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Electron impact processing of ices in moons orbiting giant planets.

Implications for organic chemistry.

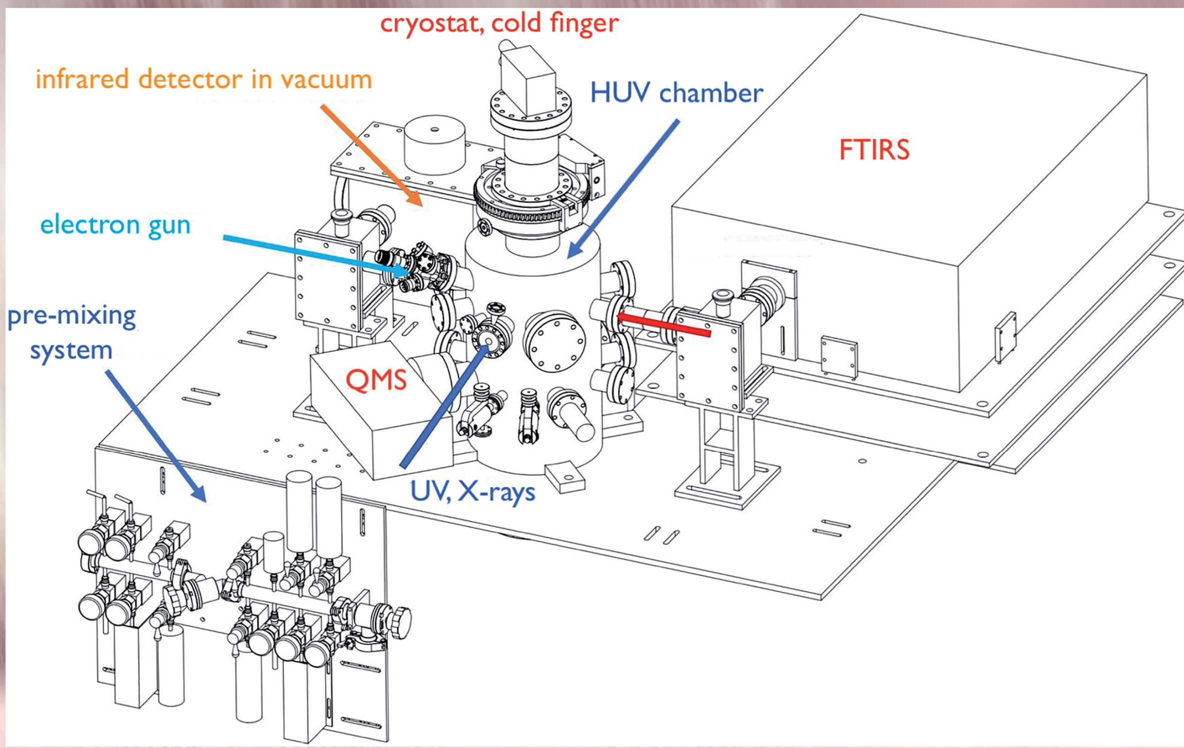
MOONS, EXOMOONS, AND CHEMISTRY

- astronomers have known for decades that water is fairly common in the Universe;
- as a dominant form of oxygen water controls the chemistry of many other species;
- all the major satellites of the outer Solar system planets contain water ice, mixed with lower quantities of other volatiles (CO, CO_2 , NH_3 + organics);
- such materials are bombarded with ions and electrons from the magnetosphere of the parent giant planet, as well as with ultraviolet photons and X-rays from the central star;
- the relevant number of Jupiter-sized exoplanets discovered so far, and the ubiquity of water in space make these environments an exciting case to study (e.g., habitability);
- physico-chemical properties: non-thermal processes linked to well-known thermal and radical-driven mechanisms of organic chemistry.

THE PROJECT

- study of the chemical mechanisms induced by (sub-keV) electron radiolysis in cosmic (interstellar, planetary, and cometary) ice analogues;
- the interaction of free electrons with the ice liberates an abundance of secondary electrons of which most have energies below 30 eV (similarly to X-ray case);
- the induced chemistry leads to formation of larger products in binary ice layers consisting of small molecules; increase in the chemical inventory with more complex ice mixture (e.g., reaction of C_2H_4 with NH_3, H_2O, and CH_3OH to provide formamide, formic acid and methyl formate);
- focus on species of particular prebiotic interest (e.g., NCO-bond carriers);
- studies of diffusion and mobility at very low temperatures; analysis of electron-stimulated desorption; morphology of the ice (e.g., bilayered, chemical segregation); comparison with X-ray processing;

EXPERIMENTS AND CONSOLIDATED RESULTS



IEPS (Interstellar Energetic-Process System) @ National Central University (NCU), Taiwan

- single ice component, CO, exploiting electrons in the energy range between 200 and 1000 eV (Huang+20);
- binary mixture H_2O+CO (4:1), same range of energy, (Huang+22);