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Citizen Science Discovery of a Recurrently Active Jupiter-Family Comet: (551023) 2012 UQ192

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Published December 2023 • © 2023. The Author(s). Published by the American Astronomical Society.

Research Notes of the AAS, Volume 7, Number 12

Citation Jarod A. DeSpain *et al* 2023 *Res. Notes AAS* **7** 257

DOI 10.3847/2515-5172/ad0ed6

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1. Received November 2023

2. Accepted November 2023

3. Published December 2023

Asteroids; Comet tails; Comet dynamics; Short period comets; Astronomy data analysis

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Abstract

We have discovered evidence of cometary activity originating from (551023) 2012 UQ₁₉₂ (alternately designated 2019 SN₄₀), which we dynamically classify as a Jupiter Family Comet (JFC). JFCs have eccentric Jupiter-crossing orbits and originate in the Kuiper Belt. Analysis of these objects can provide vital information about minor planets in the outer solar system, such as the distribution of volatiles within the solar system. Activity on 2012 UQ₁₉₂ was first recognized by volunteers on our NASA Partner Citizen Science project *Active Asteroids*. Through our own examination of archival image data, we found a total of ~30 images presenting strong evidence of activity near perihelion during two separate orbits. 2012 UQ₁₉₂ is notable as we found it to be recurrently active. When 2012 UQ₁₉₂ approaches its perihelion passage in 2027 September, we predict it will reactivate and will be a prime subject for follow-up observations.

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1. Introduction

Jupiter Family Comets (JFCs) are minor planets that have a Tisserand parameter relative to Jupiter $2 < T_J < 3$ (Levison 1996). (551023) 2012 UQ₁₉₂ (alternately designated 2019 SN₄₀), discovered in 2005, is one such object. JFCs likely originate from the Kuiper Belt, having been thrust into the inner solar system due to the gravitational influence of Neptune (Lowry et al. 2008). Since activity exhibited by JFCs is often caused by volatile sublimation, observations of JFCs give us insight into the solar system's volatile distribution. (Cheng et al. 2015).

2. Methods

Since objects exhibiting cometary activity are relatively rare, we solicit assistance from Citizen Science volunteers via our NASA Partner program *Active Asteroids* to help us find more of these objects. Using images we extracted from archival Dark Energy Camera (DECam) data, volunteers

sift through images of minor planets, classifying whether they see activity or not (Chandler et al. 2018, 2019, 2020, 2021; Chandler 2022) . When volunteers flag an object as active, we cross-reference archival images and conduct follow-up observations using telescopes for verification. Since the project's launch in 2021 August, over 8500 volunteers have completed 6.9 million classifications.

3. Results

Active Asteroid volunteers classified one image (Figure 1) of 2012 UQ₁₉₂ (semimajor axis $a=3.69$ au, eccentricity $e=0.48$, inclination $i=16^\circ 6'$, perihelion distance $q=1.92$ au, aphelion distance $Q=5.47$ au, Tisserand parameter with respect to Jupiter $T_J=2.82$, retrieved UT 2023 August 23 from JPL Horizons; Giorgini et al. 1996) originally acquired UT 2014 April 30, as exhibiting activity. Through further searches of archival image data, we found evidence of activity on 2012 UQ₁₉₂ during two separate orbits. We found ~ 4 images acquired UT 2014 April 30–May 5 (true anomaly angle $96^\circ 4' < f < 97^\circ 3'$) that showed a distinct tail pointed in the anti-motion direction. Additionally, we found >20 archival Zwicky Transient Facility (ZTF) images showing activity between UT 2020 November 4–2021 May 5 ($36^\circ 7' < f < 89^\circ 9'$). In both cases the object was outbound from a recent perihelion passage. Given the recurrent activity near perihelion and its eccentric Jupiter-crossing orbit, with $T_J=2.82$, we classify 2012 UQ₁₉₂ as a JFC. 2012 UQ₁₉₂ is currently outbound (on UT 2023 November 1 $f=173^\circ$), and will reach perihelion on UT 2027 September 15.

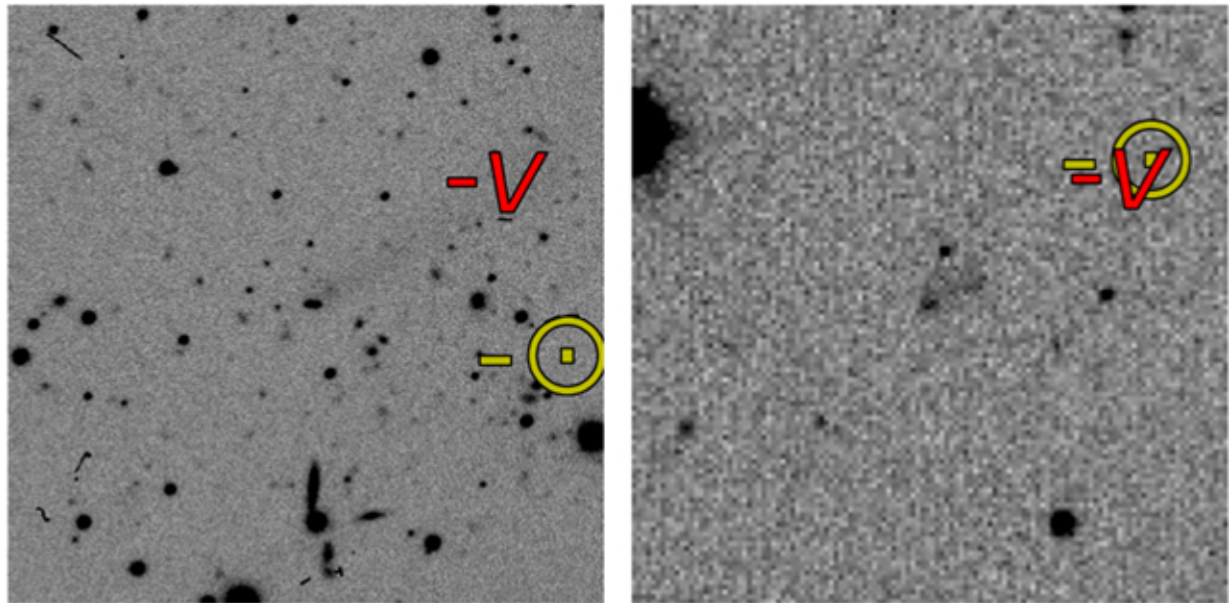


Figure 1. Two images of 2012 UQ₁₉₂. The fields of view are 126'' $\times$ 126'', with north up and east left. Left: UT 2014 April 30, 90s VR-band image taken with the DECam on the 4m Blanco telescope (Cerro Tololo Inter-American Observatory, Chile; Prop. ID 2014A-0283, PI Trilling, observers D. Trilling, L. Allen, J. Rajagopal, T. Axelrod). A clear tail is present, oriented on-sky roughly toward the anti-motion (red $-v$) direction and pointed toward 2 o'clock. Right: UT 2020 November 12, 30s r -band ZTF image taken by the 1.22m Samuel Oschin Telescope (Palomar Observatory, USA) shows a diffuse tail pointed toward the coinciding anti-motion and anti-solar (yellow $-☉$) vectors.

Acknowledgments

We thank Arthur and Jeanie Chandler for their ongoing support.

We thank Elizabeth Baeten (Leuven, Belgium) for moderating the Active Asteroids forums. We thank our NASA Citizen Scientists who examined 2012 UQ₁₉₂: Al Lamperti (Royersford, USA), Brian K. Bernal (Greeley, USA), Dr. Brian Leonard Goodwin (London, UK), Dan Crowson (Dardenne Prairie, USA), Elisabeth Baeten (Leuven, Belgium), Eric Fabrigat (Velaux, France), Graeme Aitken (Town Mountain, Australia), Graham Mitchell (Chilliwack, Canada), Ivan A. Terentev (Petrozavodsk, Russia), Jayanta Ghosh (Purulia, India), Marvin W. Huddleston (Mesquite, USA), Michele T. Mazzucato (Florence, Italy), Milton K. D. Bosch MD (Napa, USA), Panagiotis J. Ntais (Philothai, Greece), Shelley-Anne Lake (Johannesburg, South Africa), Thorsten Eschweiler (Übach-

Palenberg, Germany), Tiffany Shaw-Diaz (Dayton, USA), Washington Kryzanowski (Montevideo, Uruguay), Zac Pujic (Brisbane, Australia), and @WRSunset (Shaftesbury, UK). Many thanks to Cliff Johnson (Zooniverse), Marc Kuchner (NASA), and Chris Lintott (Oxford) for their ongoing Citizen Science guidance.

C.O.C. 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. LINCC Frameworks is supported by Schmidt Futures, a philanthropic initiative founded by Eric and Wendy Schmidt, as part of the Virtual Institute of Astrophysics. 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 NASA grant 80NSSC19K0869. W.J.O. and C.A.T. acknowledge support from NASA grant 80NSSC21K0114. This work was supported in part by NSF awards 1950901. 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, the NASA/IPAC Infrared Science Archive, 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. Based on observations at Cerro Tololo Inter-American Observatory, NSF's NOIRLab (NOIRLab Prop. ID 2019B-1014; PI: F. Olivares).

Facilities: CTIO:4m (DECam) - , IRSA - ¹⁷ PO:1.2m (ZTF; Bellm et al. 2019).

Software: CADC Solar System Object Information Search (Gwyn et al. 2012), astrometry.net (Lang et al. 2010), SAOImageDS9 (Joye 2006), SkyBot (Berthier et al. 2006).

Footnotes

17 <https://www.ipac.caltech.edu/doi/irsa/10.26131/IRSA539>

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