Interstellar Catalysis – a Route to Molecular Complexity in Space

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Interstellar space is home to surprisingly complex chemistry. In spite of the very low temperatures and pressures more than 200 different molecules have so far been detected. Catalytic reactions on dust grain surfaces are expected to play a dominant role in interstellar chemistry. However, the degree of chemical complexity attainable via such reactions is still under exploration. Specifically, we aim to answer the question of whether the molecular building blocks of life – amino acids, DNA bases, sugars and fatty acids – can form in interstellar space, before the formation of stars and planets [1]. Heterogenous catalytic reactions are highly dependent on the specifics of the catalytic surface. The elemental composition, defects, nano-structure, porosity, ice coatings and thick icy layers all impact heavily on reactivity. Scanning tunneling microscopy (STM) allows us to image surface structures and adsorbate molecules at the atomic level. Such measurements allow us to detect reaction products with single molecule detection sensitivity and to study the structure of low temperature icy clusters forming on surfaces of interstellar relevance. Here I present results on water ice cluster formation at temperatures down to 12 K and on imaging reaction products from PAH hydrogenation reactions [2-3].

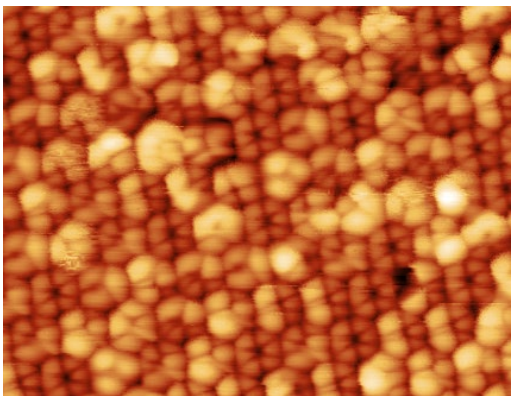

Fig. 1. Scanning Tunneling Microscopy image of superhydrogenated Coronene on HOPG.

[1] S. Ioppolo et al., Nature Astronomy **5**, 197 (2021)
[2] R. Jaganathan et al., Astronomy & Astrophysics **663**, A136 (2022)
[3] M. Leccese et al., Monthly Notices of the Royal Astronomical Society **519**, 5567 (2023)