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The volatile composition of comet C/2017 K2 (PanSTARRS)

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We present high resolution spectra of comet C/2017 K2 (PanSTARRS) (hereafter 17K2), obtained using the upgraded high resolution spectrometer of the VLT, CRIRES+. We will show our findings in the (2.8 – 5.3) μm range, searching for primary volatiles (e.g., H_2O, HCN, NH_3, CO, C_2H_6, CH_4, ...) and studying their evolution as the comet approach the Sun. 17K2 is a long period comet, very active already at record heliocentric distances of 16 au, and represents a unique opportunity to study the composition of a mostly unaltered comet.

Comets formed from the material surrounding the proto-Sun about 4.6 billion years ago, and after their formation they were scattered into their current reservoirs [1,2], where the frozen nuclei have preserved most of the chemical and mineralogical properties linked to their formation site until today. Probing the chemical diversity in comets may thus unveil the processes that were in effect within the mid-plane of our proto-planetary disk, and test the hypothesis that comets may have contributed in delivering water and prebiotics to the early Earth [3].

Among other techniques, the composition of active comets can be studied from ground based telescopes using high resolution spectroscopy in the infrared (IR - 3 to 5 μm), where it is possible to observe emission lines produced by solar-pumped fluorescence of primary species, i.e., molecules released directly from the nucleus. High spectral and spatial resolutions are necessary to resolve different molecular species in the spectra, to study their distribution within the coma and to separate emission lines of the comet from their counterpart in the atmosphere.

Comet 17K2 is in excellent observing conditions in 2022, allowing infrared high resolution studies. The comet shows already activity, probably driven by CO and other hyper-volatiles that can sublimate at distances from the Sun larger than 5 au [4,5]. Discovered in 2017 at about 16 au from the Sun [6], it is most likely entering the inner solar system for the first time, and its observation offers a unique opportunity to study its mostly unaltered material.

We will present the results obtained from different spectra acquired using CRIRES+ at ESO-VLT at various epochs. We acquired comprehensive high-resolution spectra of the comet as it progressively moved towards the Sun, with the goal of monitoring the evolution of sublimating material with the heliocentric distance. In particular, we have granted time at the beginning of May, beginning of July, and end of August 2022, with the Sun-17K2 distance varying from about 3.5 to 2.3 au. In this heliocentric range, the comet is crossing the CO to H_2O ice sublimation regime [7].

Data are reduced using custom semi-automated procedures (see [8] and references therein) that allow a fast analysis of the spectra. Spectral calibration and compensation for telluric absorption are achieved by comparing the data with highly accurate atmospheric radiance and transmittance models obtained with PUMAS/PSG [9]. Flux calibration is obtained using the spectra of a standard star observed closely in time with the comet, and reduced with the same algorithms. Production rates and relative abundances (i.e. mixing ratios with respect to water) of different primary species in the coma are obtained using state-of-the-art fluorescence models (see for example [10] and [11]).

The molecular abundances found in this comet will be compared to reference median values retrieved for the comet population [12] and with the abundances found in other Oort Cloud Comets.

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