Variations in the deuterium enrichment of amino acids formed by photolysis of ice mixtures containing mono-deuterated methanol at 10 K

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Methanol is one of the most representative interstellar molecules highly enriched in deuterium (D). The deuterated methanol isotopologs, mostly formed by surface reactions on interstellar icy grains [1], may be processed further by UV photons and/or cosmic-rays toward the formation of more complex organic molecules like amino acids and sugars in clouds [e.g. 2]. In the present study, we quantitatively analyzed deuterated amino acid isotopologues formed by photolysis of interstellar ice analogs containing mono-deuterated methanol (CH_2DOH or CH_3OD, hereafter denoted as d_1-CH_3OH), using a state-of-the-art high resolution mass spectrometer coupled with a liquid chromatography.

Five amino acids (glycine, α- and β-alanine, sarcosine, and serine) and their deuterated isotopologs were identified in the organic residues formed after the photolysis of ice mixtures containing H_2O:CO:d_1-CH_3OH:NH_3 (5:2:2:2) at 10 K followed by warming up to room temperatures [3]. The abundances of mono-deuterated amino acids (d_1-AAs, whose D atoms are bound to their C atoms [3]) relative to each non-deuterated counterpart were in the range of 0.3-1.1 when CH_2DOH was used. While, the relative abundances of d_1-AAs when CH_3OD was used were about one order of magnitude lower than the former case. These results suggest that "hydrogen isotope scrambling" does not readily occur during photolysis of ice mixtures at 10 K and warming-up phases. In addition, structural isomers having a molecular formula $C_3H_7NO_2$ (α- and β-alanine and sarcocine) show a different degree of deutrium enrichment [3], which might be reflective of their different formation pathways. The present results might be useful to clarify a possible reaction network on interstellar grains induced by UV irradiation.

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