OPEN ACCESS

New Active Quasi-Hilda Asteroid 2004 CV50: A Citizen Science Discovery

Colin Orion Chandler[1,2,3], William J. Oldroyd[3], Chadwick A. Trujillo[3], William A. Burris[3,4], Henry H. Hsieh[5,6], Jay K. Kueny[16,3,7,8], Kennedy A. Farrell[3], Jarod A. DeSpain[3], Nima Sedaghat[1], Mark Jesus Mendoza Magbanua[9]

+ Show full author list

Research Notes of the AAS, Volume 7, Number 11

Citation Colin Orion Chandler *et al* 2023 *Res. Notes AAS* **7** 237

DOI 10.3847/2515-5172/ad09c1

coc123@uw.edu

[1] Department of Astronomy & the DiRAC Institute, University of Washington, 3910 15th Ave NE, Seattle, WA 98195, USA; coc123@uw.edu

[2] LSST Interdisciplinary Network for Collaboration and Computing, 933 N. Cherry Avenue, Tucson, AZ 85721, USA

[3] Department of Astronomy & Planetary Science, Northern Arizona University, P.O. Box 6010, Flagstaff, AZ 86011, USA

[4] Department of Physics, San Diego State University, 5500 Campanile Drive, San Diego, CA 92182, USA

[5] Planetary Science Institute, 1700 East Fort Lowell Rd., Suite 106, Tucson, AZ 85719, USA

[6] Institute of Astronomy and Astrophysics, Academia Sinica, P.O. Box 23-141, Taipei 10617, Taiwan

[7] University of Arizona Department of Astronomy and Steward Observatory, 933 North Cherry Avenue Rm. N204, Tucson, AZ 85721, USA

[8] Lowell Observatory, 1400 W Mars Hill Rd, Flagstaff, AZ 86001, USA

[9] Department of Laboratory Medicine, University of California San Francisco, 2340 Sutter Street, San Francisco, CA 94143, USA

[10] Department of Terrestrial Magnetism, Carnegie Institution for Science, 5241 Broad Branch Road. NW, Washington, DC 20015, USA

[11] Active Asteroids Citizen Scientist

[12] Royal Astronomical Society, Burlington House, Piccadilly, London, W1J 0BQ, UK

[13] Physical Sciences Group, Siena Academy of Sciences, Piazzetta Silvio Gigli 2, I-53100 Siena, Italy

[14] Delaware Valley Amateur Astronomers, 112 Pebble Beach Drive, Royersford, PA 19468, USA

[15] Astronomical Society of Southern Africa, P.O. Box 9 Observatory 7935, Cape Town, South Africa

[16] National Science Foundation Graduate Research Fellow.

Colin Orion Chandler https://orcid.org/0000-0001-7335-1715

William J. Oldroyd https://orcid.org/0000-0001-5750-4953

Chadwick A. Trujillo https://orcid.org/0000-0001-9859-0894

William A. Burris https://orcid.org/0000-0002-6023-7291

Henry H. Hsieh https://orcid.org/0000-0001-7225-9271

Jay K. Kueny https://orcid.org/0000-0001-8531-038X

Kennedy A. Farrell https://orcid.org/0000-0003-2521-848X

Jarod A. DeSpain https://orcid.org/0000-0002-7489-5893

Nima Sedaghat https://orcid.org/0000-0003-4734-2019

Mark Jesus Mendoza Magbanua https://orcid.org/0000-0003-2113-3593

Scott S. Sheppard https://orcid.org/0000-0003-3145-8682

Michele T. Mazzucato https://orcid.org/0000-0002-2204-6064

Milton K. D. Bosch https://orcid.org/0000-0002-9766-2400

Ivan A. Terentev https://orcid.org/0000-0002-0654-4442

1. Received October 2023
2. Accepted November 2023
3. Published November 2023

Asteroids; Comet tails; Comae

Journal RSS

Create or edit your corridor alerts

What are corridors?

Abstract

We report that minor planet 2004 CV_{50} displayed cometary activity in the form of a short, diffuse tail, first identified by volunteers of the Citizen Science program *Active Asteroids*, a NASA Partner program hosted on the *Zooniverse* online platform. The activity is present in three images, from UT 2020 February 15 and UT 2020 March 14, that were acquired with the Dark Energy Camera on the Blanco 4m telescope at the Cerro-Tololo Inter-American Observatory in Chile. We find that 2004 CV_{50} is most likely an active quasi-Hilda object rather than an active asteroid, despite 2004 CV_{50} having a Tisserand parameter with respect to Jupiter of 3.06.

Export citation and abstract BibTeX RIS

◀ **Previous** article in issue

Next article in issue ▶

---

1. Introduction

Minor planets that display comet-like activity, such as tails or comae, teach us about the solar system's volatile distribution, including the origins of terrestrial water (Hsieh et al. 2015). Minor planet populations aside from comets are known to exhibit activity, decreasing the distinction between comet and asteroid (see Jewitt & Hsieh 2022). Several populations with active members are known, such as active asteroids and active quasi-Hilda objects. While active asteroids are typically found in the asteroid belt, active quasi-Hildas are minor planets on orbits similar to the Hilda asteroids, but quasi-Hildas are not in stable 3:2 interior mean-motion-resonance with Jupiter. Like Hildas and Jupiter Trojans, quasi-Hildas are often identified through dynamical integration, an added challenge for distinguishing between populations. Aside from comets, active small-body populations are rare, with fewer than 100 known among the 1.3 million minor planets identified to date.

2. Methods

To locate more of these elusive objects we created the *Zooniverse*-hosted Citizen Science program *Active Asteroids*, [17] a NASA Partner (Chandler 2022). We show volunteers images of minor planets we extracted from archival Dark Energy Camera (DECam) images and ask if they see evidence of activity, such as a tail or coma. We investigate volunteer-highlighted activity candidates by searching through astronomical image archives as well as conducting telescope follow-up, when possible.

For dynamical classification, we make use of the Tisserand parameter with respect to Jupiter,

where a and a_J are the semimajor axes of 2004 CV_{50} and Jupiter, e is orbital eccentricity, and i is inclination. Bodies with $T_J<3$ are nominally cometary (Levison 1996), though $T_J=3.08$ is also used (Jewitt et al. 2015). In practice, $3.05<T_J<3.10$ is an ambiguous parameter space (Hsieh & Haghighipour 2016) that requires modeling to distinguish between, for example, Jupiter Family Comets and Hilda asteroids. We make use of the REBOUND *N*-body integration package (Rein & Liu 2012) for this purpose (Chandler et al. 2022; Oldroyd et al. 2023).

3. Results

Figure 1 shows 2004 CV_{50} with a diffuse tail on two different dates. On UT 2020 February 15 (one image), 2004 CV_{50} was at a heliocentric distance of $r_H=1.68$au and a true anomaly angle of $f=343°$. On UT 2020 March 14 (two images) 2004 CV_{50} was at $r_H=1.66$au and $f=359°$, essentially at perihelion. For both dates, the tail orientation was in the anti-motion direction. In February the anti-solar and anti-motion directions were coincident.

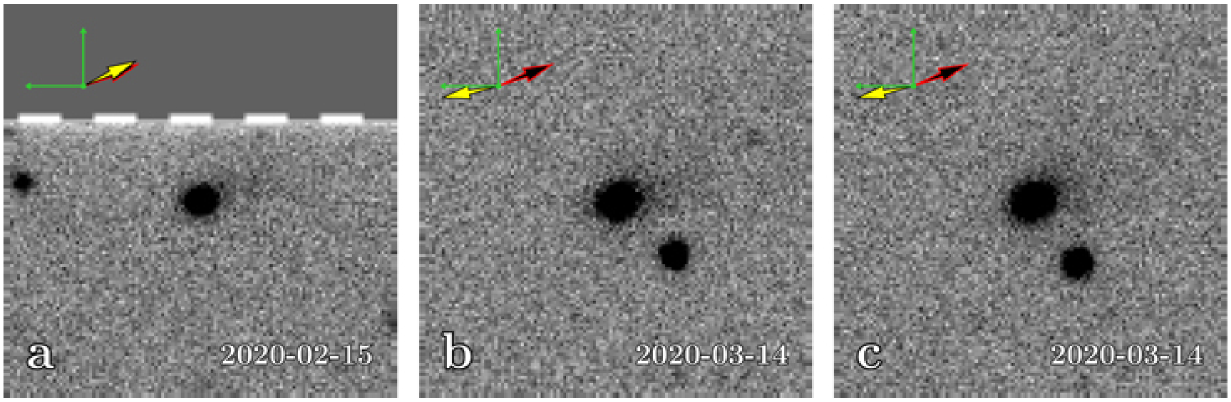

Figure 1. 2004 CV_{50} (at center) with a short, diffuse tail in these 120s *i*-band DECam exposures (Prop. ID 2020A-0399, PI Zenteno, observer A. Diaz). Anti-motion (yellow arrow) and anti-solar (red-bordered black arrow) directions are indicated. The FOV is 32''× 32'', with north up and east left. (a) UT 2020 February 15 at 08:47:22. (b) UT 2020 March 14 at 06:40:53. (c) UT 2020 March 14 at 06:44:38.

2004 CV_{50} (a=3.113au, e = 0.438, i=1.413°, perihelion distance q=1.748au, aphelion distance Q= 4.478au;retrieved UT 2023 September 22 from JPL) has T_J=3.061, typically indicating an asteroidal orbit. However, 2004 CV_{50} experiences close encounters with Jupiter, most recently 1.1 au on UT 2022 May 28, and our dynamical integrations indicate 2004 CV_{50} is an active quasi-Hilda. Along with 282P (Chandler et al. 2022), 2009 DQ_{118} (Oldroyd et al. 2023), and 2018 CZ_{18} (Trujillo et al. 2023), 2004 CV_{50} represents the fourth active quasi-Hilda identified via the *Active Asteroids* program.

Acknowledgments

Many thanks to Arthur and Jeanie Chandler for their ongoing support.

We thank Elizabeth Baeten (Belgium) for moderating the *Active Asteroids* forums. We thank our NASA Citizen Scientists who examined 2004 CV_{50}: Al Lamperti (Royersford, USA), Angelina A. Reese (Sequim, USA), Dr.Brian Leonard Goodwin (London, UK), C. D'silva (Mumbai, India), Carl L. King (Ithaca, USA), Clara Garza (West Covina, USA), Dan Crowson (Dardenne Prairie, USA), Dawn Boles (Bakersfield , USA), Eric Fabrigat (Velaux, France), Graeme Aitken (Towen Mountain, Australia), Ivan A. Terentev (Petrozavodsk, Russia), Leah Mulholland (Peoria, Illinois, USA), Melina Thévenot (Belgium), Michele T. Mazzucato (Florence, Italy), Milton K. D. Bosch, MD (Napa, USA), Rosemary Billington (Wilmslow, UK), Somsikova Liudmila Leonidovna (Chirchik, Uzbekistan), Thorsten Eschweiler (Übach-Palenberg, Germany), Tiffany Shaw-Diaz (Dayton, USA), Tomasz Konecki (Warsaw, Poland), Virgilio Gonano (Udine, Italy), Washington Kryzanowski (Montevideo, Uruguay), and @WRSunset (Shaftesbury, UK).

Many thanks to Cliff Johnson (Zooniverse), Marc Kuchner (NASA), and Chris Lintott (Oxford) for their ongoing guidance.

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 award 1950901. LINCC Frameworks is supported by Schmidt Futures, a philanthropic initiative founded by Eric and Wendy Schmidt, as part of the Virtual Institute of Astrophysics. Chandler acknowledges support from the DiRAC Institute in the Department of Astronomy at the University of Washington. The DiRAC Institute is supported through generous gifts from the Charles and Lisa Simonyi Fund for Arts and Sciences, and the Washington Research Foundation.

Computational analyses were run on Northern Arizona University's *Monsoon* computing cluster, funded by Arizona's Technology and Research Initiative Fund. This research has made use of NASA's Astrophysics Data System, and data and/or services provided by the International Astronomical Union's Minor Planet Center. 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).

Facility: CTIO:4m (DECam) - .

Software: astropy (Robitaille et al. 2013), astrometry.net (Lang et al. 2010), REBOUND (Rein & Liu 2012) SAOImageDS9, SkyBot (Berthier et al. 2006).

Footnotes

17 http://activeasteroids.net