MONITORING THE ACTIVITY AND THE COMPOSITION OF COMET C/2017 K2 (PANSTARRS). E. Jehin[1], M. Lippi[2], M. Vander Donckt[1], S. Hmiddouch[1,3], D. Hutsemékers[1], J.Manfroid[1], Y. Moulane[4], A. Jabiri[3], Z. Benkhaldoun[3]. [1]Space sciences, Technologies & Astrophysics Research (STAR) Institute, University of Liège, Belgium (ejehin@uliege.be); [2]INAF - Osservatorio astrofisico di Arcetri, Largo Enrico Fermi 5, 50125 Firenze, Italy; [3]Oukaimeden Observatory, High Energy Physics and Astrophysics Laboratory, Cadi Ayyad University, Marrakech, Morocco; [4]Physics Department, Leach Science Center, Auburn University, AL 36832, USA.

Introduction: The long-period comet C/2017 K2 (PanSTARRS) was discovered in 2017 at a large heliocentric distance of 16 au [1]. Pre-discovery images from 2013 show that K2 was even active at a record distance of ~24 au from the Sun well beyond the snow line, indicating that, most probably, CO and CO_2 ices - the most abundant species after water – might drive its activity. CO was indeed detected in K2's coma in the sub-mm range at a heliocentric distance of 6.7 au and K2 was claimed to be a CO-rich comet [2]. Detecting comets at such large distances is becoming more frequent, but it is still a rare occasion to study a well preserved comet surface coming directly from the Oort Cloud or on a several million years orbit, and especially if it is of an unusual type.

K2 reached its perihelion on 2022 December 19 (Rh=1.8 au, Δ=2.5 au) and became a bright target with good observing conditions from the Southern hemisphere. We started a spectroscopic campaign on May 8 (Rh=3.2 au), 2022 with simultaneous observations in the optical and IR using UVES and CRIRES$^+$ at the ESO VLT to obtain high resolution and good SNR to characterize the detailed coma composition of its daughter and parents species at three different epochs before perihelion. We also used TRAPPIST-North and South telescopes to monitor the comet activity over several years up to now. We present in this work the results of these different techniques.

UVES observations: UVES was setup with a slit width of 0.45" (length of 10") to provide a resolving power of 80.000, and we selected two different settings to cover the whole optical range (304-1040 nm) at each epoch. These spectra allowed us to follow the onset of the different gaseous species with the heliocentric distance and to measure the detailed composition of its coma: the production rates of the daughter species (OH, CN, C_2 etc.) to check if the comet is a C-chain depleted or typical comet [3] and to try to link those production rates with those from the parent species observed in the IR with CRIRES$^+$, to search for CO^+ and CO_2^+ lines to check if K2 is a CO-rich comet, to measure the ratio of the [OI] lines, and search for faint FeI and NiI lines which are a new and puzzling component of the cometary coma [4]. The comet was unfortunately too faint to measure the C and N isotopes from the CN radical.

CRIRES$^+$ observations : We present simultaneous high resolution NIR spectra 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., H2O, HCN, NH_3, CO, C_2H_6, CH_4, ...) studying their evolution as the comet approach the Sun (from 3.5 to 2.1 au) and compare to the daughter species obtained in the optical. In this heliocentric range, the comet is crossing the CO to H_2O ice sublimation regime [5]. The molecular abundances found are compared to reference median values retrieved for the comet population [6] and with the abundances found in other Oort Cloud Comets.

TRAPPIST observations: We started observing K2 with TRAPPIST-North on October 25, 2017 using broad-band filters when the comet was still at 15 au from the Sun with a magnitude of 18. We started collecting broad and narrow-band images [7] with TRAPPIST-South on September 9, 2021 (rh=5.4 au) when the comet became visible and bright from the southern hemisphere. We monitored the activity of K2 on both sides of perihelion until now. We detected close to perihelion emission of OH, CN, C_2, and C_3 radicals as well as the dust continuum in four bands. By fitting the observed gas profiles with a Haser model and after subtraction of the dust continuum, we derived the gas production rates. From the continuum and broad-band images, we computed the Afρ parameter, a dust production proxy. We present the magnitude evolution of K2 over the last 5 years (2017-2023), as well as the gas and dust activity for several months as a function of the heliocentric distance.

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References: [1] Wainscoat, R. J., et al., 2017,CBET, 4393, 1. [2] Yang, B., et al. 2021, ApJL, 914, L17. [3] A'Hearn et al. 1995, Icarus, 118, 223. [4] Manfroid, J., et al., 2021, Nature, 593, 372. [5] Jewitt, D., et al., 2007, Protostars and Planets V, Tucson, 863. [6] Lippi, M., et al., 2021, AJ, 162, 74. [7] Jehin, E., et al., 2011, The Messenger, 145, 2.