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Preferential Pathway for Glycine Formation in Star-Forming Regions

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Abstract. Interstellar clouds, similar to that from which the solar system was formed, contain many organic molecules including aldehydes, acids, ketones, and sugars Ehrenfreund & Charnley (2000). Those organic compounds have important functions in terrestrial biochemistry and could also have been important in prebiotic synthesis. The simplest amino acid, glycine (NH_2CH_2COOH), was recently detected in the hot molecular cores Sgr B2(N-LMH), Orion KL, and W51 e1/e2 Kuan *et al.* (2003). The formic acid ($HCOOH$) and acetic acid(CH_3COOH) have also been detected in those regions Liu *et al.* (2002), Remijan *et al.* (2004).

The goal of this work is to study experimentally photoionization and photodissociation processes of glycine precursor molecules, acetic acid and formic acid to elucidate a possible preferentially in the glycine synthesis between ice and gas phase.

The measurements were taken at the Brazilian Synchrotron Light Laboratory (LNLS), employing soft X-ray photons from a toroidal grating monochromator TGM) beamline (100 - 310 eV). The experimental set up consists of a high vacuum chamber with a Time-Of-Flight Mass Spectrometer (TOF-MS). Mass spectra were obtained using PhotoElectron PhotoIon Coincidence (PEPICO) technique. Kinetic energy distributions and abundances for each ionic fragment have been obtained from the analysis of the corresponding peak shapes in the mass spectra. Dissociative and non-dissociative photoionization cross sections for both molecules were also determined Boechat-Roberty, Pilling & Santos (2005).

Due to the high photodissociation cross section of formic acid it is possible that in PDRs regions, just after molecules evaporation from the grains surface, it is almost destructed by soft X-rays, justifying the observed low abundance of $HCOOH$ in gaseous phase Ehrenfreund *et al.* (2001). Acetic acid have shown to be more stable to the ionizing field, and its main outcomes from dissociation process were the reactive ionic fragments $COOH^+$ and CH_3CO^+.

To complete our research we performed *ab initio* calculation of some potential pathway to glycine formation involving mainly $COOH^+$, $HCOOH^+$ and CH_3COOH^+ in both gas and ice phase. Our Enthalpy reaction calculation confirm that even acetic and formic acids could lead to glycine products, perhaps it may be some preferential pathway for the glycine formation. We expected that reactions involving acetic acid (and its photodissociation ionic fragments) to form glycine and its precursors might occurs preferentially at gas phase. On the other hand reactions via formic acid could be more effective at ice phase, before mantle evaporation.

Keywords. astrobiology, astrochemistry, ISM: molecules, methods: laboratory, molecular data, molecular processes, X-rays: ISM

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