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Towards biosignature detection on Icy Moons with ORIGIN

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In the search for life beyond Earth, the icy moons Europa and Enceladus have been brought forward as the most promising targets within our Solar System. Recently, the Enceladus Orbilander mission has gained significant interest as it has been selected as a NASA flagship mission[1]. This emphasises the need for reliable in-situ instrumentation capable of biosignature detection and identification.

In-situ instrumentation must not only meet flight-capability requirements, but the detection capabilities should extend beyond single molecules or compound groups. Various groups of compounds are listed to be of astrobiological interest, such as amino acids, lipids, and nucleobases[1–3]. Ideally, instruments should be capable of simultaneously detecting several different compound groups, in varying abundances from major components down to trace level. Therefore, to successfully detect both trace abundances and highly abundant compounds, a high sensitivity and wide dynamic range coverage are essential as well.

This contribution will provide a comprehensive overview of the ORIGIN (ORganics Information Gathering INstrument) space-prototype, a Laser Desorption Ionisation Mass Spectrometer (LDI-MS), designed for the in-situ detection of molecular biosignatures. ORIGIN's light-weight and robust design, includes a nanosecond pulsed laser system (λ=266 nm, 20 Hz, τ=3 ns) and a miniature reflectron-type Time-Of-Flight mass analyser (RTOF) (160 mm x Ø 60 mm)[4]. The instrument is designed to address the challenges of flight-capability, sensitivity, and dynamic range coverage, which are all essential for reliable biosignature detection on exploration missions.

ORIGIN's analytical capabilities have been demonstrated for amino acids and lipids, and have recently been extended to nucleobases[4-6]. We will discuss results of the recent experiments to give an overview of ORIGIN’s detection capabilities including sensitivity and dynamic range, which are crucial for future space exploration missions. The determined limit of detection for three lipids (□7×10−13 mol µL−1) aligns with the specified requirements in the Enceladus Orbilander mission concept (1×10−12 mol µL−1)[3,6]. The application of ORIGIN towards the detection of biosignatures on icy moons and the envisioned concept of ice sample handling will also be discussed.

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