

# Are asteroid fragments drifting around a distant white dwarf star?

February 4 2016, by Tomasz Nowakowski

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In this artist's conception, a tiny rocky object vaporizes as it orbits a white dwarf star. Slowly the object will disintegrate, leaving a dusting of metals on the surface of the star. Credit: CfA/Mark A. Garlick

(Phys.org)—WD 1145+017, a white dwarf star located some 570 light years from the Earth, captured the attention of astronomers [last year](#), when evidence suggested that a rocky object orbiting it was being ripped apart. It was the first discovery of a planetological body transiting a white dwarf. Now, a team of astronomers lead by Saul Rappaport of the Massachusetts Institute of Technology (MIT), unveils evidence that the mysterious object is an asteroid and its fragments are drifting around this dense star remnant. A paper describing the new findings was published online on Feb. 1 in the arXiv journal.

Rappaport, together with Andrew Vanderburg from the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, were part of an international team that detected changes in brightness of WD 1145+017 using NASA's Kepler K2 mission. Their research determined that something must be transiting this white dwarf. The scientists joined forces once again to make follow-up observations of the star to get insights about the nature of objects orbiting it.

Four privately operated amateur observatories equipped with modestly sized telescopes with apertures ranging from 28 to 80 cm were used with the intention of uncovering more details regarding WD 1145+017 and its surroundings. The photometric observations were carried out on 37 nights between Nov. 1, 2015 and Jan. 21, 2016.

The team reports the detection of 237 transit events, more specifically, significant dips in flux. These dips are probably the effect of obscuration by dust from bodies orbiting around the white dwarf. The scientists managed to observe six to ten dips per orbit, tracking down 15 independent drifting features orbiting the star with periods near 4.5 hours.

"Some 237 significant dips in flux were observed during 192 hours of exposure... We find some 15 dip features that repeat from one night to

the next, and typically last for a few weeks," the researchers wrote in the paper.

The object is being ripped apart by intense gravity, and is in the process of vaporization by starlight. Rappaport's team argues that the drifting motion is caused by fragments breaking off from the asteroid and going into a slightly smaller orbit than that of the asteroid.

"There is a substantive, long-lived body in the 4.5-hour orbit (the asteroid), which loses fragments of matter that are a tiny fraction of its total mass, and that naturally go into slightly shorter period orbits," the paper reads.

The scientists were even able to determine the mass of the object that is braking apart, deriving it from the drift rate. They assume that the asteroid has about 10 percent of the mass of dwarf planet Ceres in our solar system.

The researchers found out that the drift rates of the different features are rather similar to each other, but are not all exactly the same. According to the study, at least some of the drifting dip features in the light curve seem to have limited lifetimes, lasting few weeks. The release rate of the fragments was estimated to be one piece every few days. The computations made by the scientists show that if the current activity level is maintained, the expected lifetime of the asteroid would be about 5,000 years.

The team concluded that the study showed changes in overall activity level of this source on timescales of only 2.5 months. Thus, they urge long-term observations with larger telescopes covering as wide a wavelength range as possible to determine the wavelength dependence of the dips on larger timescales. This would allow a deeper look into the nature of this curious distant object in the process of vaporization.

**More information:** Drifting Asteroid Fragments Around WD 1145+017, arXiv:1602.00740 [astro-ph.EP] [arxiv.org/abs/1602.00740](https://arxiv.org/abs/1602.00740)

## Abstract

We have obtained extensive photometric observations of the polluted white dwarf WD 1145+017 which has been reported to be transited by at least one, and perhaps several, large asteroids (or, planetesimals) with dust emission. We have carried out 53 observation sessions on 37 nights, totaling 192 hours, of this 17th magnitude star with small to modest size telescopes covering the interval 2015 November 1 to 2016 January 21. In all, we have detected some 237 significant dips in flux. Periodograms of the data reveal a significant periodicity of 4.5004 hours that is consistent with the dominant ("A") period detected with K2. The folded light curve at this period shows there is an hour-long depression in flux with a mean depth of nearly 10%. This depression is comprised of a series of shorter and sometimes deeper dips that do not always occur at exactly the same orbital phase, and which would be unresolvable with K2. In fact, we also find numerous dips in flux at other orbital phases. Nearly all of the dips associated with this activity appear to drift systematically in phase with respect to the "A" period by about 2.5 minutes per day with a dispersion of  $\sim 0.5$  min/d, corresponding to a mean drift period of 4.4928 hours. In all, we can track approximately 15 of these drifting features. There is no detection of the "B"- "F" periods found with K2, but if they remain at the K2 levels we would not expect to have seen them. We explain the drifting motion as that of smaller bodies ('fragments') that break off from the asteroid and go into a slightly smaller orbit than that of the asteroid. If our interpretation is correct, we can use the drift rate to determine the mass of the asteroid. Under that scenario, we find that the mass of the asteroid is  $M_a \sim 10^{23}$  grams, or about 1/10th the mass of Ceres, with an uncertainty of about a factor of 2.

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