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## Method Article

## Clusters formation and fragmentation of nitromethane at 266 nm



D. Martínez, A. Guerrero, E. Prieto, I. Álvarez\*, C. Cisneros

*Institute of Physical Science- UNAM, Av. Universidad s/n Chamilpa, 62210, Cuernavaca, Morelos, México*

## A B S T R A C T

We carry out experiments on the fragmentation of nitromethane by multiphoton absorption at the wavelength 266 nm. This was conducted in a reflectron (Jordan), modified in the laboratory. Due to the large number of fragments, special care has been taken into the calibration of the system, in the simultaneity between the laser pulse and the sample, and the associated electronics to ensure that produced fragment spectra arise from the interaction laser-sample. We emphasize the next aspects of the method:

- Simple design for introducing a gas sample at laser interaction region to facilitate the cluster formation
- Astonishing number of fragments produced by multiphoton absorption.

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## A R T I C L E I N F O

*Method name:* Molecular multiphoton absorption and TOF Spectroscopy*Keywords:* TOF Mass Spectrometry, Multiphoton Absorption, Clusters*Article history:* Received 22 May 2019; Accepted 27 April 2020; Available online 1 May 2020

\* Corresponding author.

*E-mail addresses:* [alfonsog@icf.unam.mx](mailto:alfonsog@icf.unam.mx) (A. Guerrero), [ialvarez@icf.unam.mx](mailto:ialvarez@icf.unam.mx) (I. Álvarez), [carmen@icf.unam.mx](mailto:carmen@icf.unam.mx) (C. Cisneros).

## Specifications table

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Time-of-Flight Mass Spectrometer with Improved Resolution	
W. C. Wiley and I. H. McLaren, Rev. Sci. Instrum. 26, 1150 (1955); <a href="https://doi.org/10.1063/1.1715212">https://doi.org/10.1063/1.1715212</a>	
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## Method details

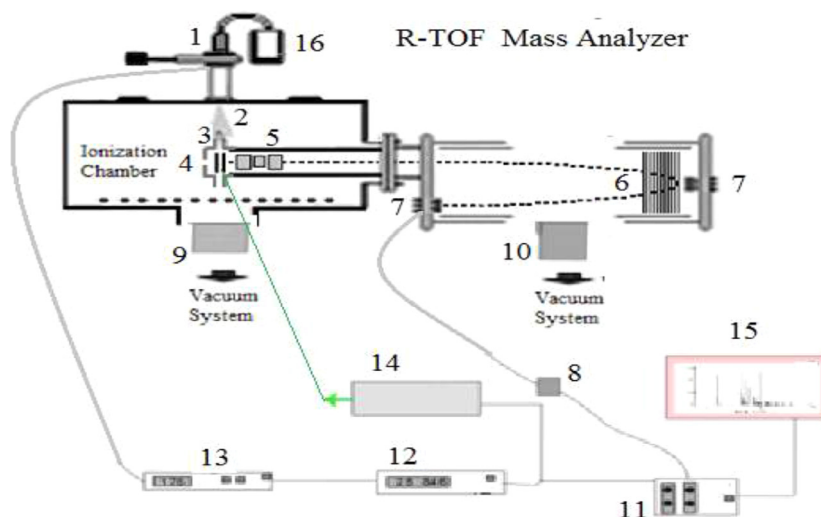
We used a pulsed valve and a skimmer to generate a supersonic molecular beam in a collision free system. Between the valve and the skimmer there is an 10 cm stainless steel extension with a 2 mm conical termination inside the chamber, that allowed the adiabatic gas to expand closer to the skimmer. That extension allows cluster formation [1]. There is a 10 mm gap between the end of the extension and the entrance of the skimmer.

The laser radiation (with a Gaussian profile and vertically polarized) was focused into the interaction region using a 15 cm focal length lens. The diameter at the focal point was 80.0  $\mu\text{m}$ . Radiation intensities between  $10^9$  and  $10^{10}$   $\text{W}\cdot\text{cm}^{-2}$  were achieved under these experimental conditions.

A sample of liquid nitromethane from Sigma-Aldrich (purity ~99%) was used. The nitromethane vapor pressure was 3.7 kPa (27.75 torr) at 20°C. The sample was heated at a constant temperature of 28°C and introduced by a pulse valve into the ionization chamber in the gas phase.

The nitromethane gas and laser pulse interact at 90°. The interaction region was located between two polarized electrodes separated by 6 mm with a circular mesh of 90% transparency and a 1 cm diameter. The positive fragments formed at the nanosecond laser pulse were accelerated to the free field region of the R-TOF mass spectrometer by applying an extraction voltage to the electrodes, in the present case it was 1.5 keV [2].

After the ions passed the drift zone, they were directed to the detector, which was a 25 mm dual microchannel plate (Chevron). The signals from the microchannel plate were routed to a fast preamplifier VT 120 (ORTEC) and a picosecond time analyzer (Mod. 9308 ORTEC). A computer (software PTA-32 ORTEC) collected and processed the data according to the arrival time of the



**Fig. 1.** Diagram of the experimental system. 1.Pulsed valve. 2.Extension. 3.Skimmer. 4.Interaction region: polarized electrodes 5. Electrostatic focus & deflection plates 6. Reflector discs, 7. Detector: microchannel plate of the R-TOF 8. Preamplifier. 9 &10. Vacuum system, 11. ORTEC picoameter, 12. Electronic for the control the time for the valve and the laser. 13 Control of valve 14 laser, 15. Data processing, 16. Sample container.

mass/charge fragments. The operating pressure was  $2 \times 10^{-6}$  torr with an open valve (175  $\mu$ s) and a base pressure of  $10^{-8}$  torr by the operation of two turbo molecular pumps (Pfeiffer Vacuum and Agilent) while the ions were produced. Once the fragment spectra were obtained it is necessary to identify the correspondent peak to a specific fragment.

The electronics of the detection system allows practically any ions to be recorded, since it is the time difference that differentiate the masses. In the multichannel system, the temporal scan can be done from very short time (400 ns) to very long time (2.7 years) using around 65 thousand channels. The detector is a microchannel plate (MCP), which receives the signal of ions, when hits the detector surface and the small electric charge which is produced goes to the preamplifier and converted to a voltage pulse. The response is of the order of nanoseconds.

The time interval for that single charge masses [1,2] will be:  $\Delta(1,2) = 0.95 \times 10^{-6}$  seg

The difference in time of arrival to the detector for ions with 1 amu and 2 amu is  $\sim 10^{-6}$  seg and the detection time is  $10^{-9}$  seconds. Microchannel plate is therefore able to differentiate the times of arrival of each ion. On the other hand, the electronic response time is  $10^{-12}$  seconds. So, an excellent resolution to transform the current generated by the ions to analog and finally digital signal is guaranteed.

The Fig. 1 shows the experimental setup with the related electronics.

## Declaration of Competing Interest

All authors have participated in the conception and design and writing of the article, and have no affiliation with any organization with a direct or indirect financial interest in the subject matter discussed in the manuscript.

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**Supplementary materials**

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.mex.2020.100909](https://doi.org/10.1016/j.mex.2020.100909).

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