RNAAS RESEARCH NOTES OF THE AAS

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To cite this article: Colin Orion Chandler *et al* 2023 *Res. Notes AAS* **7** 27

Draft version February 7, 2023
Typeset using LaTeX default style in AASTeX631

New Active Asteroid 2015 VA108: A Citizen Science Discovery

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ABSTRACT

We announce the discovery of activity, in the form of a distinct cometary tail, emerging from main-belt asteroid 2015 VA_{108}. Activity was first identified by volunteers of the Citizen Science project Active Asteroids (a NASA Partner). We uncovered one additional image from the same observing run which also unambiguously shows 2015 VA_{108} with a tail oriented between the anti-solar and anti-motion vectors that are often correlated with activity orientation on sky. Both publicly available archival images were originally acquired UT 2015 October 11 with the Dark Energy Camera (DECam) on the Blanco 4 m telescope at the Cerro Tololo Inter-American Observatory (Chile) as part of the Dark Energy Camera Legacy Survey. Activity occurred near perihelion and, combined with its residence in the main asteroid belt, 2015 VA_{108} is a candidate main-belt comet, an active asteroid subset known for volatile sublimation.

Keywords: Asteroid belt (70), Asteroids (72), Comae (271), Comet tails (274)

1. INTRODUCTION

Roughly 40 active asteroids have been discovered to date and, consequently, much about these objects remains unknown. Known for their unexpected display of cometary activity (i.e., tails, comae) despite being on asteroidal orbits (e.g., main-belt), active asteroids provide unique insights into dynamical, thermophysical, and astrochemical processes (Jewitt et al. 2015). Some bodies exhibit activity caused by volatile sublimation, such as the Main-belt comets (MBCs) found in the asteroid belt (Hsieh et al. 2015), and thus help us map the distribution of volatiles in the solar system. MBCs are also rare, with fewer than 15 identified thus far. With so few active asteroids and MBCs known, discovering additional active asteroids is crucial to gaining additional insights into these remarkable populations.

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2. METHODS

Active Asteroids[1], a NASA Partner program, is an online Citizen Science project (hosted on the Zooniverse[2] platform) that we created for the purpose of identifying more unusual active minor planets while engaging the public in the search (Chandler 2022). Volunteers of the project look through images of small solar system bodies that we previously extracted from Dark Energy Camera (DECam) publicly available archival image data (Chandler et al. 2018, 2019, 2020, 2021, 2022). We ask participants if they see activity or not, and we analyze their classification data to identify candidate objects. As of UT 2023 February 6, approximately 7,000 volunteers have carried out over 2.5 million classifications since the project launch in 2021 August, and our team has been consistently following up on promising candidates.

3. RESULTS

Active Asteroids volunteers identified an image of 2015 VA_{108} (semi-major axis $a = 3.13$ au, eccentricity $e = 0.22$, inclination $i = 8.50°$, perihelion distance $q = 2.45$ au, aphelion distance $Q = 3.81$ au, Tisserand parameter with respect to Jupiter $T_J = 3.160$; retrieved UT 2023 January 27 from JPL Horizons; Giorgini et al. 1996) as showing activity. Our team carried out additional searches through archival image data and found one additional image of 2015 VA_{108} acquired during the same observing run as the image that prompted our study.

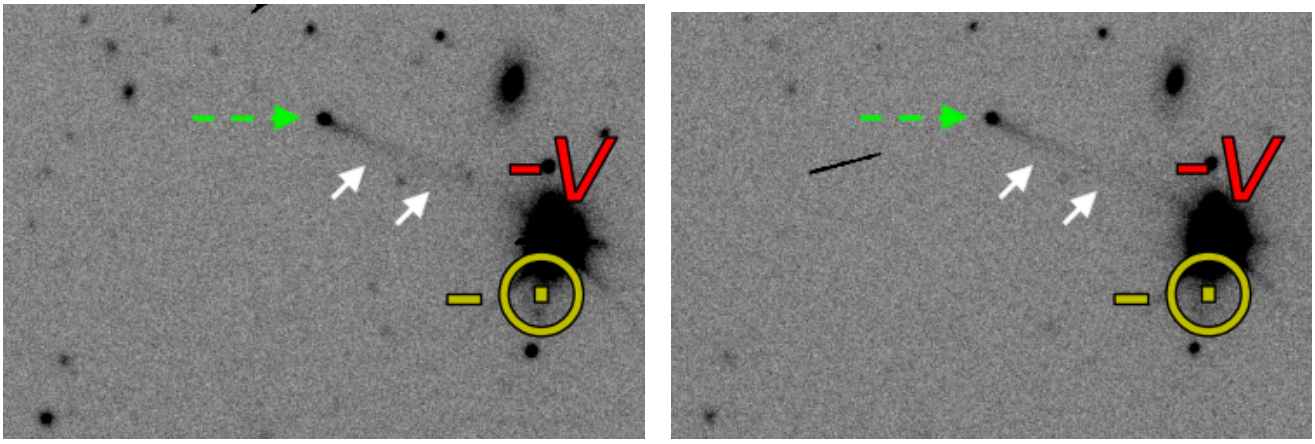

Figure 1. 2015 VA_{108} (dashed arrow) with a pronounced tail (white arrows) oriented between the anti-motion ($-v$) and anti-solar ($-\odot$) directions. These 114 s r-band (left) and 125 s g-band (right) DECam images were captured with the Blanco 4 m telescope (Cerro Tololo Inter-American Observatory, Chile) on UT 2015 October 11 (Program 2014B-0404, PIs Schlegel and Dey, observers D. James, A. Dey, A. Patej).

Figure 1 shows 2015 VA_{108} with a conspicuous tail approximately oriented between the anti-solar and anti-motion vectors as projected on the plane of the sky. At the time (UT 2015 October 11), 2015 VA_{108} was at a heliocentric distance $r_h = 2.44$ au, outbound from its recent perihelion passage. 2015 VA_{108} qualifies as an MBC candidate because (1) activity occurred near perihelion, and (2) 2015 VA_{108} has an orbit bound to the main asteroid belt.

[1] http://activeasteroids.net

[2] https://www.zooniverse.org

ACKNOWLEDGEMENTS

General: Many thanks to Dr. Mark Jesus Mendoza Magbanua (University of California San Francisco) for continued feedback about the project and its findings.

Citizen Science: We thank Elizabeth Baeten (Belgium) for moderating the Active Asteroids forums. We thank our NASA Citizen Scientists that examined 2015 VA_{108}: Al Lamperti (Royersford, USA), Melany Van Every (Lisbon, USA), Michele T. Mazzucato (Florence, Italy), Milton K. D. Bosch, MD (Napa, USA), Nazir Ahmad (Birmingham, UK), Steven Green (Witham, UK), Tiffany Shaw-Diaz (Dayton, USA), and Timothy Scott (Baddeck, Canada). We also thank super-classifier Marvin W. Huddleston (Mesquite, USA). Many thanks to Cliff Johnson (Zooniverse) and Marc Kuchner (NASA) for their ongoing guidance.

Funding: This material is based upon work supported by the NSF Graduate Research Fellowship Program under grant No. 2018258765 and grant No. 2020303693. C.O.C., H.H.H., and C.A.T. acknowledge support from the NASA Solar System Observations program (grant 80NSSC19K0869). W.J.O. acknowledges support from NASA grant 80NSSC21K0114. This work was supported in part by NSF awards 1950901 (NAU REU program in astronomy and planetary science). Computational analyses were run on Northern Arizona University's Monsoon computing cluster, funded by Arizona's Technology and Research Initiative Fund.

Software & Services: World Coordinate System corrections facilitated by *Astrometry.net* (Lang et al. 2010). This research has made use of NASA's Astrophysics Data System, the Institut de Mécanique Céleste et de Calcul des Éphémérides SkyBoT Virtual Observatory tool (Berthier et al. 2006), and data and/or services provided by the International Astronomical Union's Minor Planet Center, SAOImageDS9, developed by Smithsonian Astrophysical Observatory (Joye 2006).

Facilities & Instrumentation: This project used data obtained with the Dark Energy Camera (DECam), which was constructed by the Dark Energy Survey (DES) collaboration. This research uses services or data provided by the Astro Data Archive at NSF's NOIRLab. Based on observations at Cerro Tololo Inter-American Observatory, NSF's NOIRLab (NOIRLab Prop. ID 2014B-0404; PI: D. Schlegel). The Legacy Surveys consist of three individual and complementary projects: the DECam Legacy Survey (DECaLS; Proposal ID #2014B-0404; PIs: David Schlegel and Arjun Dey), the Beijing-Arizona Sky Survey (BASS; NOAO Prop. ID #2015A-0801; PIs: Zhou Xu and Xiaohui Fan), and the Mayall z-band Legacy Survey (MzLS; Prop. ID #2016A-0453; PI: Arjun Dey).

Facilities: CTIO:4m (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)

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