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Recurring Outbursts of P/2019 LM₄ (Palomar)

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Abstract

We present a preliminary analysis of comet P/2019 LM₄ (Palomar) as observed by the Zwicky Transient Facility (ZTF) survey in 2019 and 2020. We find that the discovery of the comet in 2019 and the recovery in 2020 is largely attributed to two separate outbursts that are $\gtrsim 2$ and $\gtrsim 3.9$ mag in strength. The two outbursts occurred between the end of April and early May in 2019, and between 2020 May 8.31 and 9.52 UTC.

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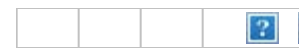


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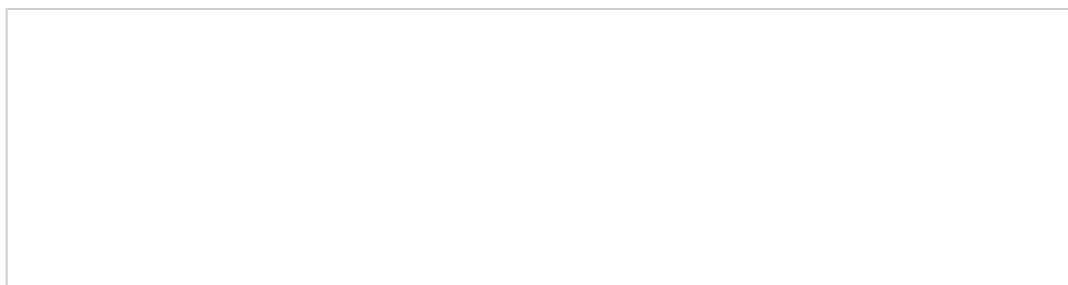
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Cometary outbursts are brief, unexpected increases in the brightness of comets that indicate a sudden and dramatic change in the activity (Patashnick 1974; Hughes 1990). Such events sometimes lead to the discovery of originally inactive or weakly active comets which would otherwise not be detectable (Kramer et al. 2017; Ye 2017).

Our preliminary analysis of images of comet P/2019 LM₄ (Palomar) acquired with the Zwicky Transient Facility (ZTF) survey (Bellm et al. 2019) has revealed recurring brightenings or outbursts of activity. P/Palomar was first detected as an asteroidal object on 2019 June 4 and 7 in the course of the ZTF Twilight Survey (Ye et al. 2020). Following the recent recovery of the object,⁷ we searched the ZTF Data Release 2 (Masci et al. 2019) and Partnership archives within the 3σ positional uncertainty as predicted by JPL orbit solution #3 for additional observations. The data are calibrated to the Pan-STARRS 1 photometric system (Masci et al. 2019), with colors corrected assuming a reddened solar spectrum ($g_{P1} - r_{P1} = 0.49$ and $r_{P1} - i_{P1} = 0.34$). For images where the comet is detected, the photometry is measured using a 5" radius aperture. For the non-detections, we compute the 5σ upper limits based on the ZTF pipeline.

Figure 1 shows the composite lightcurve of P/Palomar produced using ZTF observations. The ATLAS precovery on 2020 May 9 is also plotted for reference, with an assumed color of $r_{P1} - g_{ATLAS} = 0.05$ derived from a solar spectrum and the filter throughput curves (ASTM International 2006; Tonry et al. 2012; Tonry et al. 2018). We also plot two lightcurve models: the HG model (Bowell et al. 1989) assumes $H = 14.1$ and $G = 0.15$, while the coma model is computed using the Halley–Marcus phase function (Schleicher et al. 1998; Marcus 2007; Schleicher and Bair 2011) following $m_{\text{coma}} = 14.1 + 5 \log \Delta + 10 \log r_H - 2.5 \log \Phi(\alpha)$, where Δ and r_H is geocentric and heliocentric distances in au, and $\Phi(\alpha)$ is the Halley–Marcus phase function applied to phase angle α .



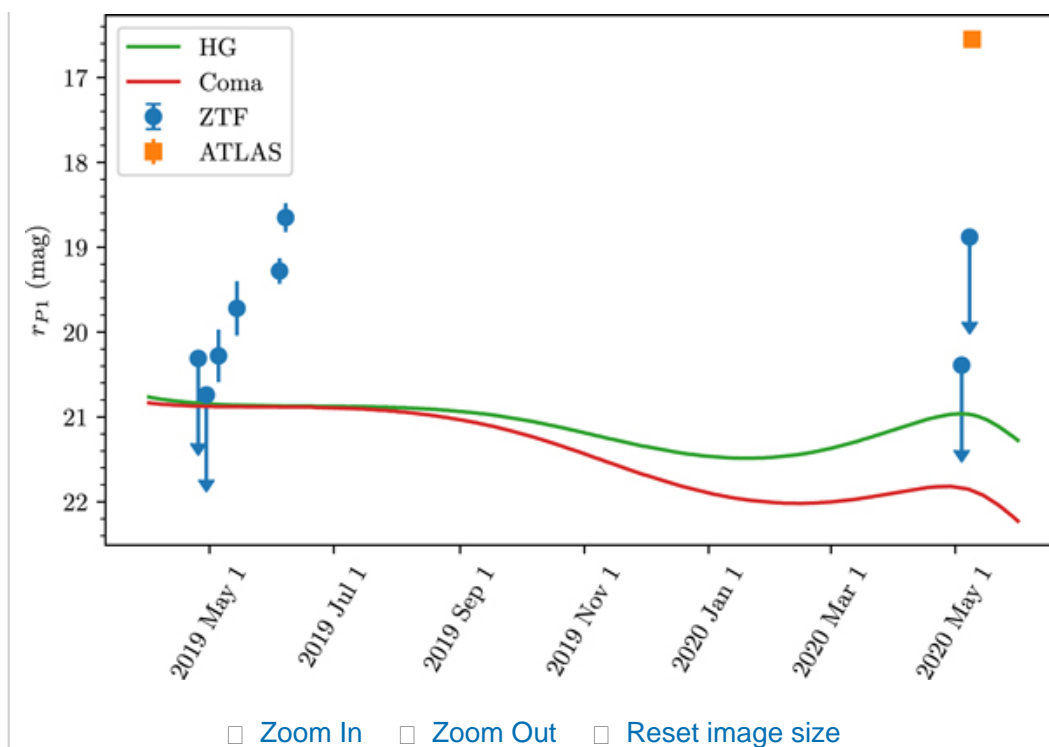


Figure 1. The composite lightcurve of P/2019 LM₄ made using the ZTF detections and 5 σ upper limits. The ATLAS detection on 2020 May 9 at $r_{P1} = 16.8$ is also shown for reference. Also shown are the HG model and a coma model computed using the Halley–Marcus phase function. The ZTF photometry is available as the Data behind the Figure. (The data used to create this figure are [available](#).)

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Precovery detections are identified on images taken on 2019 May 5 and 14, but not on images taken on 2019 April 29 or earlier. It can be concluded that the comet had brightened by at least 2 mag around the end of April to early May of 2019, when it was at ~ 2.4 au from the Sun or ~ 50 days before perihelion. As shown in Figure 1, a normal comet would have largely remained at a constant apparent magnitude over this period. In 2020, the most recent pre-discovery ZTF field that covers the uncertainty ellipse of the comet, taken on UT 2020 May 8.31, reveals no comet. The first detection was made by the Asteroid Terrestrial-Impact Last Alert System (ATLAS) program (Tonry et al. 2018) on UT 2020 May 9.52 UTC. This suggests an outburst onset between May 8.31 and 9.52 UTC, with a strength of at least 3.9 mag, corresponding to a phase-corrected $Af\rho \approx 16 \pm 2$ cm. The

outburst happened when the comet was at a heliocentric distance of 3.50 au, 325 to 326 days after perihelion.

Based on observations obtained with the Samuel Oschin Telescope 48 inch at the Palomar Observatory as part of the Zwicky Transient Facility project. ZTF is supported by the National Science Foundation under grant No. AST-1440341 and a collaboration including Caltech, IPAC, the Weizmann Institute for Science, the Oskar Klein Center at Stockholm University, the University of Maryland, the University of Washington, Deutsches Elektronen-Synchrotron and Humboldt University, Los Alamos National Laboratories, the TANGO Consortium of Taiwan, the University of Wisconsin at Milwaukee, and Lawrence Berkeley National Laboratories. Operations are conducted by COO, IPAC, and UW.



Facility: PO:1.2 m. -

Software: `sbgpy` (Mommert et al. [2019](#)), `zChecker` (Kelley et al. [2019](#)).

Footnotes

- 7 See Minor Planet Electronic Circular 2020-J68:
<https://www.minorplanetcenter.net/mpec/K20/K20J68.html>, as well as
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