

The Development of a Miniaturized Raman Instrument Optimized for the Detection of Biosignatures on Europa

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Abstract : In recent years, Europa has been one of the major focus points in astrobiology due to its high potential of harbouring life in the vast ocean underneath its icy crust. However, the detection of life on Europa faces many challenges due to the harsh environmental conditions and mission constraints. Raman spectroscopy is a highly capable and versatile in-situ characterisation technique that does not require any sample preparation. It has only been used on Earth to date; however, recent advances in optical and laser technology have also allowed it to be considered for extraterrestrial exploration. So far, most efforts have been focused on the exploration of Mars, the most imminent planetary target. However, as an emerging technology with high miniaturization potential, Raman spectroscopy also represents a promising tool for the exploration of Europa. In this study, the capabilities of Raman technology in terms of life detection on Europa are explored and assessed. Spectra of biosignatures identified as high priority molecular targets for life detection on Europa were acquired at various excitation wavelengths and conditions analogous to Europa. The effects of extremely low temperatures and low concentrations in water ice were explored and evaluated in terms of the effectiveness of various configurations of Raman instruments. Based on the findings, a design of a miniaturized Raman instrument optimized for in-situ detection of life on Europa is proposed.

Keywords : astrobiology, biosignatures, Europa, life detection, Raman Spectroscopy

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