

Dear Editor,

On behalf of all authors, we are pleased to submit our manuscript entitled **“Photodissociation Pathways of Vinylacetylene (C₄H₄) and Implications for Interstellar Hydrocarbon Chemistry”** for consideration in *The Astrophysical Journal*.

Vinylacetylene (CH₂=CH–C≡CH) is an important molecule in low-temperature hydrocarbon chemistry. It plays a key role in forming polycyclic aromatic hydrocarbons through the hydrogen-abstraction, vinylacetylene-addition (HAVA) pathway. Researchers have found vinylacetylene in cold molecular clouds like TMC-1. However, its photodissociation pathways and product branching under collision-free conditions are not well understood. In this report, we detail both experimental and theoretical studies of vinylacetylene photodissociation at 193 nm. We used a supersonic molecular beam connected to a rotatable mass-spectrometric detection system. Our time-of-flight (TOF) spectra and forward-convolution analysis show three main dissociation channels: loss of atomic hydrogen (H), which forms C₄H₃ isomers; loss of molecular hydrogen (H₂), which produces butatrienylidene (C₄H₂); and cleavage of carbon–carbon bonds, resulting in acetylene/vinylidene (C₂H₂/CCH₂) fragments. The experimental branching ratios we obtained are C₄H₃ : C₄H₂ : C₂H₂/CCH₂ = (75 ± 2) : (10 ± 2) : (15 ± 2). These findings, supported by electronic-structure and RRKM calculations, offer specific insights into the photoproducts and their formation pathways.

We think this work is suitable for *The Astrophysical Journal* because it provides laboratory data that is directly relevant to astrochemical models of hydrocarbon evolution and PAH growth in interstellar environments influenced by photons. Our results suggest that the photochemistry of vinylacetylene should be examined in an isomer-specific way instead of solely by molecular formula. This is because different product isomers can lead to unique chemical pathways in interstellar conditions.

This manuscript is original and has not been published before. It is not being considered for publication elsewhere. All authors have approved the submission and declare no conflicts of interest.

We suggest the following referees:

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Thank you for considering our manuscript for publication in *The Astrophysical Journal*.

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