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NANOSCIENCE AND VACUUM TECHNOLOGY FOR STUDYING THE ORIGIN OF LIFE: FROM THE EARTH TO THE COSMOS

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Throughout the history of mankind, one of the most highly pursued enigmas is that related to our origin on Earth. Where are we from is a question many of us has deliberated, but until recently the answer to this uncertainty has been almost exclusively confined within the domains of philosophy or religion. In this presentation we will confront this problem from a purely scientific point of view, summarizing the most veiled points and the current trends in an exciting new and interdisciplinary domain. Nanoscience shares many common aspects with research on the origin of life. These two fields have a joint scientific objective: the understanding of the bottom-up assembly processes that transform simple molecules into complex chemical and biological structures. The characterisation capabilities of current experimental techniques together with the modelling abilities of surface-science have established nanoscience as a new playground for obtaining fundamental information about some of the most enigmatic points on the origin of life. Along this talk, we will review how on-surface chemical reactions, studied by surface science characterization techniques [1,2], can mimic prebiotic conditions to provide new concepts about the first bottom-up mechanisms operating on Earth. Moreover, we will not exclusively discuss reactions taking place on surfaces mimicking those of our Planet, but also chemistry related to the formation of molecular species in space or other planets, that could be transferred to Earth [5]. Within this frame, two different vacuum-based experimental set-up will be discussed. First, we have designed a simulation machine called MARTE, which is nowadays one of the most versatile vacuum vessels specifically designed to recreate the most relevant physical environmental parameters of the Mars planet[4]. This simulation chamber has been conceived to test electromechanical devices and instruments to be used in space missions searching for life-fingerprints, as the meteorological station currently on the Curiosity rover. The origin of chemical complexity in space is other of the puzzle points. Polycyclic aromatic hydrocarbons (PAHs) as well as other organic molecules appear among the most abundant observed species in interstellar space and are key molecules to understanding the prebiotic roots of life. However, their existence and abundance remain a mystery. Moreover, while cosmic molecules are formed under a large range of physical conditions, dust grains can only be efficiently formed in the innermost warm regions of evolved stars and more massive stars producing supernovae. These nanosized grains travel to the interstellar medium interacting with the circumstellar gas, and leading to the formation of new species. This trip will be simulated by an ultra-high vacuum machine, called STARDUST, which will provide to the scientific community an unique tool to study insitu cosmic gas and dust interactions [3,5]. Summarizing, although very valuable information can be obtained applying surface science techniques and protocols to understand the origin of life on Earth and the formation of complex molecular forms in Space, the step from chemistry to biology still remain covered with much more shadows than lights. Only an interdisciplinary approach can help to change the balance.