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The NIR chemical composition of C/2021 A1(Leonard) at perihelion from CRIRES+ at the VLT

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We will present our observations of the bright comet C/2021 A1 (Leonard) with the newly upgraded CRIRES+ high resolution IR spectrometer mounted on the ESO VLT in Paranal, Chile. C/2021 A1 is a long period comet that reached perihelion on January 3, 2022, at 0.62 AU from the Sun. It is one of the brightest comet of recent years, reaching a visual magnitude of 3 close to perihelion (Seiichi Yoshida's webpage).

Originating from the cold Oort Cloud were it spent most of its dynamical lifetime, C/2021 A1 has presumably experienced little transformation or activity, keeping a pristine memory of the chemistry of the protoplanetary disk at the place where it formed. The sublimation of the nucleus volatile ices during its close approach to the Sun was an unique opportunity to have a glimpse at C/2021 A1 composition through the fluorescence of the species in its coma. We observed the comet with CRIRES+ for three nights close to its perihelion at 0.62 AU between December 28, 2021, and January 3, 2022, and derived the production rates of several parent volatiles including H_2O, CH_4, C_2H_6, H_2CO and CH_3OH. During the period of observation, the proximity to the Sun triggered a series of outbursts in C/2021 A1 (Jehin et al, 2022), enhancing the release of material in the coma and ultimately leading to the disintegration of the comet. The observations were made nodding on sky to subtract telluric features in the spectra, and the spectra were later corrected for atmospheric absorption (dominant in the NIR region) and wavelength calibrated by an atmospheric transmittance model computed with the ESO MOLECFIT software (Smette 2015). A flux reference star was also observed to calibrate the target's flux. The chemical composition of the comet will be compared to other comets from the same and other dynamical groups. The ongoing effort to build a chemical taxonomy of comets (A'Hearn et al., 1995; Dello Russo et al., 2016; Lippi et al., 2021) and compare it to the established dynamical classification underlies the need to better constrain the chemical composition of an increasing number individual comets.

The high resolution IR spectrometer CRIRES+ is an upgrade of the CRIRES spectrometer into a cross-dispersed spectrograph, increasing the simultaneously covered wavelength by a factor 10 (Dorn et al, 2020). It has been available at the VLT since October 2021, offering a resolving power up to 100000 with a 0.2'' slit between 1 and 5 µm. This first observation of a comet with CRIRES+ will also serve to demonstrate its capabilities to target such objects in the IR.