

Radical and iCOM Formation From VUV Photolysis of H₂O:CO Interstellar Ice Analogues: an EPR Coupled to IR and QMS-TPD Study

Layssac, Y.,^{1*} Gutiérrez-Quintanilla, A.,¹ Butscher, T.,¹ Henkel, S.,² Tsegaw, Y.A.,² Grote, D.,² Sander, W.,² Chiavassa, T.,¹ Duvernay, F.¹

¹yohann.layssac@univ-amu.fr, Aix Marseille Univ, CNRS, PIIM, Marseille, France

²Lehrstuhl für Organische Chemie II, Ruhr-Universität Bochum, 44780 Bochum, Germany

More than 60 interstellar complex organic molecules (iCOMs) have been identified in different interstellar environments including star forming regions and cold dense molecular clouds¹. The formation mechanisms of these iCOMs are not yet established and could take place either in the gas phase or in the solid phase in interstellar ices, as proposed by many experimental and theoretical works^{2,3}. In this contribution, we propose a new experimental approach allowing, in the same set of experiments, the solid phase detection of precursors, radical intermediary species as well as final products. This is possible thanks to the concomitant use of infrared and EPR spectroscopies and mass spectrometry. This unique procedure allows us to detect intermediary species such as H, CH₂OH, and HOCO radicals and stable carboxylic acids such as formic acid (HCOOH) and glycolic acid (HOCH₂COOH) from the VUV photolysis of CO/H₂O interstellar ice analogues. As a result, we are able to propose a solid phase formation route for formic and glycolic acids in interstellar ices (see figure 1).

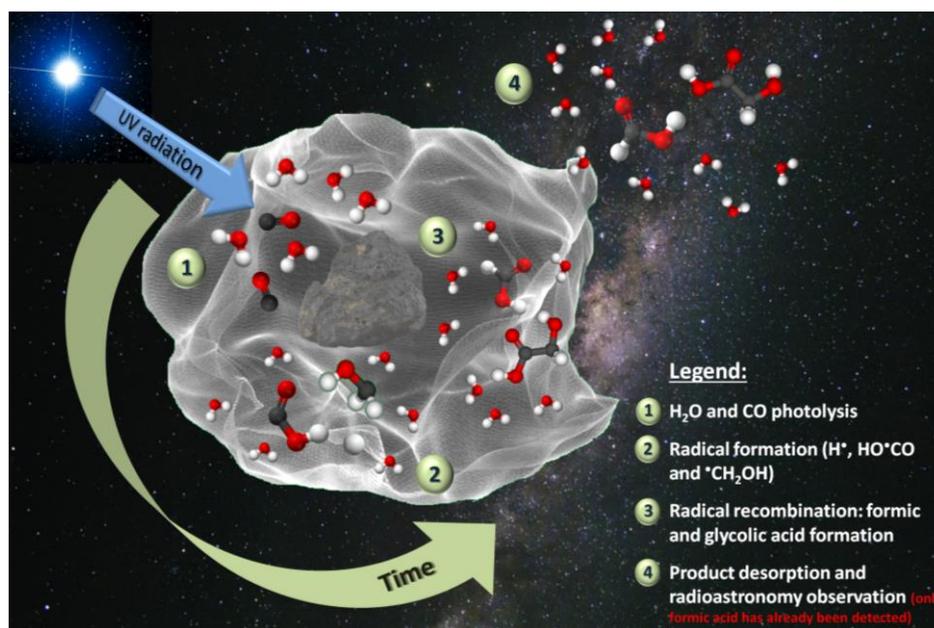


Figure 1: Proposed solid phase mechanism for formic and glycolic acid in interstellar ices.

¹ McGuire, B. A. 2018 census of interstellar, circumstellar, extragalactic, protoplanetary disk, and exoplanetary molecules. *ApJS*. **2018**, 239, 17.

² Chuang, K.-J.; Fedoseev, G.; Qasim, D.; Ioppolo, S.; van Dishoeck, E.; Linnartz, H. Production of complex organic molecules: H-atom addition versus UV irradiation. *MNRAS*. **2017**, 467, 2552.

³ Skouteris, D.; Balucani, N.; Ceccarelli, C.; Vazart, F.; Puzzarini, C.; Barone, V.; Codella, C.; Lefloch, B. The genealogical tree of ethanol: gas-phase formation of glycolaldehyde, acetic acid, and formic acid. *ApJ*. **2018**, 854, 135.