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Characterization of Active Asteroid (6478) Gault

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Abstract

Active asteroids are interesting because they enable us to understand the transition population between inert asteroids and hyperactive comets. The composition and driver for activity on these active asteroids is a source of great debate in the scientific community. Here we report the results from our rotational and spectral characterization of main belt active asteroid (6478) Gault to understand the driving mechanism for its activity.

1. Background

Asteroid (6478) Gault is a <10 km-sized object located in the inner part of the main belt (a~2.3 AU) in the S-type Phocaea family. Observations obtained by the Zwicky Transient Facility (ZTF) survey showed that Gault experienced two brightening events, one on October 18, 2018 and the other on December 24, 2018 [1]. Images obtained by ATLAS on December 8, 2018 revealed that Gault became active, displaying a 30"-long tail at a position angle PA=290°. On January 5, 2019, new images of Gault obtained by ATLAS showed that the tail was measuring 135" long [2], and later that month a second dust tail was detected [3].

Based on ZTF photometric measurements, [1] suggested that the most likely scenarios to explain the activity of this asteroid were rotational excitation or merger of near-contact binaries. [4] obtained photometric data of Gault in order to determine its rotation period. However, the lightcurves showed no significant variation over time, which was attributed to the presence of dust around the asteroid, preventing a direct observation of its surface/shape. [5] observed Gault for 10 days in February 2019 and determined that it has a rotation period of ~ 2 h. They noticed that this value is close to the critical breakup limit of a rubble pile, suggesting that the dust emission was caused by disruption or landslides resulting from a YORP-induced rotational disturbance. [1] found that the broadband color of Gault was more similar to that of C-type asteroids than S-types. Gault has also been dynamically linked with the low-albedo Tamara family [5], which resides in the Phocaea region [6].

2. Results

Our team observed Gault in an attempt to verify the rotation period and determine its size and composition to confirm if the activity observed is due to rotational excitation on a low-albedo primitive asteroid as suggested by [1]. Based on three nights of observations, we could not confirm the rotation period of ~2 h for Gault, as no obvious variability in the lightcurves was found (Fig.1). A thermal model fit to WISE data yielded values of p_v=0.176±44%, and D=3.96±22% km for the geometric albedo and size, respectively. Near-infrared (NIR) spectroscopic data (0.7-2.5 μm) obtained with the Infrared Telescope Facility (IRTF) showed a spectrum similar to that of S-type asteroids (Fig.2).

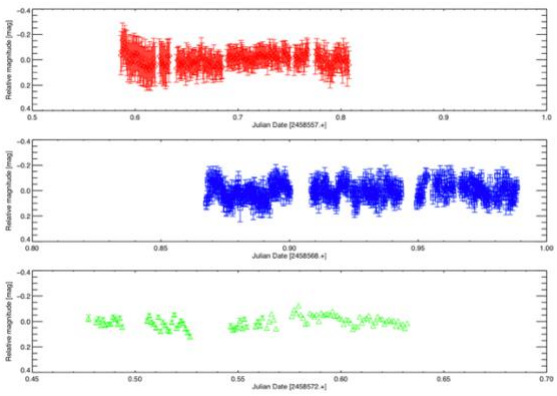

Figure 1. Lightcurves of (6478) Gault presented in chronological order. Top panel: Data obtained on March 15, 2019 with a 0.61m f/6.8 at the CTIO. Middle panel: IRTF MORIS data obtained on March

26. Bottom panel: Data obtained on March 30 with the SMARTS 1.0 m telescope at CTIO.

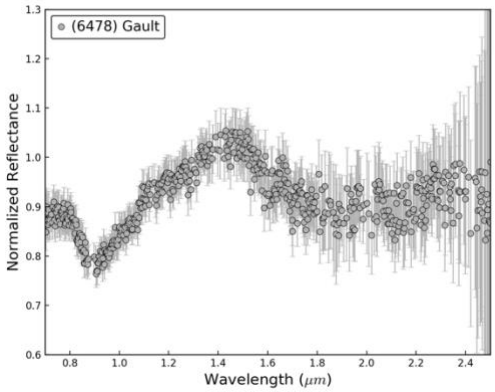

Figure 2. NIR spectrum of (6478) Gault obtained using the SpeX instrument on NASA IRTF on March 26, 2019. The spectrum exhibits two absorption bands at ~1- and 2-μm due to the presence of olivine and pyroxene.

Spectral band parameters, including the Band I center, were extracted and used along with the equations of [7] to determine the composition of the asteroid, which was found to be consistent with H chondrite meteorites (Fig.3). These results favor a compositional affinity between Gault and asteroid (25) Phocaea, and rules out a compositional link with the Tamara family.

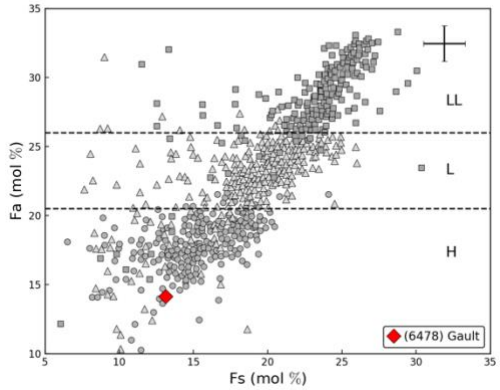

Figure 3. Iron abundance in silicate minerals on Gault represented as Mol % of fayalite (Fa) vs. ferrosilite (Fs). Measured values for LL (squares), L (triangles), and H (circles) ordinary chondrites from [8] are also included. The error bars in the upper right corner correspond to the uncertainties derived by [7], 1.3 mol% for Fa, and 1.4 mol% for Fs. Figure adapted from [8].

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4. References

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