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Photometric and spectroscopic monitoring of the outbursting Halley-type comet 12P/Pons-Brooks

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We present photometric and spectroscopic observations of comet 12P/Pons-Brooks (hereafter 12P) during its 2024 passage. 12P is a 71 years period comet on a Halley-type orbit discovered by J.L. Pons in 1812 and rediscovered during its following passage by W.R. Brooks in 1883 [1,2]. As during previous passages, the comet showed during its recent approach several impressive outbursts [3], with up to 4 units of magnitude increase. Peculiarly, those outbursts occurred at heliocentric distances between 4 and 2.5 au, excluding the sublimation of water ice as the main source of this activity. A recent study looking in more details at the mass and energy releases by the outbursts pointed towards the crystallization of amorphous water ice as a likely mechanism [4].

Our photometric survey contains over 130 nights of observation with the TRAPPIST-North and -South telescopes [5] from May 6, 2023 (rh = 4.62 au, inbound), to September 7, 2024 (rh = 2.06 au, outbound). We collected images with broad-band Johnson–Cousins filters (BVRI) as well as narrow-band HB filters [6] (OH, CN, C_2, C_3 and NH for gas species and RC, GC and BC for the dust continuum) to compute the comet's gas activity, using the Haser model [7], and dust activity, using the proxy A(0)fρ [8].

From the lightcurve we detect more than 10 outbursts, accompanied with gas and dust activity increases; OH production rate reaching values as high as 10^{29} molecules/s and A(0)fρ as high as 10^5 cm. Individual dust images show the formation of a horn-shaped coma and the expansion of a dust shell the days following the strongest outbursts (see Fig. 1). Since we had images for several days after outbursts, the dust shell velocity could be measured. Observations with narrow-band filters allowed the study of the gas and dust ratios behaviour during those events, which differs from recent observations of outbursting comets closer to the Sun.
Analysis of CN jet features allowed us to estimate to rotation period of the comet and measure the gas ejection velocity in the plane of the sky

Long-slit low resolution spectra were obtained at the Observatoire de Haute Provence with the MISTRAL instrument [9] (5.5'x1.9'' slit, R~700@6000 Å) on the night of March 23, 2024, when the comet was at a heliocentric distance of 0.94 au. The spectra were extracted from the observed data and calibrated to analyse the emissions from the different molecular bands. Usual emission bands from the neutral molecular species, C_2 , NH_2 , CN, were observed. Additionally, a detection of H_2O^+ close to the photocenter has also been made.

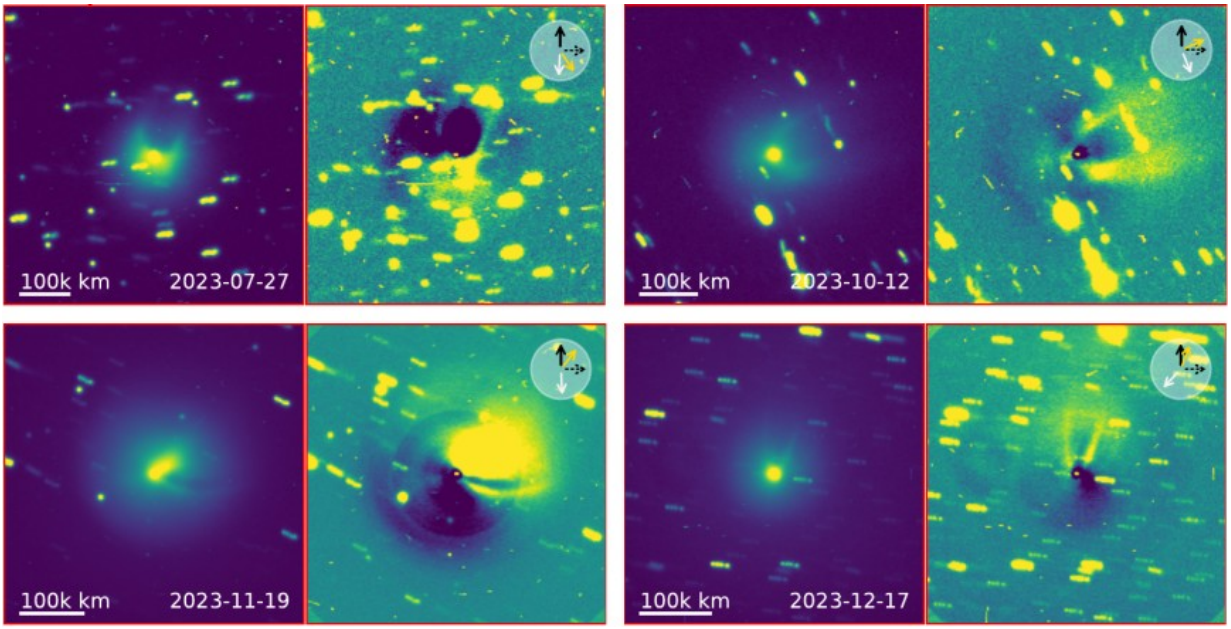

Fig. 1: Comet 12P/Pons-Brooks in the R filter during different outbursts. Left is the unmodified image and right is the image after subtraction by an azimedian profile. The dust shell and the two horns are visible during all the shown outbursts, although the shape of the horns change between the occurrences. The yellow and white arrows are the antisunward and the negative of the target heliocentric velocity vector directions, respectively. Images are oriented north up and east right.

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Acknowledgments

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