

EXPLORING EUROPA WITH RAMAN AND LIBS

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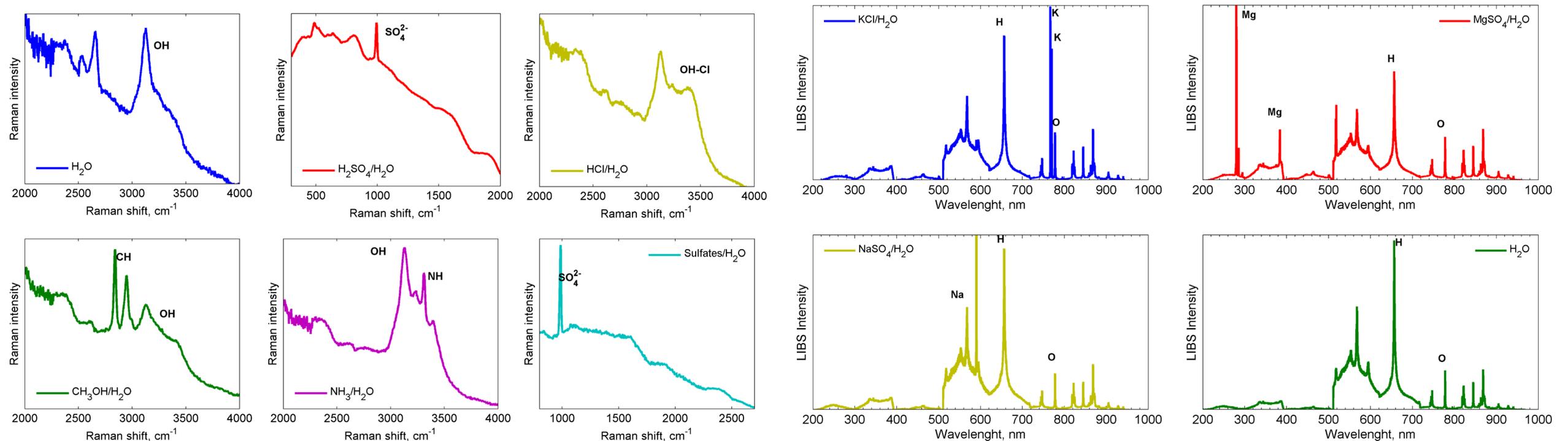
EUROPA EXPLORATION

- The US congress has instructed NASA to include a lander component in the next Europa mission. Its primary goal will be to search Europa's icy surface for evidence of life that may persist within the ice shell or subsurface ocean.
- Miniaturization, sensitivity, and quick deployment and operation will be baseline requirements for any payload element.

RAMAN-LIBS ADVANTAGE

- Laser Raman and LIBS are uniquely suited tools for quantitative analyses of organic content, minerals, and volatiles in icy matrices.
- LIBS can reveal the relative concentration of major (and often trace) elements.
- Raman provides molecular identification, and molecular quantitation of complex organic compounds, including pre-biotic compounds; biomolecules minerals; volatiles; ice composition, crystallinity; and ice phase.
- A combined instrument can provide rapid, in-situ (no sampling) analyses on Europa.

CASE STUDY: LIBS AND RAMAN SPECTRA OF MIXTURES OF ICE WITH SALTS AND ORGANICS



Raman spectra of mixtures, including a mixture of Ca, Mg, Na, and K-sulfates and H₂O ice (sulfates/H₂O). The spectra were obtained at -50 °C. Molecular vibrational modes have been identified, which in turn inform about potential associated ions, thus complementing LIBS.

LIBS spectra of ionized H₂O and frozen supersaturated solutions of KCl, MgSO₄, and NaSO₄ in water. Spectra recorded at -25 °C and 1020 mbar of air. The emission lines related to H and O were monitored at 656.3 and 777.4 nm, respectively. K, Mg, and Na are monitored at 766.6, 285.6, and 568.8 nm, respectively.

CONCLUSIONS

- **Elemental and molecular features of water ice mixed with salts and organics, relevant to Europa, can be analyzed using laser Raman and LIBS.**
- **Our groups at the Carl Sagan Center and Impossible Sensing are developing and maturing new instrument concepts for the *in-situ* exploration of Europa, including instrument requirements, concepts of operation, and science-driven measurement strategies.**