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Vacuum ultraviolet photochemistry of small biomolecules

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In recent years we have been studying the VUV photophysics and photochemistry of biotic and prebiotic molecules, such as amino acids, nucleic acid bases, formic acid, acetic acid and others in the 6-22 eV photon energy range. We use synchrotron radiation as a light source as well as various experimental techniques, such as photoabsorption spectroscopy, photoionisation mass spectrometry (PIMS), photofragment fluorescence spectroscopy (PFS) and photoelectron spectroscopy (PES), to get new insight into photophysical processes occurring in this energy region. The VUV photochemistry of prebiotic and biotic molecules is of considerable interest in view of the possible delivery of these molecules, and even more complex molecular structures, from space to the primitive Earth. Such data are also needed for the improvement of astrochemical models of interstellar molecular clouds [1], because important processes, like photoionisation and dissociative photoionisation become very efficient in this energy region. Furthermore, a quantitative understanding of the VUV photochemistry of simple biotic molecules is very useful for understanding their degradation under space conditions, but also of more complex structures like proteins or DNA. In this report we focus on our detailed results obtained for amino acids and nucleic acid bases [2,3].

Amino acids are found in both meteorites and micrometeorites [4,5]. Much effort is currently being undertaken to directly identify these important biological species in the interstellar medium [6]. Purines and pyrimidines, the basic molecular units of the nucleic acid bases have been reported in the Vega 1 flyby of comet Halley but no amino acids [7]. We have undertaken a photoionisation mass spectrometry study of five amino acids [2] and four nucleic acid bases [3] in order to elucidate the fragmen-

tation pathways of these molecules in the VUV regime and deliver thermochemical data previously not known. The photoion yield curves of parent and fragment ions have been measured as a function of the energy deposited in these molecules. The fragmentation patterns, ionization energies and ion appearance energies (AE) are reported, many for the first time. Thermochemical data, coupled with the observed AE's are used to clarify fragmentation pathways. Astrophysical implications concerning the prospects for observation and survival of theses molecules in the ISM and meteorites are discussed.

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