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TRAPPIST monitoring of the activity and composition of the small near-Earth Jupiter Family Comets : 41P and 252P

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Abstract

We report on photometry and imaging of the Jupiter Family Comets (hereafter JFC) 252P/LINEAR (hereafter 252P) and 41P/Tuttle-Giacobini-Kresak (hereafter 41P) with TRAPPIST telescopes [1]. We observed 252P with TRAPPIST-South from February 4 to June 8, 2016, while we collected the data for 41P with TRAPPIST-North from February 16 to July 27, 2017. We monitored the evolution of the gaseous species OH, NH, CN, C_3 and C_2 production rates as well as the evolution of the dust proxy, A(θ)fρ parameter. The peak of the water production rate of 41P reached $(3.5\pm0.2)\times10^{27}$ molecules/s on April 3, 2017 when the comet was at 1.05 au from the Sun. 41P is a unique comet that showed a rapid slow down of its rotation period during this recent apparition from 20 hrs to 50 hrs in 2 months [2, 3]. The peak of the water production rate of comet 252P reached $(8.5\pm0.08)\times10^{27}$ molecules/s on April 10, 2016 two weeks after perihelion. The similarity of the orbit of 252P and the asteroidal object P/2016 BA14 may indicate that the later could be a fragment of the comet[4]. The comparison of the coma morphologies exhibited by the gas species and the dust will be discussed for both comets.

1. Introduction

JFCs are defined as comets with Tisserand parameter between 2 and 3, which is a measure of the influence of Jupiter on the dynamics of the comets.

41P is a near-Earth Jupiter family comet (5.42 yr), discovered by Horace Parnell Tuttle on May 3, 1858. 41P has a small nucleus (0.7-1 km) [5], this radius is less than 70% of all measured radii of JFCs [6]. This comet was observed with TN (and 2 nights with TS) over 5 months. Its perihelion was on April 12, 2017 at 1.0 au from the Sun and the comet was at its closest distance to Earth on April 1 at only 0.14 au.

252P is a near-Earth Jupiter family comet (5.32 yr), discovered by the LINEAR survey on April 7, 2000. The nucleus size of 252P is also very small, about 0.3-0.5 km [7]. We monitored 252P over 4 months, its perihelion was on March 15, 2016 when the comet was at 0.996 au from the Sun and did a very close approach 0.053 au from the Earth.

2. Production rates and dust (Afρ)

In order to derive the production rates, we converted the flux for different gas species (OH, NH, CN, C_3 and C_2), through the HB narrow band cometary filters [8], to column densities and we have adjusted their profiles with a Haser model [9]. The model adjustment is performed around a physical distance of 10000 km from the nucleus. We computed a vectorial-equivalent water production rate (Figure 1) from our Haser-model OH production rates using Q(H_2O)=1.36 $\times r^{-0.5}\times$ Q(OH) [10].

We derived the Afρ parameter, proxy of dust production [11], from the dust profiles using the HB cometary narrow-band BC, GC and RC filters [8] and the broad-band Rc filter. We corrected the A(θ)fρ from the phase angle effect to obtain A(0)fρ.

3. Coma morphology

The morphological analysis revealed several features in the coma of both comets. Using a simple rotational filter which takes the difference between two oppositely-rotated copies of the image, we enhanced the CN narrow-band images of 41P and 252P. Two jets are detected like partial spirals in a counter-clockwise rotation in 41P images. This technique has been used to measure the rotation period of 41P which shows an increase from 30 hrs at the end of March to 50 hrs at the end of April.

4. Figures

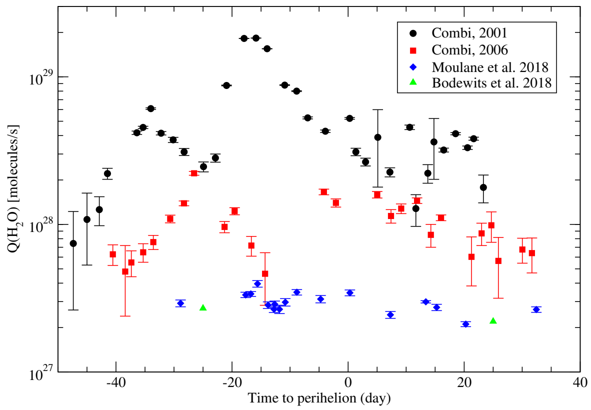

Figure 1: The logarithm of the water production rate for different apparitions of comet 41P in 2001, 2006 and 2017 as a function of time to perihelion.

5. Summary and Conclusions

We monitored 41P and 252P on both sides of perihelion with the TRAPPIST telescopes. The gas species production rates were computed as well as the Afρ parameter for both comets. Our results have shown that the two JFCs have a *typical* composition according to the Q(C_2)/Q(CN) and Q(C_3)/Q(CN) ratios but have a low gas and dust activity compared to other JFCs. We found that the activity of 41P is decreasing by about 30% to 40% from one apparition to the next. We confirmed rotation period derived from coma features slowed down by 20 hours in 2 months [2]. 252P has shown an increase in production rates and dust production after perihelion which is believed to be associated with thermal processing of the nucleus surface.

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