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# Six Years of Persistent Activity from Active Asteroid (6478) Gault

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## Abstract

We present archival observations of asteroid (6478) Gault that show this object has been persistently active since 2013. (6478) Gault is a member of the predominantly desiccated Phocaea asteroid family and, to date, no evidence of volatiles have been detected in the comae of (6478) Gault. As such it is unlikely the activity we observe is due to volatile sublimation. This main belt object may represent the first of a new class of active asteroid, persistently exhibiting comet-like activity due to rotational spin-up. However, given the multiple-epoch outburst history we observe in (6478) Gault, we do not expect it will catastrophically break apart.

## 1. Introduction

Active asteroids are unusual objects which appear dynamically asteroidal but exhibit comet-like features such as comae and tails (see Figure 1). In addition to appearing comet-like, active asteroids share a number of orbital characteristics (e.g., their orbits are interior to Jupiter); see [6] for an in-depth discussion. Main belt comets are an active asteroid subset whose activity is caused by volatile sublimation [11].

Because only ∼20 active asteroids are known to date they remain poorly understood. We know of so few in part because these objects are generally dark and faint. Moreover, the underlying causes behind activity outbursts are difficult to distinguish and are not necessarily mutually exclusive.

Volatile sublimation (e.g., 133P/Elst-Pizarro [4]) is particularly of interest because it tells us about water availability in our solar system. Perihelion passage is generally associated with increased activity in active asteroids (see [2] Table 1) but distance is not the only factor, as punctuated by the recent 27 au activity display of Comet C/2010 U3 (Boattini) [5].

Impact driven events (e.g., (596) Scheila [1]) are singular incidents which can eject material and/or expose volatiles to sublimation. Thermal fracture due to extreme temperature changes (e.g., (3200) Phaethon [9]) may also eject material or expose volatiles to sublimate, but recurrence is likely. Rotational breakup (e.g., 311P/PanSTARRS) occurs if an object spins fast enough to overcome gravitational and cohesive forces.

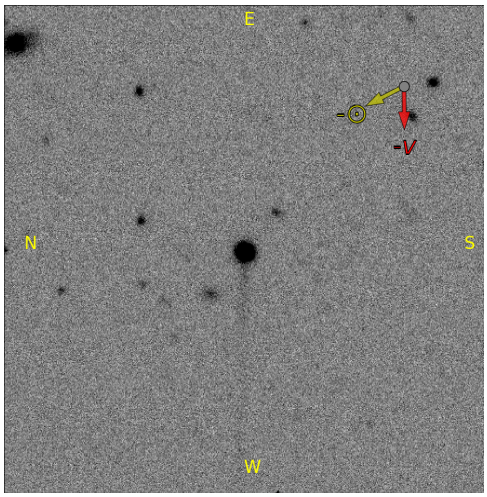


Figure 1: (6478) Gault displays a prominent tail (6 o'clock) during September 2013 when (6478) Gault was halfway between perihelion and aphelion. The 90 s $g$-band exposure was taken with the National Optical Astronomy Observatory Dark Energy Camera (DECam).Antisolar (-⊙) and anti-heliocentric velocity vectors (-$v$) are indicated by yellow and red arrows, respectively. See [3] for additional thumbnails.

## 2 Methods

We queried our own custom database containing DECam archival observation parameters (e.g., exposure time). We assessed *observability*, defined as when

(6478) Gault was visible (i.e., above the horizon at night) and at elevation $> 15°$. We then extracted thumbnail images which we visually inspected.

## 3 Results

We produced $\sim$30 thumbnail images of (6478) Gault from 9 separate observations. We saw activity in at least one image in each observation set.

## 4 Discussion

As a member of the predominately desiccated Phocaea family of asteroids it is unlikely the activity we see from (6478) Gault is due to volatile sublimation. Activity has been reported as multiple outbursts having begun as early as 2018 November [10] or 2018 December [12] but we find activity has been persistent for nearly six years. (6478) Gault is markedly brighter now than in our archival images. Rotational breakup due to spin-up may explain the observed activity [8]. This argument is supported by dust models [10] and a lack of gas signatures in spectral observations [7].

## 5. Summary and Conclusions

We present evidence of persistent activity from (6478) Gault dating back to 2013. As a probable desiccated S-type asteroid showing no signs of gas emission it is unlikely the observed activity originates from sublimation. The most plausible explanation is spin-up induced material ejection, for which (6478) Gault is the first of its kind in the main belt. The sustained activity coming from (6478) Gault is the longest outburst of its type known to date. We predict this new class of object, persistently active due to rotational spin-up, will continue to display activity for the foreseeable future, making it an ideal target for study.

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