Misidentification of TYC3055-988-1 as a Variable Star in the KELT Survey

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The Kilodegree Extremely Little Telescope, hereafter KELT, is a telescope array that is surveying millions of stars looking for exoplanets. While doing this, it has generated light curves for a large sample of bright objects. From this data the KELT survey has identified over fifty thousand stars as variable objects (Oelkers et al. 2018). This list was compared to the American Association of Variable Stars Observers archive and fewer than twenty thousand of the stars had been previously identified as variable stars. From this sample we

selected a number of targets with potential to be short period pulsating stars that we could examine at a higher cadence using our group of small robotic telescopes. One of these targets, J15265381+4035414, seemed like an ideal target. It was listed as having a magnitude of $V = 11.48$ and a period of 0.11563 day (2.775 hr). The coordinates given for this target corresponded to TYC 3055-9880-1. Here we will discuss the results of a deeper examination of this target.

To supplement the data provided by KELT we gathered time series data from a number of online sources including the ASAS-SN (Jayasinghe et al. 2018) and ATLAS (Heinze et al. 2018) sky surveys. Searches were made in a 2' region around the coordinates provided by KELT, given the high plate scale for KELT. We also obtained new time series data on the field of TYC 3055-988-1 in 2019 May using the Johnson *V* band (see Figure 1(b)). Three nights were obtained with the 0.25 m telescope from BYU's Orson Pratt Observatory and one was obtained with BYU's David Derrick 0.4 m telescope. The data were processed using standard protocols with IRAF and light curves were generated using AstroImageJ (Collins et al. 2017).

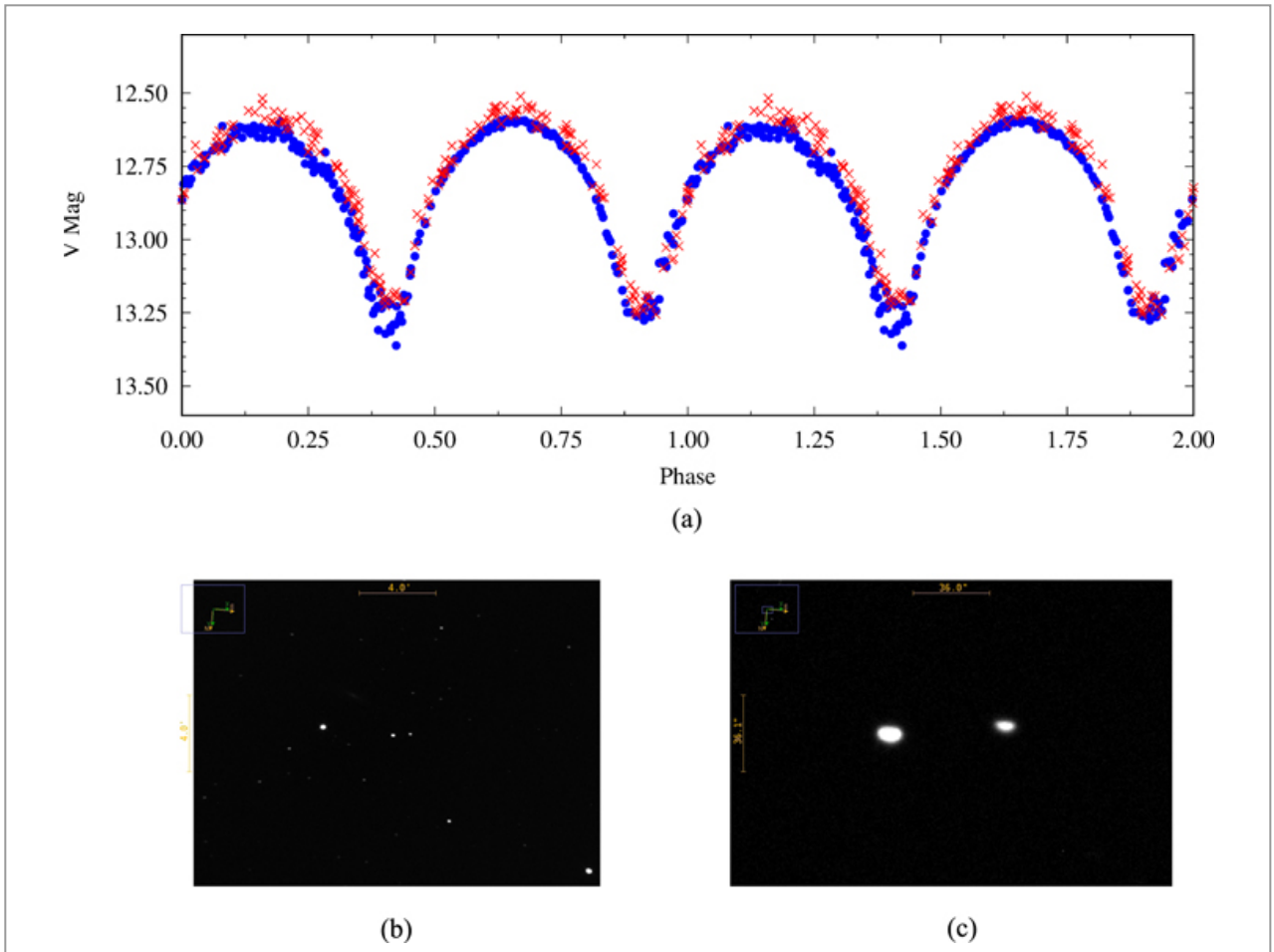

Figure 1. Top image is the light curve produced by superimposing phased data taken with BYU Telescopes (blue circles) and ASAS-SN data (red x's). The image in the bottom left of the figure shows the field of view for the telescopes at BYU. The image on the bottom right shows the separation of the genuine variable on the right and the star KELT misidentified.(The data used to create this figure are available.)

TYC 3055-988-1 had a reported a period of 2.77 hr in the KELT catalog. However, when we examined the ASAS-SN data, we found a period of 3.139 hr using a Fourier decomposition in Period04 (Lenz & Breger 2005). These two periods differ by almost thirty minutes, which prompted us to investigate this system further. When we generated the light curves for the field of TYC 3055-988-1 using our BYU data, we found that a star 36" away was the source of the variation identified by KELT (see Figure 1(c)). We found that this star was a previously identified eclipsing binary system by the Catilina sky survey (Drake et al. 2014) as CRTS J152658.4+403531. When we determined the true source of light variations we searched the

ASAS-SN database using the coordinates of the known variable and found that it had also identified the correct star. Both surveys reported a period of 6.278 hr, twice the period that we found using the ASAS-SN data.

Using the 6.278 hr period we phased the BYU data and found that the depths of the two eclipses differed by less then 0.03 mag in *V* as shown in Figure 1(a). This similarity in depth caused Period04 to identify the minima as identical and report half of the actual period. In Figure 1(a) we do note that while the ASAS-SN data has very similar depths, our data has a deeper drop on one eclipse. Gathering all the data we checked for any evidence of a period change. Based on the entire data set we found that the period was staying constant within 10^{-4} hr. This was determined using 582 data points obtained within the last 24 months.

We believe the incorrect star was identified due to the high plate scale of 23" per pixel that KELT uses. This allows for a separation of less then two pixels for the stars on the detector which would have resulted in blending. We believe KELT identified TYC 3055-988-1 as the variable because it is brighter by 1.4 mag in the *V* filter. However, this does not explain the misidentification of the period in the KELT database. We obtained the data the KELT survey used to determine the variability of the star to see if we could find a reason for the error in identifying the period. We found that we were able to identify a period of 3.139 hr, half of the correct period of 6.278 hr. To eliminate spurious variables KELT excludes periods near several observational aliases. We found that while this period does not fall into one of those regions the KELT team also excludes periods that have multiples that fall within those regions. The period we found has a multiple of 0.5232 days which falls in the 0.5 ± 0.025 exclusion band from the KELT survey. This indicates that the correct period was rejected and a shorter period of 2.77 hr was reported.

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