Dalian coherent light source reveals oxygen production from three-body photodissociation of water

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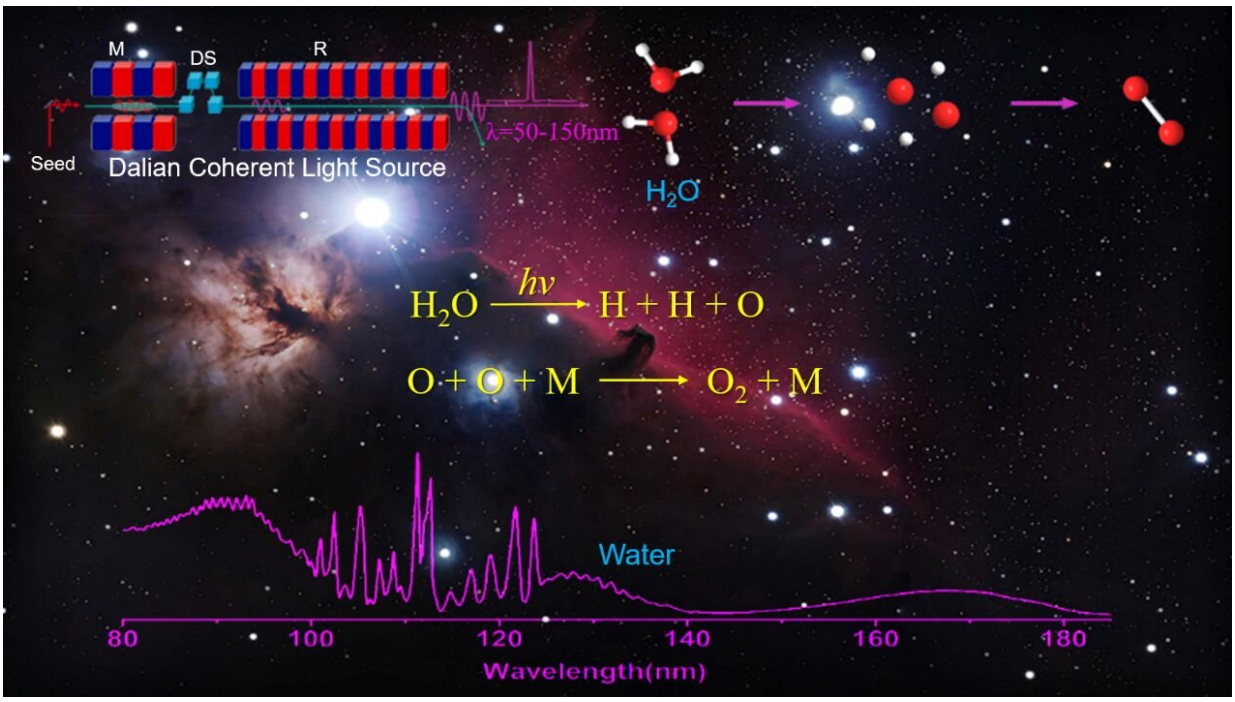

Dalian Coherent Light Source revealing three-body photodissociation of water as an important prebiotic-O2 source. Credit: DICP

The provenance of oxygen on Earth and other solar planetary bodies is a fundamental research issue. It is widely accepted that the prebiotic pathway of oxygen production in the Earth's primitive atmosphere was

via vacuum ultraviolet (VUV) photodissociation of CO_2 and subsequent recombination of two O atoms.

In contrast, the photodissociation of H_2O, one of the dominant oxygen carriers, has long been assumed to proceed mainly to produce hydroxyl $(OH)^-$ and hydrogen (H)-atom primary products, and its contribution to oxygen production is limited.

Recently, a research group led by Prof. Yuan Kaijun and Yang Xueming from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences revealed oxygen production from the three-body photodissociation of water molecule using the Dalian Coherent Light Source.

Their findings were published in *Nature Communications* on April 30.

The VUV free-electron laser facility at the Dalian Coherent Light Source allows the researchers to quantitatively assess the importance of H_2O photochemistry for oxygen production.

"Our experimental results indicated that H_2O under VUV excitation can break into three fragments: one O atom and two H atoms, where the O atoms are in the ^1D and ^3P states. The three-body dissociation process is the dominant channel for H_2O photochemistry in the 90-110 nm region," said Prof. Yuan.

The quantitative determination demonstrated that approximately 20% of the H_2O photoexcitation events resulted in O atoms. Considering the water abundance in widely interstellar circumstances such as in interstellar clouds, atmospheres of the solar-family comets, and even in the Earth primitive atmosphere, O production from water photolysis must be an important process. The subsequent recombination of O atoms produced O_2, which represented an important prebiotic O_2-production

pathway.

More information: Yao Chang et al. Three body photodissociation of the water molecule and its implications for prebiotic oxygen production, *Nature Communications* (2021). DOI: 10.1038/s41467-021-22824-7

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