3D Presentation Rosetta-Philae –
The Detection of Organic Molecules on the Surface of a Cometary Nucleus

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ESA's Rosetta mission had made spectators from all over the world dream: On Wednesday, 12 November 2014, the Rosetta mission tried to pose the little robot Philae on the nucleus of comet 67P/Churyumov-Gerasimenko. The Rosetta Space Probe aimed to collect information about the composition of the comet nucleus during its spectacular approach to the sun [1]. Rosetta is the first probe to place itself in orbit around the comet and to place a lander on the surface of a cometary nucleus. The Rosetta probe carried 11 scientific instruments and a Philae lander which itself comprises 10 additional instruments. After 10 years of travel, the separation of the Philae lander from the Rosetta orbiter was carried out on November 12, 2014. The cometary sampling and composition (COSAC) instrument, a device onboard Philae, which we developed in an international partnership lead by the Max Planck Institute for Solar System Research, is a gas chromatograph using eight stationary phases coupled with a mass spectrometer time of flight type. 25 minutes after Philae's landing and bouncing on the cometary nucleus, COSAC successfully performed the first chemical analysis of cometary surface material that cannot be analyzed from the Earth. 16 organic molecules were identified in the cometary sample by using COSAC's MS-only mode [2]. After two additional bouncing events Philae finally landed on the cometary surface and operated for 60 h. During this time the COSAC instrument recorded 420 mass spectra in the enantioselective GC-MS mode. The identification of organic species in these mass spectra remains difficult because of the unexpected 'vertical' landing of Philae and the unexpected low amount of sample that was filled into the oven of COSAC's sample injector system. The results of the analysis of the cometary nucleus surface by the COSAC instrument will be presented. These *in situ* cometary results will be interpreted in relation to laboratory experiments that allow for the simulation of cometary ices by condensing volatile molecules such as H_2O, NH_3, CO, CO_2, and CH_3OH in an ultra-high vacuum from the gas phase onto a cooled surface of $T = 12$ K. The room temperature residues of the cometary ice analogues were shown to contain amino acids [3], aldehydes [4] and ribose [5] as produced in form of simulated cometary ices in the laboratory [6]. The laboratory simulation experiments thereby confirm data on the chemical composition obtained by the Rosetta-Philae cometary probe.

Literature References

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