

Photodestruction of PAHs in Planetary Nebulae

Boechat-Roberty H. M.¹, Neves R.¹, Pilling S.^{1,2},
de Souza G. G. B.², Lago A.²

¹Observatório do Valongo, Universidade Federal do Rio de Janeiro, Ladeira Pedro Antônio 43, CEP 20080-090, Rio de Janeiro, RJ, Brazil.

²Instituto de Química, Universidade Federal do Rio de Janeiro, Ilha do Fundão, CEP 21949-900, Rio de Janeiro, RJ, Brazil.

Abstract. It is known that polycyclic aromatic hydrocarbons (PAHs) are mainly formed in the dust shells of late stages of AGB type carbon rich stars. After the ejection of H-rich envelope those stars become the proto-planetary nebulae (PPNs). The chemistry in PPNs has been strongly modified by the UV photons coming from the hot central star and by the X-rays associated with its high-velocity winds. Benzene (C_6H_6) and small PAHs like Anthracene ($C_{14}H_{10}$) were effectively detected in the PPNs CRL 618 (Cernicharo et al. 2001) and Red Rectangle (Vijh, Witt & Gordon 2004) respectively.

The goal of this work is to experimentally study photoabsorption, photoionization and photodissociation processes of the benzene, biphenyl ($C_{12}H_{10}$), naphthalene ($C_{10}H_8$), phenanthrene ($C_{14}H_{10}$) and methyl-anthracene ($C_{14}H_9(CH_3)$). The measurements were taken at the Brazilian Synchrotron Light Laboratory (LNLS), using soft X-ray and UV photons from a toroidal grating monochromator TGM beamline (12 - 310 eV). The experimental set-up consists of a high vacuum chamber with a Time-Of-Flight Mass Spectrometer (TOF-MS). Mass spectra were obtained using PhotoElectron PhotoIon Coincidence (PEPICO) technique. Kinetic energy distributions and abundances for each ionic fragment have been obtained from the analysis of the corresponding peak shapes in the mass spectra. Dissociative and non-dissociative photoionization cross sections for some molecules were also determined (see for example: Boechat-Roberty, Pilling & Santos 2005). We have observed that PAHs molecules are extreme resistant to UV photons, confirming that PAHs absorb the UV photons and after some internal energetic rearrangements, they can emit in the IR range. However, these molecules are destroyed by soft X-rays photons producing several ionic fragments, some of them with great kinetic energy.

In the mass spectra of the Benzene and methyl-anthracene molecules, the observed ionic fragments $C_4H_2^+$, $C_6H_2^+$, C_4HCH_3 and C_2HCH_3 , could correspond to the same ions and radicals detected in the CRL 618 (Cernicharo et al. 2001). This result also points out the possibility of PAHs and PAHs methylated can be actively present in those environments. From the photodissociation cross sections and the stellar radiation field we have determined the photodissociation rate and the half-life, as well as its upper limit abundance of the benzene molecule in the CRL618. The relative yields of some key fragments together their observed abundances in the astrophysical target allow to estimate an upper limit of father molecules in those regions.

Keywords. astrochemistry, ISM: molecules, methods: laboratory, molecular data, molecular processes, X-rays: ISM

References

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