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## New Active Asteroid (588045) 2007 FZ18

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## Abstract

We present evidence that, on UT 2018 February 15, main-belt asteroid (588045) 2007 FZ<sub>18</sub> displayed cometary activity in the form of two tails, one each in the anti-solar and anti-motion directions. Activity was first identified by volunteers of the NASA Partner program Active Asteroids, a Citizen Science program hosted on the Zooniverse platform, in an image acquired with the Dark Energy Camera on the Blanco 4 m telescope at the Cerro Tololo Inter-American Observatory in Chile. Notably, (588045) 2007 FZ<sub>18</sub> is inbound toward perihelion, so telescope observations are timely to detect a possible second activity outburst.

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## 1. Introduction

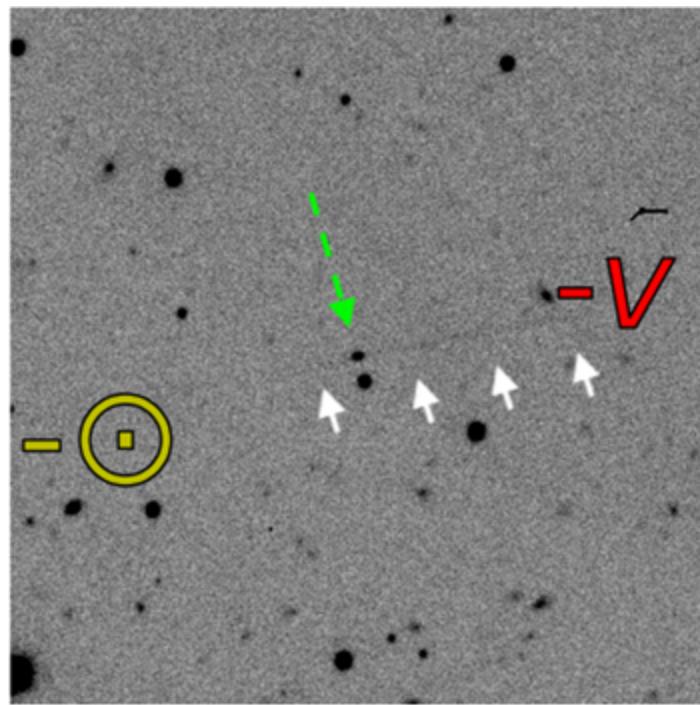
Active asteroids are small solar system bodies that display tail(s) and/or coma commonly associated with comets but, notably, active asteroids are found on orbits normally associated with asteroidal bodies such as main-belt asteroids (Jewitt et al. 2015). To date, active asteroids have remained poorly understood in part because of their paucity, with ~50 known. Moreover, multiple underlying processes can cause activity, including stochastic (e.g., impact) or recurrent (e.g., sublimation). While all activity teaches us about astrophysical processes, sublimation-driven active objects are especially important to locate as they help pinpoint the solar system volatile distribution, past and present. One rare (~20) active asteroid sub-population, the Main-belt comets (MBCs), orbit within the main asteroid belt and exhibit sublimation-driven activity (Hsieh et al. 2015).

## 2. Methods

In 2021 August we launched our NASA Partner program *Active Asteroids*<sup>13</sup> to search for more active minor planets with the help of volunteers on the Zooniverse Citizen Science platform (Chandler 2022). We show participants small images centered on known minor planets, and ask if they see evidence of activity. We extracted these images from publicly available Dark Energy Camera (DECam) data using our own pipeline designed for this purpose (Chandler et al. 2018, 2019, 2020, 2021, 2022).

## 3. Results

*Active Asteroids* volunteers classified an image (Figure 1) of (588045) 2007 FZ<sub>18</sub> (semimajor axis  $a = 3.18\text{au}$ , eccentricity  $e = 0.12$ , inclination  $i = 1^\circ 14'$ , perihelion distance  $q = 2.78\text{au}$ , aphelion distance  $Q = 3.57\text{au}$ ,  $T_J = 3.19$ , retrieved 2023 January 26 from JPL Horizons; Giorgini et al. 1996) as showing activity. A faint tail is seen in the anti-solar direction, and a more pronounced tail points toward the anti-motion vector. (588045) 2007 FZ<sub>18</sub> is a MBC candidate as it orbits within the asteroid belt and the activity occurred near perihelion.



**Figure 1.** (588045) 2007 FZ<sub>18</sub> (green dashed arrow) with a pronounced tail (white arrows) in the anti-motion (red  $-v$ ) direction and a faint tail (white arrow) in the anti-solar (yellow  $-\odot$ ) direction. This 60s VR-band image was taken with the DECam on the Blanco 4m telescope at CTIO (Chile) on UT 2018 February 15 (Program 2014B-0404, PI Schlegel, observer S. G. A. Gontcho). The FOV is about 126''  $\times$  126''.

Notably, (588045) 2007 FZ<sub>18</sub> is currently approaching perihelion, thus the object is an excellent target for observations to help determine if the object is recurrently active, an important diagnostic indicator of sublimation.

General: We thank Dr. Mark Jesus Mendoza Magbanua (University of California San Francisco) for his ongoing, timely feedback on 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 (588045) 2007 FZ<sub>18</sub>: Al Lamperti (Royersford, USA), Michele T. Mazzucato (Florence, Italy), Milton K. D. Bosch, MD (Napa, USA), Robert Bankowski (Sanok, Poland), Steven Green (Witham, UK), Tiffany Shaw-Diaz (Dayton, USA), and Timothy Scott (Baddeck, Canada). We also thank super-classifiers Ivan A. Terentev (Petrozavodsk, Russia) and Marvin W. Huddleston (Mesquite, USA) . Many thanks to Cliff Johnson (Zooniverse) and Marc Kuchner (NASA) for their ongoing Citizen Science guidance.

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**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 CTIO, NSF's NOIRLab (NOIRLab Prop. ID 2014B-0404; PI: D. Schlegel). The LBT is an international collaboration among institutions in the United States, Italy and Germany. The VATT referenced herein refers to the Vatican Observatory's Alice P. Lennon Telescope and Thomas J. Bannan Astrophysics Facility. We are grateful to the Vatican Observatory for the generous time allocations (Proposal ID S165, PI Chandler).

**Facilities:** CTIO:4 m (DECam) - , LBT (LBCB - , LBCR) - , VATT (VATT4K) -

**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://activeasteroids.net>

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