OrganiCam: A Time-Resolved Fluorescence Imager and Raman Spectrometer for Organic Reconnaissance

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In situ characterization of Europa's surface is the first step in determining how likely Europa's oceans are habitable. Biomarkers, if they exist in the oceans, should be evident from exploring younger terrains on the Europan surface. Organic molecules, including biomolecules, tend to exhibit prompt fluorescence that can be distinguished from mineral luminescence by its few nanosecond lifetime. For example, chondrules have strong luminescence from rare Earth element color centers (mineral luminescence). Fortunately, time-resolved laser-induced fluorescence can easily distinguish between organic signals and signals from chondrites, and from minerals in general. A pulsed laser provides the stimulation, and synchronization to a nanosecond time-gated detector provides the discrimination in the time domain needed to distinguish organics from luminescent minerals. The interrogating laser has the ability to also probe beneath the immediate surface to analyze materials within the ice and protected from the harshest radiation environment right at the surface. We propose "OrganiCam" as an operationally simple, radiation hardened panoramic imager using laser-induced time-resolved fluorescence to identify organic-rich regions of interest within the arm sample area of a Europa lander. Detection limits for organics will be in the part per million range due to the strong fluorescence response, and spatial resolution will be in the millimeter range. OrganiCam also contains a spectrometer for passive visible-range, active fluorescence, and Raman spectra. A laser diffuser produces a laser spot size of ~40 cm in diameter, recording a fluorescence image and spectrum simultaneously. The diffuser can be removed to collect Raman spectra at specific locations. Operationally, the mast mounted camera would take a mosaic of fluorescence images, identify regions of interest, and retarget specific regions autonomously for Raman analysis. A lightweight prototype instrument (3-4 kg) with radiation-hardened camera optics suitable for Europa's environment has been assembled and tested.