Theoretical investigation of the formation pathways of (Z)-1,2-ethenediol and glyceraldehyde

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The origin of life in our planet is one of the holy grails of chemistry [1]. Regions between stars are hypothesized to have furnished prebiotic molecules to Earth, which further developed into life-bearing compounds. The RNA-world hypothesis proposes that early life on Earth was based on the versatility of RNA molecules to both hold information and act as catalysts [2]. Glyceraldehyde, a key precursor in the RNA-world chemical scheme, is proposed to be formed from (Z)-1,2-ethenediol, detected towards the G+0.693-0.027 molecular cloud located in the galactic center [2].

A set of reactions leading to formation of (Z)-1,2-ethenediol and its evolution to glyceraldehyde both in the gas phase and on grain surface has been considered. We model grain surface reactions using a two-water molecule cluster model. We report possible formation pathways of (Z)-1,2-ethenediol from simple radical species and discard enolization of glycolaldehyde. The addition of the OH radical to vinyl alcohol furnishes two stable species, that following H-insertion and abstraction reactions, yield cis-ethyleneglycol and (Z)-1,2-ethenediol under ISM conditions. Formation of L and D-glyceraldehyde is also proved successful from (Z)-1,2-ethenediol and glycolaldehyde.

This work provides an efficient and cost-effective view of the formation of key prebiotic species in the RNA-world scheme. Further work on the OH addition to vinylol is currently been performed, focusing on the improvement of the ice-slab and its relationship with the stereoselectivity of the formation of 1,2-ethenediol.

References

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