Journal of Physics: Conference Series **635** (2015) 032120 doi:10.1088/1742-6596/635/3/032120

Ionization and Dissociation of PAH by Stellar Winds Application to H_2 Emission from Coronene in HD44179

J.-P. Champeaux*[1], P. Moretto-Capelle, P. Cafarelli, C. Deville, M. Sence, R. Casta

* Laboratoire Collisions Agrégats et Réactivité, CNRS-UMR 5589, Université Paul Sabatier Toulouse III, 118 Route de Narbonne, F-31062 Toulouse Cedex9, France

Synopsis - Recent results on dissociation of coronene by keV protons are presented and applied to the astrophysical context of HD44179 compact nebulae. We show that coronene dissociation by stellar wind can induce strong neutral molecular hydrogen emission and more generally, that stellar wind induced dissociation of carbonated molecules like PAHs inside compact nebulae (i.e before the astro-pause) can play an important role in the complex physico-chemistry of the nebulae media which could be competitive with other photodissociaiton or photochemistry mechanisms.

The physical interactions of polycyclic aromatic hydrocarbons (PAHs), detected by their IR signature in the interstellar media [1], with stellar wind particular radiation (protons, electrons) are key to understanding the life cycle of PAHs, their abundance and their role in the complex Astro-chemistry of the interstellar medium. In this context, we present experimental results on the ionization/fragmentation of an isolated coronene molecule by a keV proton, reproducing interactions between stellar winds and PAH molecules. Using multi-coincidence time of flight spectroscopy [2], we show that such ionization/fragmentation induces intense dehydrogenation processes in which the loss of an even numbers of hydrogen atoms and the detection of CH_2^+ cations as a possible H_2 precursor strongly suggest the formation of H_2 neutral molecules as show in Figure 1.

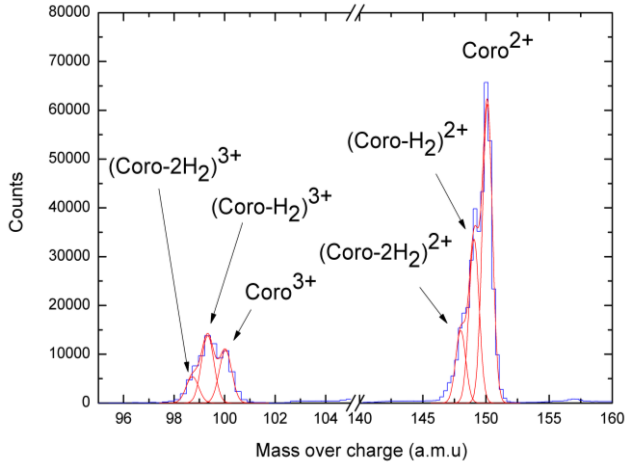

Figure 1. Zoom of coronene 2+ and 3+ fragmentation mass spectrum suggesting H_2 neutral emission.

Possible sceneries for H_2 production via -CH_2 precursors have been investigated by quantum chemical calculation.

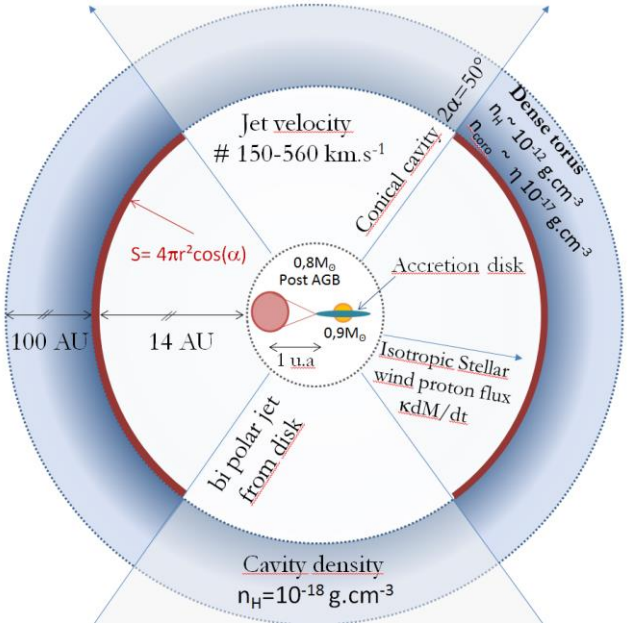

Figure 2. Schematic diagram of the core of the HD 44179 RR nebula.

We have evaluated the H_2 emission cross-section from the coronene/proton interaction at 100 and 1.6 keV to be 2.97×10^{-16} and 3.3×10^{-16} cm^2, respectively. A qualitative discussion off the formation rate of H_2 in the HD 44179 Red Rectangle (RR) nebula [3] (presented figure 2) leads to the conclusion that such processes could be very efficient, especially inside planetary nebulae rich in PAH molecules interacting with proton from high mass-loss rate stars (like asymptotic giant branch stars) or high velocity jets produced by an accretion disc [4].

References

[1] Leger A. et al. 1984 A&A 137 5
[2] J.-P. Champeaux et al. 2010 Phys. Chem. Chem. Phys. 12 5454
[3] J.D. Thomas et al. 2013 MNRAS 430 1230
[4] J.-P. Champeaux et al. 2014 MNRAS 441 1479

[1] E-mail: jean-philippe.champeaux@irsamc.ups-tlse.fr