Energetic ion processing of aromatic molecules in the solid phase

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Abstract
Formed in the dense clouds, icy mantles are condensates of small molecules on solid grains. These icy mantles are promising sites for rich chemical processes, where complex organic molecules can form, as these mantles are continuously exposed to ionizing radiation. Once dense clouds transform into an accretion disc and eventually into a planetary system, these icy mantles may potentially contribute to the reservoir of the complex molecules of the planets. In this thesis, the effects of ion irradiation on two aromatic molecules, pyridine and pyrene were investigated. The samples were exposed to ion irradiation at the GANIL (Caen, France) and ATOMKI (Debrecen, Hungary) ion beam facilities. Their evolution was monitored using in-situ infrared spectroscopy. It was found that the initial structure (amorphous or crystalline) and the irradiation temperature do not affect the destruction cross section of pure pyridine. Additionally, it was observed that the local dose is not a key parameter as previously assumed. Indeed, since the destruction of pyrene caused by heavy ions, starting from C, is significantly greater than that caused by lighter ions such as H and He for the same deposited local dose. For both molecules, a significant increase in the destruction cross section was observed for decreasing molecule concentration in the water matrix. The half-life time of pyridine and pyrene in dense clouds was estimated to be around 13 and 20 millions of years, respectively. This suggests that once formed in these environments, they could survive and contribute to planetary formation