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# Fast Rotation and Trailing Fragments of the Active Asteroid P/2012 F5 (Gibbs)

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## Abstract

We observed active asteroid P/2012 F5 with Keck II in August 2014. The data show previously undetected 200-m scale fragments of the main nucleus and reveal a very short nucleus rotation period of $3.24 \pm 0.01$ hr. P/2012 F5 is the first fragmented minor body with a known spin rate, and this spin rate turns out to be fast enough to associate the disruption with the large centrifugal forces. The results have been published [1].

## 1. Introduction

Rapid rotation has been often suspected of triggering fragmentation of comets and asteroids, and has been suggested as the likely cause of impulsive dust ejection from the surfaces of some small asteroids [2]. The so-called rotational disruption is the expected final state of the sublimation- or YORP-driven spin-up. This hypothesis could not be fully tested, however, because the rotation rate was not robustly measured for any fragmented comet or impulsively-active small asteroid. At the same time, none of the rapidly-rotating asteroids was observed to eject sizable fragments at the present-day epoch.

## 2. Observations

In early 2014 we started systematic observations of fragmented comets and disrupted asteroids, aimed at measuring their rotation periods from optical light curves. Given the small sizes and thereby intrinsic faintness of the targets, the observations required the largest optical telescopes. To date, we have successfully obtained data with Keck I, Keck II, Gemini North and Magellan Baade telescopes. Here we report the results of our observations of P/2012 F5 (Gibbs) obtained with Keck II / DEIMOS on UT 26 August 2014.

The object was discovered on UT 22 March 2012 by A. R. Gibbs with the Mt. Lemmon 1.5-m telescope and classified as a comet with an orbit in the main asteroid belt [3]. Shortly after, two teams showed that the trailing dust was emitted in a single pulse about a year before the discovery [4] [5]. In 2013 another team using the 2.2-m telescope atop Mauna Kea detected a star-like nucleus with a diameter below $\sim 2$ km [6].

## 3. Results

Our Keck II data show that this upper limit is in fact very close to the actual effective diameter of the object, which we measured to be of $1.8$ km. More importantly, however, we measured a very short nucleus rotation period of $3.24 \pm 0.01$ hr (Fig. 1) and discovered four fragments of the object (Fig. 2). The fragments are embedded in the dust trail and separated from the nucleus by $3''.1$, $12''.6$, $22''.1$, and $29''.3$. The nearest two are $\sim 5$ and $4.2$ mag fainter than the nucleus, corresponding to the equivalent diameters of $180$ and $250$ m, respectively, if the objects are discrete. The two more distant fragments may be extended.

## 4. Conclusions

The short rotation period of P/2012 F5 (shortest known among active asteroids and comets) and the existence of large fragments are clear and obvious signs of rotational disruption, confirmed by our detailed analysis [1], but a different explanation cannot be completely ruled out. Interestingly, the rapid spin rate of P/2012 F5 is very close to the spin rates of two other active asteroids in the main belt, 133P/Elst-Pizarro [7] and (62412) [8], confirming the existence of a population of fast rotators among these objects. We suppose that all types of activity demonstrated by the rapidly-rotating active asteroids may have a general origin in the rotational instability of the nucleus.

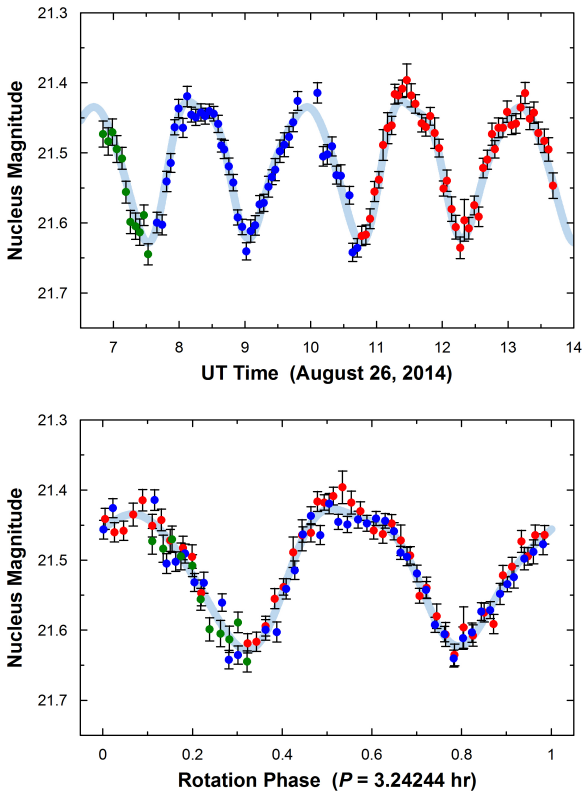


Figure 1: Periodic brightness fluctuations (R-band) of the nucleus of P/2012 F5 during two rotation cycles (coded by different colors), presented versus time (top) and versus the nucleus rotation phase (bottom).

Interesting in and of itself, that knowledge is also valuable in a broader context, as disrupting asteroids can be an important source of interplanetary dust in the zodiacal cloud and around other stars.

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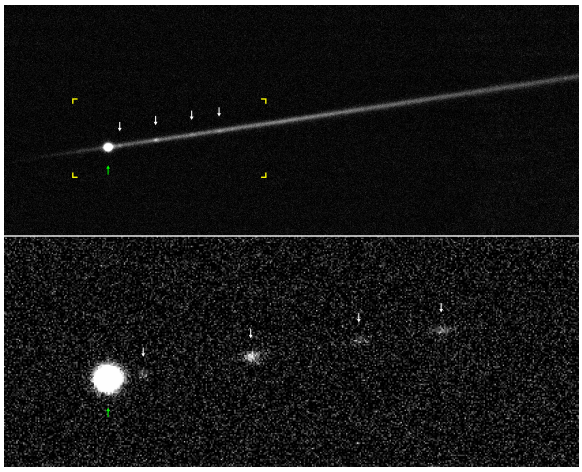

Figure 2: P/2012 F5 observed by Keck II in August 2014. The image is a stack of $92 \times 180$ and $7 \times 45$ sec R-band exposures. Top panel subtends $2.5' \times 1.0'$ and shows the main nucleus and the smaller fragments (indicated by arrows) embedded in the dust trail. Bottom panel shows a close-up view with the trail numerically removed to enhance the visibility of the fragments.

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