

## THE COMPOSITION OF C/2021 A1 (LEONARD) AS MEASURED WITH CRIRES+ AND TRAPPIST-SOUTH. M. Lippi<sup>1</sup>, M. Vander Donckt<sup>2</sup>, S. Faggi<sup>3</sup>, Y. Moulane<sup>4</sup>, M. J. Mumma<sup>3</sup>, G. L. Villanueva<sup>3</sup>, and E. Jehin<sup>2</sup>.

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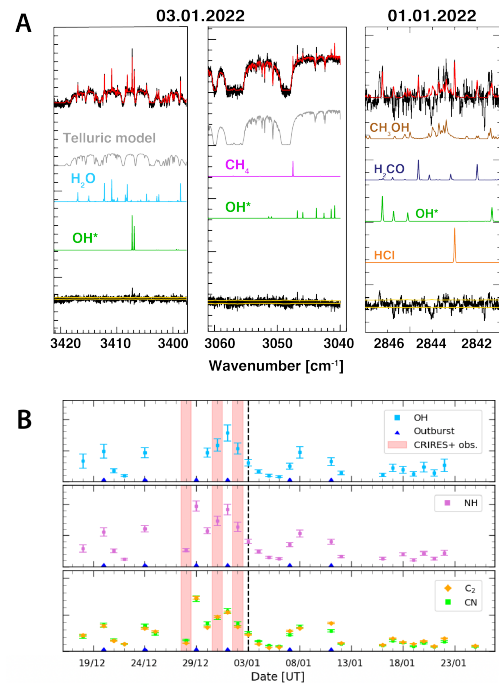
**Introduction:** Comets are the least processed bodies of the solar system and they provide key clues on the chemical and physical conditions present in our protoplanetary disc about 4.6 billion years ago. While infrared taxonomic studies of comets show a wide chemical diversity but no distinct chemical families among these bodies [1,2,3,4], near UV-optical surveys of the coma reveal instead two distinct chemical classes: “typical” and “carbon-chain depleted” [5,6]. It is still not clear if and how observing conditions, data reduction approaches and modelling may influence the results obtained at different wavelengths.

Long period comet C/2021 A1 (Leonard) (hereafter C/2021 A1) approached the Sun between Dec 2021 and Jan 2022 (perihelion at  $\sim 0.62$  au on Jan 3, 2022), and reached a minimum geocentric distance of 0.23 au on Dec 12, 2021. Close to perihelion, it showed (almost) periodical outbursts about every 4 days, disintegrating completely at the end of Feb 2022 [7].

Here, we present C/2021 A1 molecular abundances of different organic species as retrieved in the near infrared using CRIRES+ [8,9], in comparison with abundances of radical species obtained in the same period from the TRAPPIST-South [10] optical survey.

**Results and discussion:** We observed C/2021 A1 with CRIRES+ on Dec 29, 2021 and Jan 1 and 3, 2022. Despite difficult observing conditions, we managed to obtain high quality spectra (Fig. 1A) and to retrieve production rates and mixing ratios for primary species such as H<sub>2</sub>O, C<sub>2</sub>H<sub>6</sub>, CH<sub>4</sub>, CH<sub>3</sub>OH, H<sub>2</sub>CO, HCl, and the secondary species NH<sub>2</sub>. TRAPPIST-south monitored the comet from late Dec 2021 through late Jan 2022, almost on a nightly basis, allowing the observation and study of many emission lines of secondary species such as OH, CN, NH, C<sub>2</sub> and C<sub>3</sub> (Fig. 1B).

While from the IR perspective C/2021 A1 seems to be depleted in almost all the organics except formaldehyde and ammonia, UV-optical results suggest that this comet belongs to the “typical” group. The resulting chemical compositions as retrieved at different wavelengths are thus in contrast, and the reasons why are still unclear. This work highlight the need of multi-wavelength simultaneous observations for the next comets, in order to better identify and describe these differences and the processes that relate primary and product species in the coma.



**Fig 1A:** CRIRES+ detection of H<sub>2</sub>O, CH<sub>4</sub>, CH<sub>3</sub>OH, H<sub>2</sub>CO, HCl, and OH\* (prompt emission) in C/2021 A1. **1B:** Evolution of OH, NH, C<sub>2</sub> and CN production rates as monitored by TRAPPIST-South.

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