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Narrow- and broad-band photometry of the peculiar comet 21P/Giacobini-Zinner during its 2018 apparition

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Abstract

We report on narrow- and broad-band photometry of the Jupiter Family Comet (JFC) 21P/Giacobini-Zinner (hereafter 21P) observed, over than 8 months continuously, with both TRAPPIST telescopes (TN and TS [1]). We monitored the evolution of the gaseous species production rates OH, NH, CN, C_3 and C_2 as well as the evolution of the A(θ)fρ parameter, a dust proxy. Measurements on the production rates and their ratios with respect to CN and to OH will be discussed. The peak of the water production was on August 17, 2018 (r_h=1.07 au), 24 days before the perihelion, and it reached $(3.72\pm0.05)\times10^{28}$ molecules/s, while the peak value of Afρ was (575$\pm$12) cm. Comparison of the coma morphology features and the coma colors will be discussed.

1. Observation & Data Reduction

We started monitoring 21P with TN at the beginning of June 2018 and with TS at the beginning of September 2018 until February 2019. Narrow- and broad-band images were collected during 8 months for a total of 45 nights, dense monitoring was made around the perihelion (September 10, 2018) when the comet was at 1.01 au from the Sun and 0.39 au from the Earth.

Calibration followed standard procedures using frequently updated master bias, flat and dark frames. The removal of the sky contamination and the flux calibration were performed as described in [2]. In order to derive the production rates, we used the Haser Model as described in [2]. We computed the vectorial-equivalent water production rates from the OH production rates using $Q(H_2O)=1.36\ r^{-0.5}\ Q(OH)$ [3]. We derived the Afρ parameter, proxy of the dust production from the dust profiles using the HB cometary narrow-band dust continuum (BC, GC and RC) filters and the broad-band Rc and Ic filters.

2. Results

21P is a short-period JFC with an orbital period of 6.5 years. The comet was discovered in 1900 by Michel Giacobini and rediscovered by Ernst Zinner in 1913. After its discovery, 21P was observed in most of its apparitions and many photometric and spectroscopic measurements were reported. 21P was the first comet visited by the International Cometary Exporer (ICE) spacecraft mission in 1985 to study the interaction between the solar wind and the cometary atmosphere of the comet [4].

21P is the prototype of depleted comets carbon chain elements (C_2 and C_3) and ammonia [5]. The C_2 and C_3 abundances relative to CN and to H_2O are $\sim$ 5 times and $\sim$ 10 times smaller than in "typical" comets.

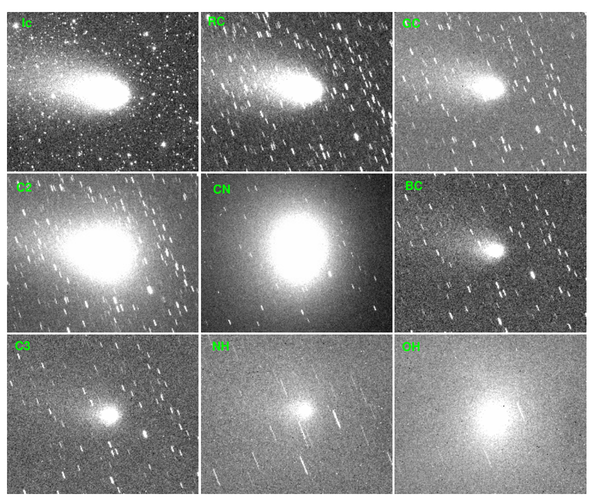

Figure 1: A panel of broad- and narrow-band images of comet 21P taken on September 17, 2018 (a week after perihelion) with TS.

In this work, we are going to show measurements of the gas production rates and the relative abundances with respect to CN and to H_2O during its last passage in 2018. We detected all the gas species at the beginning of our monitoring on June 20, 2018 (r_h=1.52 au) until the beginning of October 2018, a month after perihelion, when we lost C_3 and NH detection (r_h=0.55 au) while we lost detection of CN, C_2 and OH in the first week of November 2018 (r_h=0.72 au). The low C_2/CN abundance ratio seen in previous apparitions is confirmed by the present observations with a value of C_2/CN=0.34$\pm$0.02, while the mean value is C_2/CN=1.15 for typical comets [6]. Our observations show that the C_2 (along with C_3 and NH) is depleted with respect to H_2O. The evolution of the dust-gas ratio with respect to the heliocentric distance will be discussed as well.

21P has shown different behaviors and an asymmetric activity in the previous apparitions with respect to the perihelion. Our observations indicate that the peak of both dust and gas production rates was reached 24 days before perihelion on August 17, 2018 when the comet was at 1.07 au. The evolution light-curve of the gas and dust production rates will be shown at 2018 passage and compared to previous ones. Using broadband filters BVRI, we will derived the coma colors of 21P and discuss its evolution with respect to the heliocentric distance and compare them to those derived for other JFCs. Analyzing the coma morphology features using gas and dust filters along our monitoring will be addressed. Combining all these measurements could help us to better understand the nature and the origin of this peculiar comet [5, 7].

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