Search for Binaries in the Kepler K2 Fields Using Pulsation Timing Method

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Finding orbital solutions of binaries which have small mass ratios (<0.4) and long periods (>50 days) is challenging using traditional techniques. The radial velocity method is a good way to detect such binary stars, however it requires large telescopes. Therefore, the search for binaries in those regions is still incomplete. For binaries in this regime with at least one component that pulsates, pulsation timing is a better approach. Orbital solutions for such systems can be obtained from the periodic change in pulse arrival times as the star’s reflex motion is manifested by the changing distance along the line of sight. We present a search for binaries with δ Scuti variables in the Kepler K2 extended mission fields. We used the K2 long-cadence (sampling time = 29.45-min) light curves, which are suitable to detect pulsation periods of a few hours as in δ Scuti stars. The observation span for the Kepler K2 mission is about 80 days. Binary candidates which show evidence of periods longer than the K2 temporal window can be observed using space telescopes like TESS and ground-based 1-m class telescopes.

### Data and Methods

To find the δ Scuti variables in the K2 archive, we used the same method as Murphy et al. (2017). Long cadence (exposure time = 29.45-min) light curves were extracted for all targets in the K2 Campaign 1 and 2 with effective temperatures between 6600 K and 10000 K. This temperature range includes all δ Scuti pulsator. It also avoids the rapidly increasing number of stars without coherent pressure modes beyond the instability strip's lowest temperature edge, and also excludes the pulsating B stars. The discrete Fourier transform DFT) between 5.0 -43.9 d⁻¹ (which is the lowest and the highest possible p-mode δ Scuti variable frequencies) was calculated for each light curve obtained. Although the light curve Nyquist frequencies are 24.48 d⁻¹ and 43.9 d⁻¹, for Kepler and K2 data, respectively, they are easily distinguishable from expected pulsational peaks (Murphy et al. 2014). The stars which have pulsation amplitudes below 0.01 mmag were removed as non-pulsators. Otherwise, up to two peaks (which has pulsation amplitude larger than 0.01 mmag) were used in the pulsation timing analysis. Did you mean 0.01? We found only one pulsating binary system in which the orbital period is less than the observation time span ~ 80 days. We are planning to obtain the orbital solutions of all stars in the K2 field using the pipeline we made. Also, some of the TESS observation fields will be observed for more than 80 days, stars in those field also will be good targets for this survey. So far, only a few binary systems with orbital periods around 100 days are known. Therefore, each new discovery substantially improves the statistical significance of the present sample.

### Conclusion and Future Research

We searched all K2 Campaign 1 and 2 long-cadence (sampling time ~ 29.45-min) light curves. These data are suitable to detect pulsation periods of a few hours, typical of δ Scuti stars. Among 815 stars with 6600 < T_eff < 10000, only 69 stars showed pulsations. Among these 69 pulsating stars, only 1 is a clearly a binary with period of less than 80 days. We are planning to obtain the orbital solutions of all stars in the K2 field using the pipeline we made. Also, some of the TESS observation fields will be observed for more than 80 days, stars in those field also will be good targets for this survey. So far, only a few binary systems with orbital periods around 100 days are known. Therefore, each new discovery substantially improves the statistical significance of the present sample for stars with large pulsation amplitudes (> 1 mmag), we can also use 1-m class ground-based telescopes for the follow-up observations. This project is well-suited for undergraduate student participation.

### References


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