Title: Proposed Narrowband Science Filters for a Multispectral Imaging System on a Europa Lander Mission

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Europa's icy crust is hypothesized to overlie a large, liquid water ocean. This ocean and any interactions with Europa's silicate interior and outer surface make Europa a priority target for astrobiology-focused missions, especially a lander that would follow missions like Europa Clipper or JUICE. As specified in the Report of the Europa Lander Science Definition Team (2017), a mission landed on the surface must be supported by a Compact Remote Sensing Instrument (CRSI). We propose narrowband visible to near-infrared filters (~400-1100 nm) for such an instrument that capture absorption features in spectra of various materials suggested to be part of Europa's surface. These materials include water ice, hydrated salts and sulfuric acid, possible silicate and organic materials from exogenic sources, and irradiated products of the above. We gathered previously-published visible to near-infrared reflectance spectra of Europa-relevant materials and convolved them to filter bandpasses. The convolved spectra demonstrate that a version of the CRSI equipped with at least 6 recommended filters could identify many of the component materials and provide color, textural, and photometric information to support other instruments and surface sampling. Our proposed nominal filter centers and half-width at half maximum (in nm) for the full filter set are 525 ± 88 (broadband), 427 ± 48, 555 ± 35, 670 ± 30, 380 ± 23, 850 ± 70, 1000 ± 50, 725 ± 20, 490 ± 15, 1080 ± 40, 1027 ± 35, 900 ± 20, 450 ± 18, and 640 ± 20. We rank these filters based on relevance to the measurement objectives specified in Europa Lander SDT's report and to adapt to changing mission architecture and instrument design. For example, the use of a variable polarizing filter on a filter wheel could be easily integrated with these proposed narrowband filters.

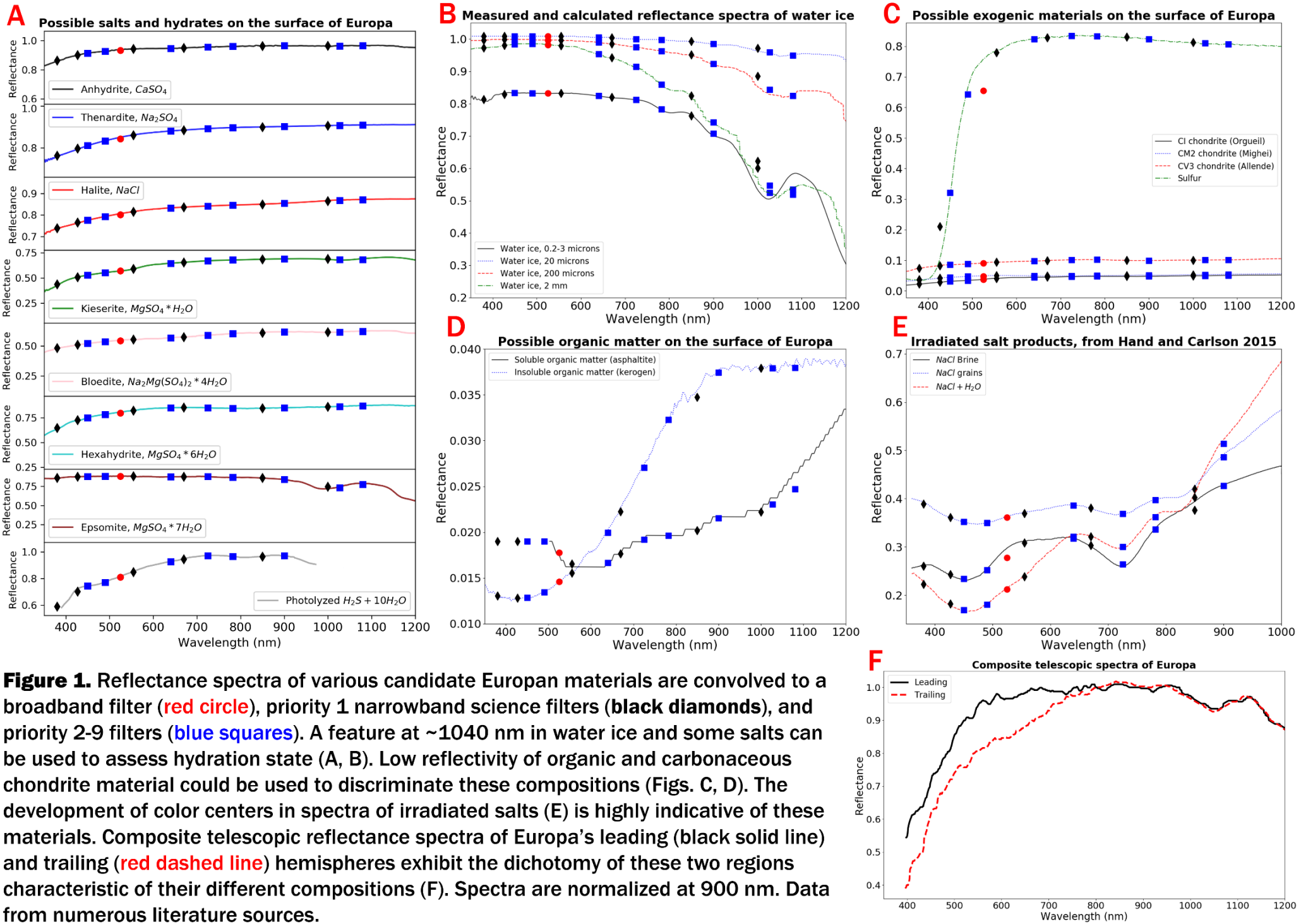

Figure 1. Reflectance spectra of various candidate Europan materials are convolved to a broadband filter (red circle), priority 1 narrowband science filters (**black diamonds**), and priority 2-9 filters (blue squares). A feature at ~1040 nm in water ice and some salts can be used to assess hydration state (A, B). Low reflectivity of organic and carbonaceous chondrite material could be used to discriminate these compositions (Figs. C, D). The development of color centers in spectra of irradiated salts (E) is highly indicative of these materials. Composite telescopic reflectance spectra of Europa's leading (black solid line) and trailing (red dashed line) hemispheres exhibit the dichotomy of these two regions characteristic of their different compositions (F). Spectra are normalized at 900 nm. Data from numerous literature sources.