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Cometary Activity on Quasi-Hilda Object 2018 CZ16

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Abstract

We present the discovery of activity originating from quasi-Hilda Object 2018 CZ_{16}, a finding stemming from the Citizen Science project *Active Asteroids*. For 2018 CZ_{16} we identified a broad (~60°) but short (~5'') tail in archival Blanco 4m data from Cerro Tololo Inter-American Observatory, Chile, (CTIO) Dark Energy Camera images from UT 2018 May 15, 17 and 18. Activity occurred 2 months prior to perihelion, consistent with sublimation-driven activity.

1. Introduction

Active asteroids are rare (~50) bodies that are found in orbits not normally associated with comets, yet they display comet-like activity such as a tails or comae (Jewitt et al. 2015). A subset (~20) of the known active asteroids display comet-like activity indicative of volatile sublimation, such as recurrent activity near perihelion (Hsieh et al. 2015). Such bodies in the main asteroid belt are often referred to as Main Belt Comets but other related and more dynamically unstable classes such as the quasi-Hilda objects (QHOs) have also shown similar activity (Oldroyd et al. 2023). Objects with recurrent activity associated with perihelion are plausibly driven by water ice and unveil the present-day volatile distribution in the solar system, potentially yielding clues to the primordial origins of terrestrial water. To date, we have found only one epoch of activity for 2018 CZ_{16} near perihelion, but we encourage future observations of the object in 2024 to identify whether the activity is recurrent.

2. Methods

Our main thesis is that there are many more known asteroids with heretofore unrecognized tails in public image databases. To find more active objects, we created the Citizen Science project *Active Asteroids* [13] (Chandler et al. 2018, 2019, 2020, 2021, 2022; Chandler 2022) where volunteers examine images of known minor planets we extract from publicly available Dark Energy Camera (DECam) data and classify these images as either active or inactive. To date, about ~7500 volunteers have made ≳5 million classifications from our project. Volunteers classified images of 2018 CZ_{16} as active, and we subsequently carried out a more detailed archival investigation to further study this object.

3. Results

We identified three archival images of 2018 CZ_{16} (semimajor axis a=3.54au, eccentricity e=0.34, inclination i=13.°7, perihelion distance q=2.27au, aphelion distance Q=4.64au;JPL Horizons Solution date 2021 April 15 20:22:55, Giorgini et al. 1996) with unambiguous indications of emission activity in the form of a broad tail (~60°) about 5'' in length. This tail does not appear to be clearly aligned with either the anti-motion or anti-solar directions (Figure 1). The orbital

parameters of 2018 CZ_{16} suggest that it is a member of the QHO class, which is a dynamical class of minor planet near, but not in, the Hilda asteroid family. We compute that 2018 CZ_{16} has Jovian Tisserand parameter T_J=2.994 and an orbital excitation parameter , similar to, but somewhat outside of the QHO definition found in Toth (2006).

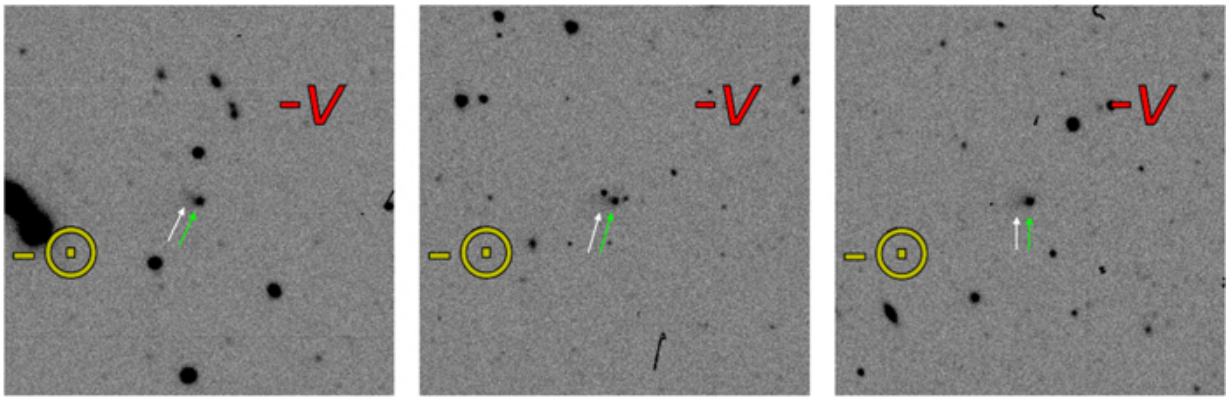

Figure 1. 2018 CZ_{16} (green arrow) displays a broad tail (white arrow) which is not aligned with either the anti-motion (–*v*) direction nor the anti-solar (–⊙) direction in these images from DECam. The field of view is about 126''×126'' and North is up and East is left. Left: 103s *r*-band, UT 2018 May 15 (Program 2014B-0404, PI Schlegel, Observers E. Savary, A Prakash). Middle: 90s *g*-band, UT 2018 May 17 (Program 2014B-0404, PI Schlegel, Observers E. Savary, A Prakash). Right: 200s *g*-band, UT 2018 May 18 (Program 2014B-0404, PI Schlegel, Observer E. Savary).

We identified other archival images from 2014 and 2018 showing hints of activity, but these were considerably poorer than the images in Figure 1, so were considered inconclusive. We encourage observers to explore this object in 2024 when it approaches opposition (late February) and as it once again approaches perihelion (late November) to determine if activity is indeed correlated with perihelion. Repeated perihelion activity, especially with a quiescent state near aphelion, would suggest that 2018 CZ_{16} has thermally driven activity indicative of water-ice sublimation, a mechanism of significant scientific interest (Hsieh & Jewitt 2006).

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Astrometry facilitated by *Astrometry.net* (Lang et al. 2010). This research has made use of NASA's ADS, the Institut de Mécanique Céleste et de Calcul des Éphémérides SkyBoT Virtual Observatory tool (Berthier et al. 2006), and data services provided by the International Astronomical Union's Minor Planet Center, and SAOImageDS9, developed by Smithsonian Astrophysical Observatory (Joye 2006).

This project used data obtained with DECam, which was constructed by the Dark Energy Survey collaboration. This research used the Astro Data Archive at NSF's NOIRLab and is based on observations from CTIO (NOIRLab Prop. ID 2014B-0404; PI Schleigel).

Facility: CTIO:4 m (DECam). -

*Software:*astropy (Robitaille et al. 2013), Matplotlib (Hunter 2007), NumPy (Harris et al. 2020), pandas (Reback et al. 2022), SAOImageDS9 (Joye 2006), SciPy (Virtanen et al. 2020).

Footnotes

13 http://www.activeasteroids.net