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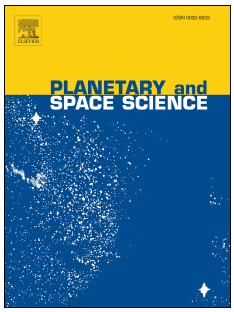

Destruction of $C_2H_4O_2$ isomers in ice-phase by X-rays: Implication on the abundance of acetic acid and methyl formate in the interstellar medium

Marina G. Rachid, Karla Faquine, S. Pilling

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Destruction of $C_2H_4O_2$ isomers in ice-phase by X-rays: Implication on the abundance of acetic acid and methyl formate in the interstellar medium

Marina G. Rachid[1], Karla Faquine[1] and S Pilling[1,2]

1 Universidade do Vale do Paraíba (UNIVAP), Laboratório de Astroquímica e Astrobiologia (LASA), Av. Shishima Hifumi, 2911, Urbanova, CEP: 12244000, São José dos Campos, SP, Brazil

2 Departamento de Fisica, Instituto Tecnologico de Aeronautica, ITA - DCTA, Vila das Acacias, São José dos Campos, 12228-900 SP, Brazil

Abstract

$C_2H_4O_2$ isomers, methyl formate ($HCOOCH_3$), acetic acid (CH_3COOH) and glycoaldehyde ($HOCH_2CHO$), have been detected in molecular clouds in the interstellar medium, as well as, hot cores, hot corinos and around protostellar objects. However, their abundances are very different, being methyl formate much more abundant than the other two isomers. This fact may be related to the different destruction by ionizing radiation of these molecules. The goal of this work is experimentally study the photodissociation processes of methyl formate and acetic acid ices when exposed to broadband soft X-ray from 6 up to 2000 eV. The experiments were performed coupled to the SGM beamline in the Brazilian Synchrotron Light Source (LNLS/CNPEM) at Campinas, Brazil. The simulated astrophysical ices (12 K) were monitored throughout the experiment using infrared vibrational spectroscopy (FTIR). The analysis of processed ices allowed the determination of the effective destruction cross sections of the parent molecules as well as the effective formation cross section of daughter molecular species such as CO, CO_2, H_2O, CH_4 and H_2CO (only for methyl formate) and the hydrocarbons C_2H_6 and C_5H_{10} (only for acetic acid). The half-lives of molecules at ices toward young stellar objects (YSOs) and inside molecular clouds (e.g. Sgr B2 and W51) due to the presence of incoming soft X-rays were estimated. We also determined the branching ratios for assigned daughter species after the establishment of chemical equilibrium and their effective formation rate. The main product from photodissociation is CO, that can be formed by recombination of ions, formed in the photodissociation, in the ice surface. The relative