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UV photolysis of ices of astrophysical interest analogs and production of organic molecules: laboratory simulations

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Irradiation of interstellar-like ices, i.e. containing molecules such as H_2O, CO, CH_4, CH_3OH, or NH_3 in laboratory using UV light leads to the production of complex molecules. Some of them have been identified in the interstellar medium (ISM) thanks to infrared and radioastronomy observations. If we keep on irradiating the ices, more complex organic molecules, stable at room temperature, are formed. The so-obtained refractory residues can be analyzed by chemical techniques such as high-performance liquid chromatography (HPLC) or gas chromatography coupled with mass spectrometry (GC-MS). A great variety of organic molecules could be identified, among which amino acids such as glycine or alanine, likely to have played an important role in prebiotic chemistry on the primitive Earth.

Another set of experiments, using the with circularly polarized UV synchrotron radiation of the SU5 beamline at LURE was also performed. The main goal was to quantify the enantiomeric excesses (e.e.) of the formed amino acids, and to estimate the uncertainties and systematic effects on the measurements, appearing when using techniques such as chiral GC-MS. The results show that, in our experimental conditions, this effect is weak, i.e. the e.e. calculated for alanine and DAP were found to be of the order of 1%, which is also the order of magnitude of the estimated detection limit for these measurements. These results were compared with the excesses found in primitive meteorites such as Murchison, and discussed in the context of the photochemical processes present in the ISM.

Keywords: molecular processes; methods: laboratory; ISM: molecules; infrared: ISM; polarization.