3, CH_2 and H atom elimination channels in the photodissociation of ethane. Credit: CHANG Yao

Understanding and exploiting the environment of extraterrestrial bodies is a central objective of planetary science. The gas giants, such as Jupiter, Saturn, Uranus and Neptune, are rich in molecular chemistry and remain the target of prolonged scientific study.

Just like the Earth, each of these planets orbit the sun with its own eccentricity and obliquity, leading to seasonal variations in incident solar radiation and thus a cycling chemical composition with latitudinal and altitudinal variations in the abundances of the various molecular constituents.

Recently, Prof. Yuan Kaijun and Prof. Yang Xueming's group from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences, in cooperation with Prof. Michael N. R. Ashfold from the University of Bristol and Prof. Christopher S. Hansen from the University of New South Wales revealed the new dissociation channels in the ethane photochemistry by using the Dalian Coherent Light Source (DCLS).

The absorption of near-infrared solar radiation by methane (CH_4) is an important contributor to heating the upper atmospheres (stratospheres) of these planets. CH_4 contributes less to stratospheric cooling, which is more reliant on emission from ethane (C_2H_6) and acetylene (C_2H_2).

Understanding the balance and interplay between CH_4 and C_2H_6/C_2H_2 is central to understanding the atmospheric dynamics of the gas giants. Therefore, the photodissociation of ethane have been studied systematically based on DCLS.

The VUV photochemistry of ethane, which is an important constituent in the atmospheres of the gas giants, has been studied in the wavelength range from 112nm to 126 nm by using the free electron laser (FEL) and multi-mass imaging detection methods.

The scientists demonstrated contributions from at least five primary photofragmentation pathways yielding CH_2, CH_3 and/or H atom products from ethane following VUV excitation.

These results point to several shortcomings in the description of ethane photochemistry used in contemporary models of the atmospheres of the gas giants and help rationalize hitherto unexplained aspects of the ethane/acetylene ratios observed in the Cassini-Huygens fly-by of

Jupiter.

The study was published in *Chemical Science*.

More information: Yao Chang et al. Ultraviolet photochemistry of ethane: implications for the atmospheric chemistry of the gas giants, *Chemical Science* (2020). DOI: 10.1039/D0SC01746A

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