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# VUV photo processing of large cationic PAHs in astrophysical conditions: coupling a VUV source to the PIRENEA setup

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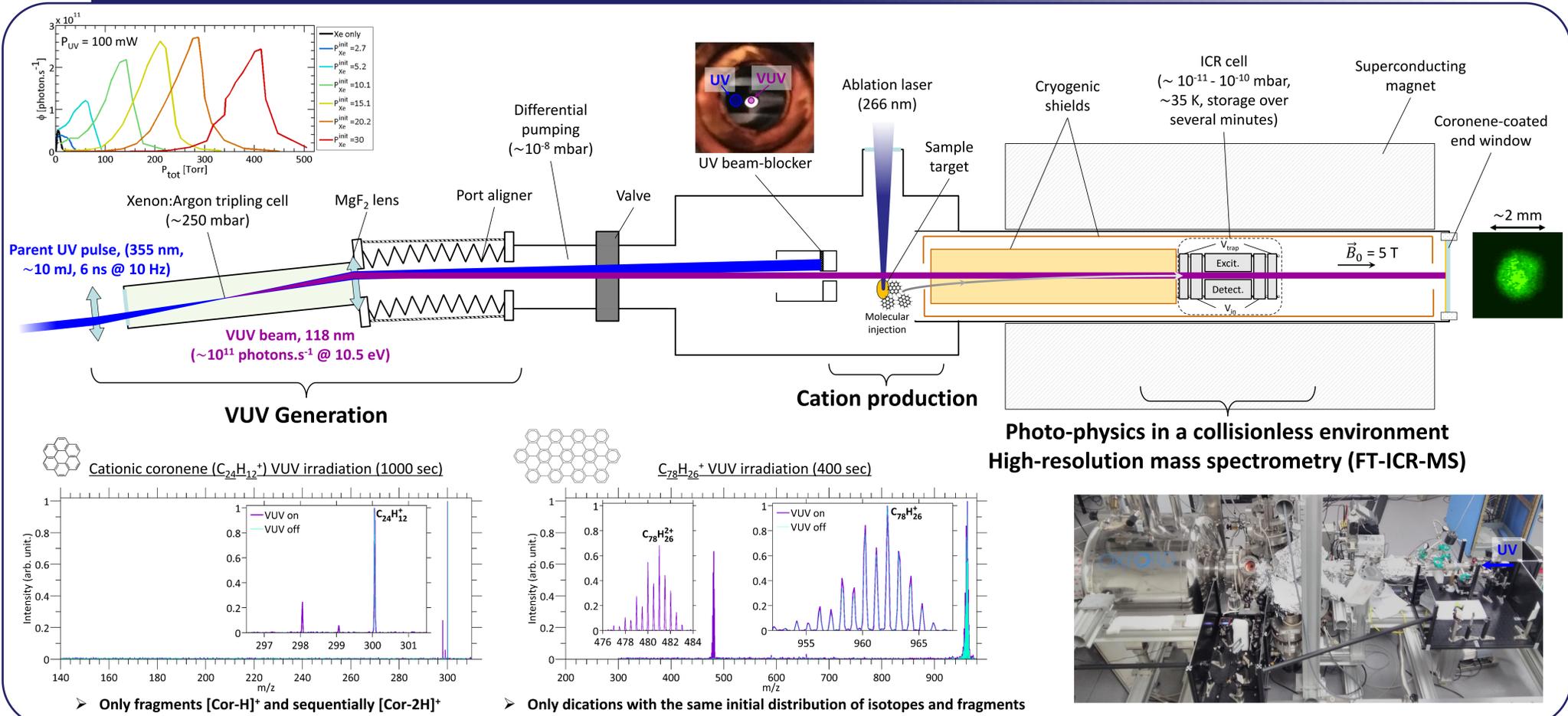
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## Abstract

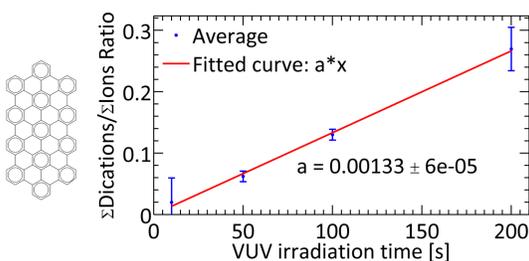
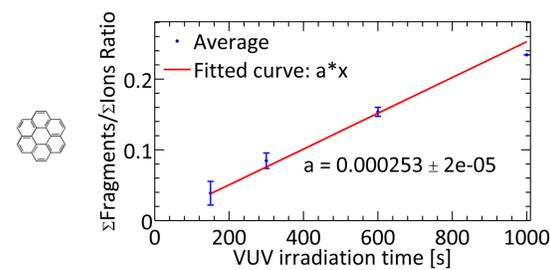
Studying the interaction of polycyclic aromatic hydrocarbons (PAHs) with UV and VUV light is crucial for the understanding of the physical and chemical evolution of the interstellar medium. Photo-processing by VUV irradiation leads to variation of the hydrogenation and ionization states of PAHs [1] and plays an important role in the heating of the gas [2]. Recent laboratory studies have shown that the VUV photoexcitation of large PAHs rather induces further ionization than fragmentation [3,4] and, more surprisingly, it can also induce non-statistical dissociation [5]. We have recently coupled a VUV source based on a Xe-Ar tripling cell to the PIRENEA (Piège à Ions pour la Recherche et l'Etude de Nouvelles Espèces Astrochimiques) setup which consists of a cryogenic (35 K) ion cyclotron resonance cell that is especially well suited to investigate ionization and dissociation on long timescales [1,5]. The produced VUV photons (10.5 eV) are sufficiently energetic to trigger dissociation in small/medium-size PAHs [6] and ionization in large PAH cations [4]. We present first measurements of VUV processing of several PAHs in a cryogenic and collisionless environment which is appropriate for interstellar conditions.

## Experimental Method : VUV photo-processing of isolated PAH molecules



## Preliminary results

### Study as a function of the VUV irradiation time



### Implications in VUV photo-processing of PAHs

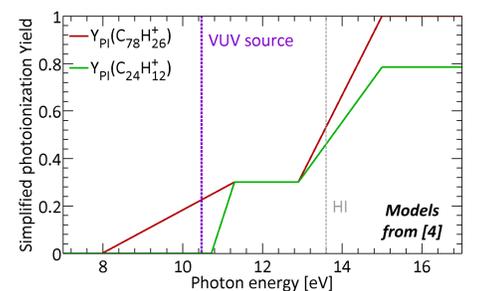
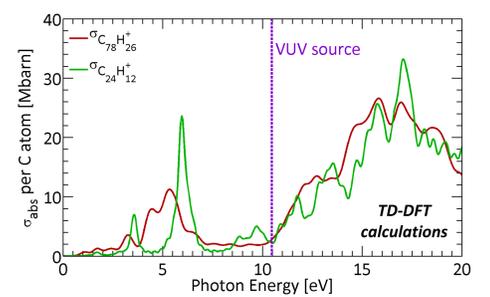
- The measured photo-products formation rate of C<sub>78</sub>H<sub>26</sub><sup>+</sup> is **5.25 times** larger than the one of C<sub>24</sub>H<sub>12</sub><sup>+</sup>.
- The absolute VUV photo-absorption cross-section of C<sub>78</sub>H<sub>26</sub><sup>+</sup> is about **3.25 times** larger than the one of C<sub>24</sub>H<sub>12</sub><sup>+</sup> (ratio of C atom number).
- A simple model for the photo-ionization yield of large PAH has been derived from measurements in a previous study [4] :  $\sim 0.23$  at 10.5 eV for C<sub>78</sub>H<sub>26</sub><sup>+</sup>.

$$\text{Absorbed photons per second} = \begin{cases} \sigma_{\text{abs}}(\text{C}_{24}\text{H}_{12}^+) \times \phi_{\text{VUV}} = \frac{a(\text{C}_{24}\text{H}_{12}^+)}{Y_{\text{diss.}}(\text{C}_{24}\text{H}_{12}^+)} \\ \sigma_{\text{abs}}(\text{C}_{78}\text{H}_{26}^+) \times \phi_{\text{VUV}} = \frac{a(\text{C}_{78}\text{H}_{26}^+)}{Y_{\text{ion.}}(\text{C}_{78}\text{H}_{26}^+)} \end{cases}$$

if  $\phi_{\text{VUV}}$  is constant

$$\Rightarrow Y_{\text{diss.}}(\text{C}_{24}\text{H}_{12}^+) \approx \frac{a(\text{C}_{24}\text{H}_{12}^+)}{a(\text{C}_{78}\text{H}_{26}^+)} \times \frac{\sigma_{\text{abs}}(\text{C}_{78}\text{H}_{26}^+)}{\sigma_{\text{abs}}(\text{C}_{24}\text{H}_{12}^+)} \times Y_{\text{ion.}}(\text{C}_{78}\text{H}_{26}^+) \approx 0.14$$

- The retrieved dissociation yield at a VUV energy close to the threshold is consistent with the results found by Zhen and coworkers [6].
- This shows that a large fraction of the 10.5 eV photons absorbed by C<sub>24</sub>H<sub>12</sub><sup>+</sup> are relaxed by radiative cooling.



## Perspectives

- Calibration to determine robust values of the dissociation yield combining experiments on smaller PAHs.
- Molecular systems from strongly dissociative to intermediate case where dissociation and ionization are in competition.
- VUV photo-chemistry by molecular gas injection.

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