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Exploring the limits of chemical complexity in the interstellar medium: present and future

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Following the initial detection of a molecule in the interstellar medium (ISM) in the late 1930s, more than 330 different species have been identified to date. The detection rate has increased in tandem with the enhancement of telescope sensitivity, particularly in the centimetre and (sub)millimetre ranges. Remarkably, the field has recently undergone a true revolution, with nearly 100 new species –constituting almost a third of the total number –being discovered in the last four years alone. The identified molecules are characterised by an increase in chemical complexity, as evidenced by the number of atoms and the diversity of their chemical composition. Of particular interest is the detection of species that are well-known precursors of prebiotic chemistry, i.e., the set of chemical processes that led to the emergence of life on early Earth. Consequently, we already know that the interstellar material from which stars and planets are formed contains at least some of the fundamental ingredients for life.

Complementarily, recent analyses of comets and asteroids using "in-situ" and sample-return space missions have revealed that our Solar System was formed in a parental cloud rich in prebiotic molecules, including a wide variety of amino acids and all five nucleobases present in RNA and DNA. However, these complex species have not yet been identified in the ISM, raising obvious questions: *does our Solar System represent a unique case with a particularly rich (prebiotic) chemistry? Or alternatively, are the prebiotic ingredients widespread in many other places in the Galaxy, or even in other galaxies?* In this talk, I will address these questions in the light of the latest results in the field. Firstly, I will summarise the state-of-the-art in the quest to detect new molecules of prebiotic interest in the ISM. Secondly, I will discuss new perspectives for the next years and decades thanks to the advent of a new generation of significantly more sensitive observational facilities.

Primary author: Dr RIVILLA, Víctor M. (Centro de Astrobiología (CAB, CSIC-INTA))

Presenter: Dr RIVILLA, Víctor M. (Centro de Astrobiología (CAB, CSIC-INTA))

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