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A Jupiter-family Comet Discovery via Citizen Science: 2005 XR132

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Abstract

We report the discovery of cometary activity associated with minor planet 2005 XR_{132}, a finding facilitated by our NASA Partner program *Active Asteroids*, hosted on the Zooniverse online Citizen Science platform. Volunteers identified activity in a Dark Energy Camera image of 2005 XR_{132} from UT 2021 March 26, and our own investigation uncovered additional images of activity in Zwicky Transient Facility data spanning UT 2021 January 3 through March 31. 2005 XR_{132} has a semimajor axis a=3.760au, eccentricity e = 0.432, inclination i=14.°474, and a Tisserand parameter with respect to Jupiter of T_J = 2.869, and thus is dynamically classified as a Jupiter-family comet.

1. Introduction

Active Asteroids [15] is a Citizen Science program created primarily to identify active asteroids—objects that exhibit cometary activity (e.g., a tail) despite being on orbits normally associated with asteroids. Our program also discovers other active bodies, including Jupiter-family comets (JFCs), that are dynamically distinct from main-belt asteroids. JFCs are typically defined as objects exhibiting cometary activity and having Tisserand parameter values with respect to Jupiter $2<T_J<3$ (e.g., Levison 1996). While it can be determined whether a newly discovered object meets the latter requirement as soon as its orbit is determined, activity may not be discovered until a later date. In the interim, such objects are simply classified as asteroids, or sometimes Asteroids in Cometary Orbits (Licandro et al. 2006).

2. Methods

Fewer than 50 of the >1 million known asteroids have been observed to show activity, so our Citizen Science program *Active Asteroids* is designed to find these rare objects. We show volunteers images of minor planets we extracted from Dark Energy Camera (DECam) data and ask if they see evidence of activity, such as a tail or coma (Chandler et al. 2018; Chandler 2022). For activity candidates we (a) search astronomical image archives, (b) carry out follow-up observations, and (c) report positive results (e.g., Chandler et al. 2023; Oldroyd et al. 2023; Trujillo et al. 2023).

Distinguishing between asteroids and comets has become increasingly nuanced (see Jewitt & Hsieh 2022), but a widely adopted dynamical criterion is the Tisserand parameter with respect to Jupiter, T_J, which describes the relative influence of Jupiter on an object's orbit:

Here a and a_J are the semimajor axes of 2005 XR_{132} and Jupiter. Dynamically, objects with $T_J>3$ are nominally asteroidal, and objects with $2<T_J<3$ are considered JFC-like (Levison 1996).

3. Results

We identified 11 images where 2005 XR_{132} showed activity: one from DECam, and 11 from Zwicky Transient Facility (ZTF) (10 r-band, 1 g-band). These images (Figure 1) show a fan-shaped tail oriented between the negative heliocentric velocity and anti-solar vectors as projected on the sky. At the time, 2005 XR_{132} had recently passed perihelion (UT 2020 November 26), ranging in heliocentric distance $2.2\lesssim r_h \lesssim 2.2$au, and true anomaly from $25°\lesssim v\lesssim °$. 2005 XR_{132} has $T_J=2.869$ and thus is dynamically classified as a JFC.

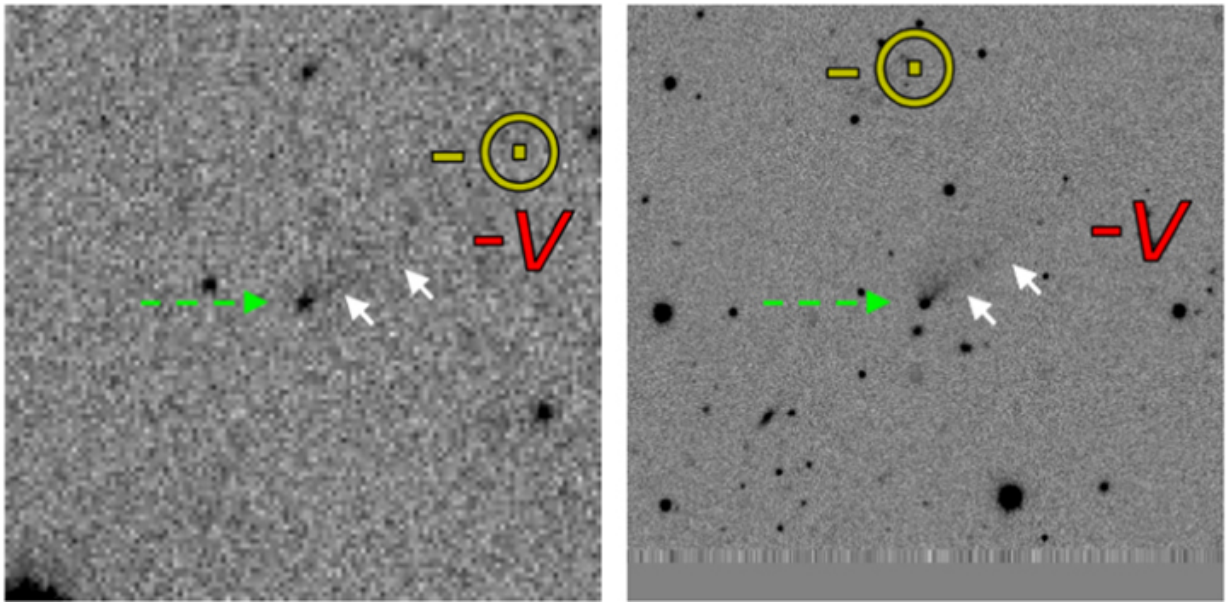

Figure 1. 2005 XR_{132} (green dashed arrows) with a tail (white arrows) oriented between the anti-solar (−⊙) and anti-motion (−*v*) directions as projected on sky. Left: UT 2021 February 8 30s *r*-band exposure (48'' Samuel Oschin telescope, Mt. Palomar, California) during the ZTF survey. Right: 105s *i*-band DECam exposure acquired UT 2021 March 26 with DECam (4m Blanco Telescope, Cerro Tololo Inter-American Observatory, Chile; Prop. ID 2021A-0149, PI Zenteno).

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This research has made use of NASA's Astrophysics Data System, the NASA/IPAC Infrared Science Archive, 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.

This project used data obtained with the Dark Energy Camera, which was constructed by the Dark Energy Survey 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: 2021A-0149; PI: Zenteno), ZTF (Bellm et al. 2019), and the CADC Solar System Object Information Search (Gwyn et al. 2012).

Facilities: CTIO:4 m (DECam) - , IRSA - , [16] PO:1.2 m (ZTF).

Software: astropy (Robitaille et al. 2013), SkyBot (Berthier et al. 2006).

Footnotes

15 http://activeasteroids.net

16 https://www.ipac.caltech.edu/doi/irsa/10.26131/IRSA539